

# The Multi-talented:

# PM 2000 HP

**pH-, redox-, temperature- and conductivity measurement with a single instrument!**

## Precision meter PM 2000

Automatic sensor recognition  
i. e. pH / redox amplifier or conductivity cell can be retrofitted at any time

Sturdy coated aluminium housing

Illuminated display:  
8 digits x 14 segments

Simple handling due to clear user guide

ON / OFF

Kind of measurement  
pH / mV / °C /  $\mu$ S / mS

Automatic pH calibration with CAL

Battery operation built-in charger, mains adapter included

Enclosure rating: IP65

**Conductivity measurement**  
Art.No.: 2000 0241

Conductivity cell useable up to 100°C for short time material: ABS

**Temperature measurement**  
Pt 1000 sensor

Low-polarisation graphite

Completely in case  
Art.No.: 2000 0190

Coiled sensor cable

pH / redox preamplifier with temperature probe  
Art.No.: 2000 0030

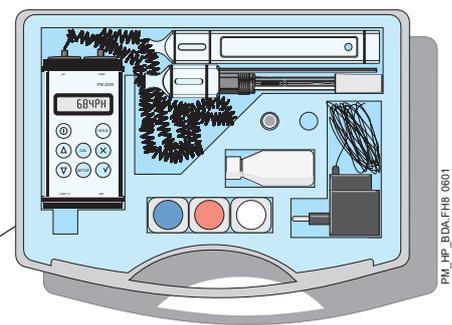
Screw plug head AS7

**Temperature measurement**

Pt 1000 sensor

**pH-measurement**  
Art.No.: 0020 3...

Combination pH electrode pH 62 / Inlab 412 / pH 120 or combination redox electrode RX 110

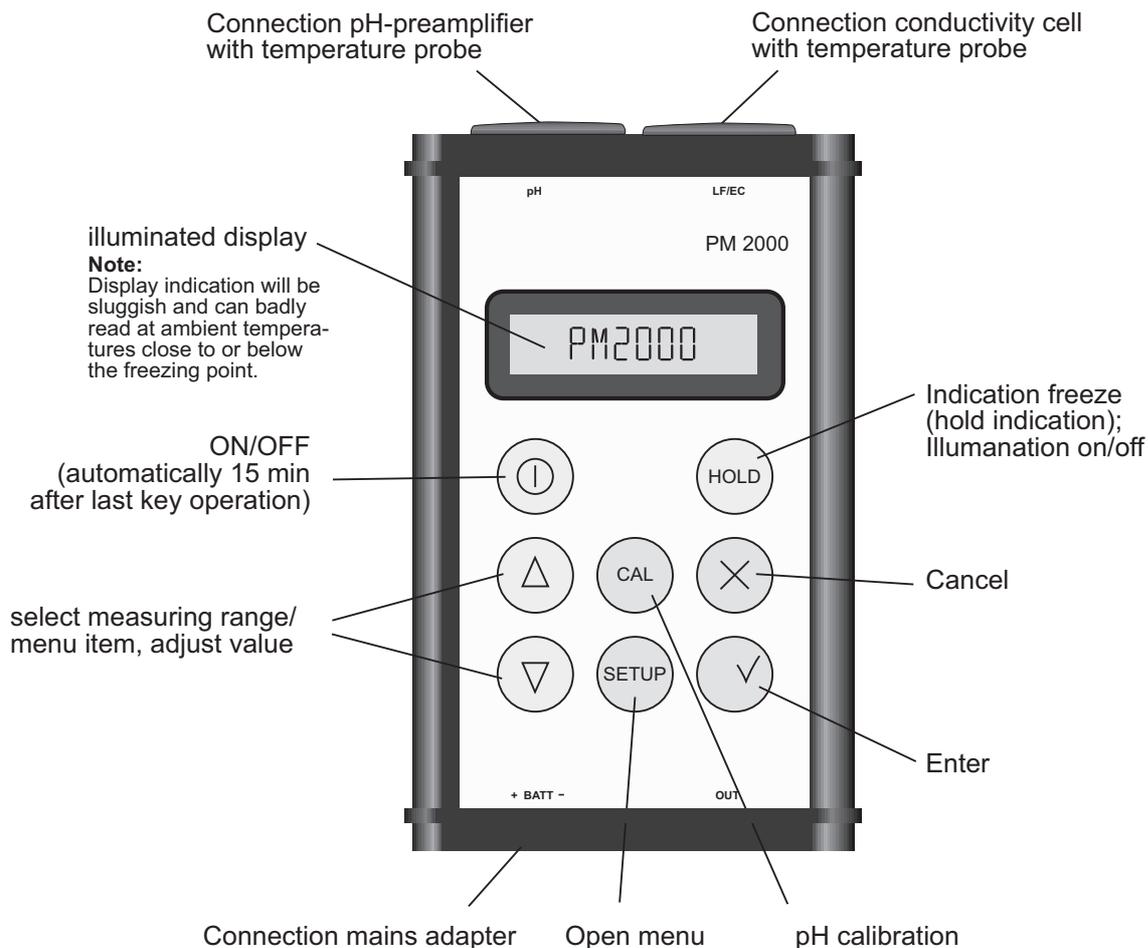


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# INSTRUMENT OVERVIEW

## OPERATING ELEMENTS:



## MAINS ADAPTER

- For continuously operating the PM 2000 on the mains supply.
- For charging the internal accus.

## CONNECTION

- Plug the two pins (red + black) of the mains adapter into the sockets provided at the bottom of the instrument. Please observe correct polarity!

## CHARGING THE ACCUS

1. If the accu is low, "LoBat" is indicated on display alternating with the measured value during operation.
2. If the accu is completely discharged there is no indication on the display.
3. Connect mains adapter.
4. If the instrument is switched off, "DISCHARG." is indicated on the display. The recharge of the accus will be completely discharged. This process takes about 2,5 - 3 hours.
5. Afterwards the accus will be charged (indication, instrument is switched off: "CHARGE").
6. If the accu is fully charged, the indication "CHARGE" turns off. (If the instrument is switched on, there is no message.)

ATTENTION: Before charging, the unit should be warmed up to room temperature.

# BRIEF INSTRUCTION PM 2000

-  Switch on (1 sec. sensor indication and 1 sec. "CONTR").
-  Switch off (the instrument also switches off automatically 15 min after the last key operation)
-    Adjust contrast (one of the keys must be pressed during the indication "CONTR")
-   Select operating mode e.g. →pH → REDOX → EC → TEMP →
-  Freeze the indication (indication is flashing)  
 press appr. 2 sec.: switch display illumination on/off  
 (illumination automatically switches off after 5 minutes)
-  pH calibration 2 sec when the display shows "pH"  
 Redox zero point when the display shows "mV"  
 Conductivity temperature coefficient when the display shows "µS/mS"  
 Source of temperature measurement when the display shows "□□"

 (2 sec.)	TC - XX X	Set conductivity compensation method and temperature coefficient.	   
	RT XX □ □	Adjust conductivity reference temperature.	   
	CC XXXXX	Adjust cell constant.	   
	PH / XX	Switch redox range on/off. Determine offset voltage of redox electrode. This requires a redox reference solution.	   
	TEMP XX	Select temperature probe for temperature indication	   
	ENGLISH	Select menu language.	   
	MANUF AC	Indication of serial and version number	

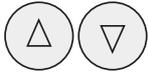
 Enter

 Cancel

## BRIEF INSTRUCTION - pH CALIBRATION



- Switch on (1 sec. sensor indication and 1 sec. " [ONTR]").



- Select pH-range (indication: " XXXXPH ").

- Remove protection cap of pH electrode.

- Rinse the electrode (if possible in destillated water).

- Immerse pH-electrode in buffer solution (calibration possible with pH7 / pH4 or with pH7 / pH9).



- Calibration is started " PH 1 [ ] wait... " [ 7.00PH ].

- Rinse the electrode.

- Immerse electrode in second buffer solution.



- " [ PH2 [ ] wait... " [ 4.00PH ].



- Steepness and zero position " +XXXZ/XXXS " are indicated.

**ATTENTION:** - If indication " +XXXZ/XXXS " is flashing, there must be a fault (see also notes on faults/error messages)

Clear fault and repeat calibration.



- Back to measurement indication.

- The calibration process can be cancelled at any time with .

# WORKING WITH THE INSTRUMENT

## SWITCH ON THE INSTRUMENT:

Press .

The instrument type is indicated for approx. 1 sec. (e.g. "PH-EE").

Indication "CONTR" appears for approx. 1 sec.

## ADJUSTING THE CONTRAST:

If the display indicates ".CONTR.", you can adjust the contrast

of the display by pressing the keys  and .

Enter the new contrast setting by  or retain the last setting by .

## SWITCHING DISPLAY ILLUMINATION ON / OFF:

Press  for at least 2 seconds to switch display illumination on / off. Display illumination automatically switches off after 5 minutes.

Please note: Display illumination is not visible at bright ambient light.

## ADJUSTING THE MEASURING RANGE:

By the keys  .

## HOLD THE CURRENT MEASUREMENT ON THE DISPLAY:

Press .

The indication is flashing; the measurement is frozen.

Press  or  to release the measurement.

## SWITCHING OFF:

The instrument switches off approx. 15 min after the last key has been operated; or press .

# MEASUREMENT

## TEMPERATURE:

- Select temperature range by  or  (indication: "X X X.X °C").
- Depending on selected temperature probe, immerse the probe in the medium and move it gently.
- If the pH electrode has to be screwed off for temperature measurement, connections of preamplifier and of pH-electrode must be protected against dirty, by putting on the protection caps.
- Read the measurement.
- Press  to check the source off temperature indication (pH- or e.C. probe)

## CONDUCTIVITY:

(only with e.C.-T, pH-e.C.)

- Select conductivity range by  or  (indication "X X X.X µS").
- Immerse conductivity cell in the medium. By moving gently possible air bubbles remaining in the contact space of conductivity cell are removed.
- For measurement, do not move conductivity cell and do not let it stand on the vessel bottom or let touch the vessel wall.
- If the indication is zero, select a smaller range with .
- If the reading is "1 . mS" or "1 . µS", select a larger range by .
- If a measurement is not credible, you should check the setting of the temperature coefficient by  or in SETUP. Changing the temperature coefficient is only possible in SETUP.  
Also check the cell type set in SETUP.

## **Warning:**

Conductivity cell is only operatable in watersoluble mediums, otherwise measuring contacts will be affected and therefore results will be wrong!

# MEASUREMENT

## REDOX:

(only with pH-T, pH-e.C.)

- For measurement of redox-voltage you have to exchange pH-electrode against a redox electrode (redox combination electrode).
- Select redox range by  or  (indication: "X X X X mV")
- Remove protection cap of redox electrode.
- Immerse the electrode in the medium and move it gently.
- Read the measurement.
- Rinse the redox electrode.
- Slide the protection cap back on the electrode.
- If the reading is not credible, you can indicate the offset of your redox electrode by  or determine it again in SETUP.

## pH:

(only with pH-T, pH-e.C.)

- Select pH range by  or  (indication: "X X X X pH").  
If " - - - - pH " is indicated there is no valid pH calibration.
  - Remove protection cap of pH electrode.
  - Immerse the electrode in the medium.
  - Read the measurement.
  - Slide the protection cap back on the electrode.
  - If the reading is not credible, re-calibrate the electrode.
- The pH value of oil, fat, and solvents not miscible with water can be determined by extraction. Direct measurement in such media is not possible, also not in resin solutions, paints, varnish or similar.

## ADJUSTMENTS

### CONDUCTIVITY:

(only with e.C.-T, pH-e.C.)

- Select conductivity range by  or  (indication: "XXXX µS").
-  "TKXX□/□" adjusted temperature coefficient is indicated.
- The temperature coefficient is only indicated by  ;  
it can only be changed in SETUP.
- By  or  back to measurement indication.

### Switching on/off automatic conductivity range selection: (only with e.C.-T, pH-e.C.)

- While instrument is switched off, keep  pressed.
- Switch on the instrument.
- Repeat operation for switching off the automatic conductivity range selection.

### REDOX

(only with pH-T, pH-e.C.)

- Select redox range by  or  (indication: "XXXX mV").
-  "N XX mV".
- The redox offset voltage setting is indicated.
- The offset is indicated by  ; it can be new determined only in SETUP.
- By  or  back to the measurement indication.

# SETUP CONDUCTIVITY ADJUSTMENTS

## CALLING UP SETUP:

Press  for at least 2 sec.

## ADJUSTING LINEAR TEMPERATURE COEFFICIENT (only e.C.-T, pH-e.C.)

Here you can set the temperature coefficient for conductivity between 0.0% and 3.9%.

Step	Key	Indication	Note
1	 at least 2 sec.	SETUP	Calling up setup
		TC-NAT	
2		<del>TC-NAT</del>	Indication flashes
3	 or 	<del>TC-LIN</del>	Switching method
4		TC <u>X</u> X <sup>0</sup> / <sub>0</sub>	Entering method
5	 or 	TC <u>1</u> X <sup>0</sup> / <sub>0</sub>	Predecimal place
6	 (  = cancel)	TC 1 <u>X</u> <sup>0</sup> / <sub>0</sub>	Entering figure
7	 or 	TC 1 <u>2</u> <sup>0</sup> / <sub>0</sub>	First decimal place
8	 (  = cancel)	TC-LIN	Entering figure
9			Escaping setup

## SETTING TEMPERATURE COMPENSATION FOR NATURAL WATERS

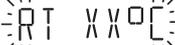
(only e.C.-T, pH-e.C.)

Step	Key	Indication	Note
1	 at least 2 sec.	SETUP	Calling up setup
		TC-LIN	
2		<del>TC-LIN</del>	Indication flashes
3	 or 	<del>TC-NAT</del>	Switching method
4	 (  = cancel)	TC-NAT	Entering method
5			Escaping setup

## SETUP CONDUCTIVITY ADJUSTMENTS

### SETTING REFERENCE TEMPERATURE FOR CONDUCTIVITY MEASUREMENT: (only with e.C.-T, pH-e.C.)

- The reference temperature for temperature compensation can be switched between 20°C and 25°C.

Step	Key	Indication	Note
1	 at least 2 sec.	SETUP	Calling up setup
		TC-XXX	
2		RT XX°C	
3			Indication flashes
4	 or 		Changing ref. temp.
5	 (  = cancel)	RT XX°C	Entering ref. temp.
6			Escaping setup

### SETTING CELL CONSTANT :

(only LF-T, pH-LF)

Cell constant adjustable from 0,8999 to 1,4999 .

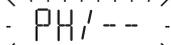
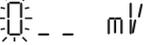
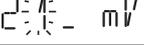
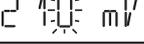
Schritt	Key	Indication	Note
1	 at least 2 sec.	SETUP	Calling up setup
		TC-XXX	
2	  ...	CC XXXXX	Current cell constant
3		CC  XXXX	First digit begins blinking
4	 or 	CC  XXXX	Enter first digit
5	 (  = cancel)	CC 1.272°C	Enter all other digits
6			Escaping setup

## SETUP REDOX

### SETTING OFFSET POTENTIAL OF REDOX ELECTRODE (pH-e.C., pH-T)

To determine the offset of your redox electrode:

- Remove protection cap of your redox electrode and rinse the electrode.
- Immerse electrode in redox reference solution.

Step	Key	Indication	Note
1	 at least 2 sec.	SETUP	Calling up setup
		TC-XXX	
2	  ...	PH/--	
3			
4	 or 		
5			Enter the redox potential of the redox reference solution
6	 or 		
7	 (  = cancel)		
8	 or 		
9	 (  = cancel)		
10	 or 		
11	 (  = cancel)	21.6 	Offset is measured
		N XX mV	Determined offset
12		PH/RX	
13			Escaping setup

- ATTENTION:**
- In future, determined offset will be considered automatically at each redox measurement and correct result will be indicated.
  - If the message "FAIL G" is indicated the divergence of zero offset of redox electrode is too high and can not be compensated automatically. In this case the offset is reset to zero.
  - If offset or error message is indicated, the last offset is cancelled !

## SETUP

### SELECTING TEMPERATURE PROBE FOR TEMPERATURE INDICATION (pH-e.C. only)

TEMP PH - for indicating the temperature range the temperature sensor of the pH preamplifier is evaluated.

TEMP EC - here the temperature sensor of the conductivity cell is evaluated.

Step	Key	Indication	Note
1	 at least 2 sec.	SETUP	Calling up setup
		TC-XXX	
2	 ...	TEMP PH	
3		<del>TEMP PH</del>	Selecting source
4	 or 	<del>TEMP EC</del>	
5	 (  = cancel)	TEMP EC	Entering
6			Escaping setup

### INDICATION OF THE SERIAL NUMBER

MANUFAC - here the instrument serial and version number are indicated.

Step	Key	Indication	Note
1	 at least 2 sec.	SETUP	Calling up setup
		TC-XXX	
2		MANUFAC	
3		N0XXXXXX	Serial number
4	 (  = cancel)	V 103	Version number
5	 (  = cancel)	MANUFAC	
6			Escaping setup

# PROBE DESCRIPTION

Conductivity cell



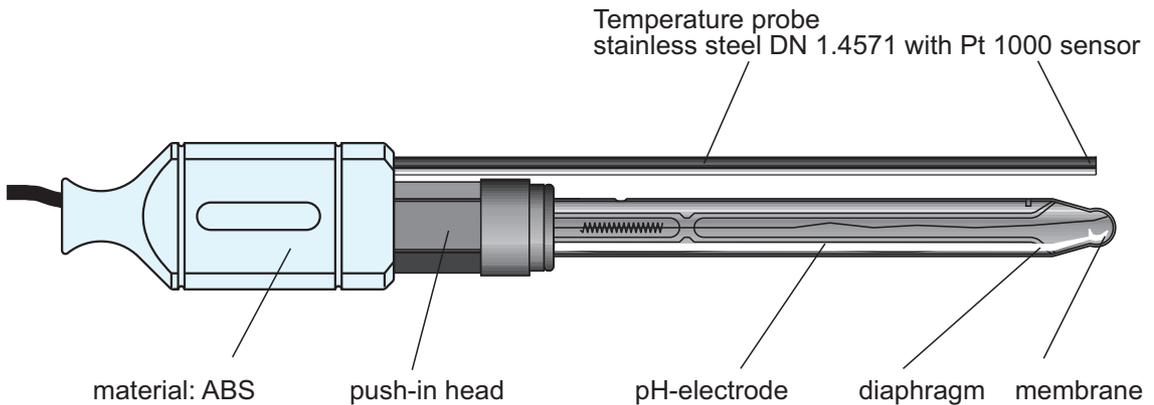
material: ABS

Temperature probe Pt 1000 sensor

Low-polarisation  
graphite electrodes

**Warning:** Conductivity cell is only operatable in watersoluble mediums, otherwise measuring contacts will be affected and therefore results will be wrong!

pH preamplifier  
with pH electrode



material: ABS

push-in head

pH-electrode

diaphragm

membrane

Temperature probe  
stainless steel DN 1.4571 with Pt 1000 sensor

# MAINTENANCE NOTES

## pH electrodes:

### Cleaning:

Any contamination deposited on the glass membrane has to be removed. If careful wiping with a moist soft tissue does not prove successful, various chemical cleaning methods can be used depending on the type of contamination.

Experience has shown that the following agents can be used for cleaning glass electrodes:

With fat and oil contamination: cleaner containing detergents, domestic detergent cleaners.

With lime deposits and metal hydroxide coatings: dilute hydrochloric acid (10%).

With deposits containing sulfides (e.g. wastewater treatment): a cleaner mixture of dilute hydrochloric acid (10%) and thiourea (saturated).

With media containing proteins (measurements on foodstuffs): a cleaner mixture of dilute hydrochloric acid (10%) and pepsin (saturated).

As regenerating solution for very sluggish pH electrodes: a fluoric acid mixture consisting of nitric acid (10%) and ammonium fluoride (50 g/l).

For cleaning dirty diaphragms it is possible to use the same methods as for glass electrodes. Diaphragms blocked by precipitated silver chloride (through prolonged contact with low-ion water) or silver sulfide (measurement in sulfide-containing media) which have a brown or black colouration; can possibly be made operatable again by treatment with 28% ammonia solution or a special diaphragm cleaning solution. At severe dirtying there is the possibility to file the surface of the diaphragm (only of the diaphragm) with a fine nail file. (Only possible on glass electrodes).

**Warning!** Observe protective precautions handling solutions containing acid. Always rinse all parts in deionised water after cleaning.

### Short-term / long-term storage:

-Short-term storage of electrodes (not suitable for pH-120)

In principle all electrodes should be stored in a 3 mol/l potassium chloride solution; for correct operation of the glass electrode the presence of the water-containing film on the surface of the membrane glass is an essential requirement.

- Long-term storage of electrodes:

All electrodes which are not being used for longer periods are best stored in dry areas at 10 - 30°C, i.e. the protection cap contains no liquid. Before use, the electrodes must be soaked for 24 hours in a 3 mol/l potassium chloride solution (formation of the membrane layer).

Electrodes are only determined storable.

It is recommendable not to exceed storage period of 6 months.

For gel-filled electrodes it is essential to store them in 3 mol/l potassium chloride solution. Refill the protection cap every 3 - 4 weeks.

**Important:** At temperatures below -5°C the electrodes may fracture through freezing of the internal buffer and the internal electrolyte. Ensure that packaging is protected against frost when shipping.

## Conductivity cell:

Occasional cleaning of the electrode surface with a commercially available cleaning detergent (with a small tooth brush) is recommended. Otherwise the conductivity cell requires no maintenance.

**Warning:** Conductivity cell is only operatable in watersoluble mediums, otherwise measuring contacts will be affected and therefore results will be wrong!

## Please note:

- The mains adapter supplied is only intended for use in dry areas (**protect it against moisture**).
- Never try to re-charge non-rechargeable accus (**danger of explosion!!!**)
- Ensure correct polarity of the accus , otherwise the instrument may suffer severe damage.
- Use only nickel-cadmium or nickel-metal hydride accus. Do not use lead-ion or lithium-ion accus.
- Cadmium is a poisonous heavy metal. Nickel-cadmium accus are no ordinary rubbish; so you have to lead it to recycling or dispose it as special waste.

# MAINTENANCE NOTES

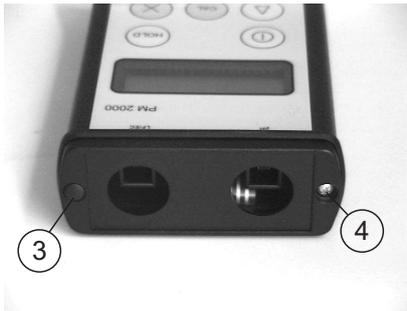
## Accu replacement:

Replace the accu only if they are obviously damaged or if its operating life is distinctly reduced.  
Replacement should take place in a dry and clean environment.

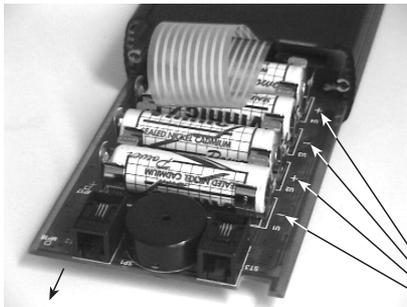
**DANGER!!!! Sensitive electronic components and the display can easily be damaged when replacing the accu.**



1. Pull off the rubber sleeve.
2. Push down locating lug on the plug and pull off the cable.



3. Lever out screw caps with a sharp object (e.g. needle).
4. Release screws and remove cover with seal.



- Pull out the board as far as all four accu are accessible (ill.)

**WARNING: FITTING ACCUS WITH INCORRECT POLARITY  
MAY DESTROY THE INSTRUMENT !!!**

- Remove the accu by hand or with a blunt and non-metallic object.
- Fit new accu according to the marking on the board.  
There must be no mechanical force on the display at the opposite side of the card.

**NOTE: Use only fully charged or rechargeable accu 1.2 V, type AA.**

- Carefully slide the board back into the housing.
- Re-assemble the instrument in reverse order.
- Ensure that the housing cover seal is fitted correctly.

## NOTES ON FAULTS

If there should be any faults during operation or calibration, please check the following items:

Fault	Fault elimination
Instrument cannot be switched on.	- Charge accus, eventually exchange against charged accus.
<b>Temperature measurement:</b>	
Reading not credible?	- Temperature probe not immersed deeply enough in the medium ? (at least 3 cm) - (on pH-EC only) It is important to note which probe has been selected for temperature measurement in SETUP.
<b>pH measurement:</b>	
Reading not credible; time for stable measurement is too long.	- Has the instrument been calibrated ? - pH membrane dirty ? - Diaphragm dirty ?
<b>Conductivity measurement:</b>	
Reading not credible.	- Are measurement contacts clean ? - Is temperature coefficient adjusted correctly ? - Is reference temperature adjusted correctly ? - Is the correct cell constant adjusted?

## ERROR MESSAGES

Message	Explanation	Fault elimination
LoBAT	- accus is empty	- Connect supplied mains adapter, accus are charged up automatically.
NoBAT	- Accu is defect or has no contact	- Replace accus. - Check the correct position of the accus within the holders
FAIL. G	- Offset of redox electrode is too high, can no longer be compensated automatically.	- Is electrode clean ? - Is redox reference solution too old or exhausted?
+XXXX/XXS-	- Zero pos. or steepness are out of determined parameters. (tolerances)	- Have membrane and diaphragm been cleaned ? - Are buffer solutions too old or exhausted ? - Is temperature probe immersed in buffer solution ? - Exchange electrode
----PH	- There is no valid pH calibration.	- Carry out pH calibration.

## Technical Data:

subject to alterations

Ambient temperature:	0 - 50°C
Indication:	8 digits x 14 segments LCD - 7mm with switchable backlight
pH input impedance:	> 10 <sup>12</sup> Ohm
pH input current:	≤ 1 pA
Accus:	4x 1,2V, operation period up to 100 hours, accus control indication, automatic switch-off after 15 min.
Weight:	0,35 kg without probe
Housing:	aluminium (black-coated)
Warranty :	1 year, exclusive consumption articles e.g. pH-electrodes
Dimensions:	L x W x D 138 x 85 x 35 mm

### pH measurement

Measuring range:  
0,00 to 14,00 pH

Automatic temperature compensation 0 to 100°C

Indication accuracy: ±0,01 pH

Automatic calibration with buffer  
pH7.00 and pH4.00 or pH7.00 and pH9.00  
(buffer value is stated and automatically recognized)

### mV measurement (redox potential):

Voltage from -1000 mV to +1000 mV

(resolution 1mV)

Zero position for redox electrodes separately adjustable.

### Temperature measurement

Range: -50,0°C to +150,0°C

Resolution: 0,1°C,  
Accuracy: 1% or 2digit

Sensor: Pt 1000 Class B

### Conductivity measurement

Measuring range:  
0 - 99,99 µS / 999,9 µS / 9999 µS / 99,99 mS / 999,9 mS

Accuracy: up to 200mS: <2% or 8 digit  
up to 500mS: <4% or 5 digit

The measuring frequency is automatically adapted  
to conductivity (approx. 50 Hz to 110 kHz)

Temp. coeff. adjustable 0 - 3,9%  
(standard setting 2,2%)  
(natural waters)

### Temperature measurement:

Range: 0°C to 100°C

Resolution: 0,1°C  
accuracy: 1% or 2 digit

Sensor: Pt 1000 Class B

### Dimensions of conductivity measuring cell:

W x D x L = 32 x 18 x 165mm

### Combination pH electrodes Dimensions: ø12mm x L=125mm

#### All round standard pH electrode with plastic shaft

Combination pH electrode **pH 62**  
1 - 12 pH, 0 - 60°C

#### Precision pH electrode with glass shaft

Combination pH electrode **InLab 412**  
0 - 14 pH, 0 - 100°C

Combination pH electrode **pH 120 - 3xL -Dia**  
0 (1) - 14 pH, 0 - 100°C  
fast, stable indication, insensitive to contamination,  
long life, long-term zero stability

### Carrying case:

Practical and convenient case, very suitable for use on site.

This portable battery operated analysis meter is suitable for every application. In the laboratory, in production, in wastewater treatment, in routine measurements on site, in all situations where precise measurements are required.

# APPENDIX

## General information:

### What is pH?

pH is the abbreviation of "potentia hydrogenii", or concentration of hydrogen. PH is the logarithmic unit of hydrogen ion concentration. Its scale extends from  $10^{-14}$  to  $10^0$ . For simplification the exponent is specified without sign. pH 7 therefore means a hydrogen ion concentration of  $10^{-7}$  or 1 gramme hydrogen ions at  $10^7$  gramme water.

### What is the significance of pH?

A high concentration of hydrogen ions in water means acidic water; a low concentration means alkaline water. At a concentration of  $10^{-7}$  = pH 7 the reaction is neutral. pH values below 7 are characterising acidic liquids, those above pH 7 alkaline liquids. Because of the logarithmic scale unit, each whole number on the pH scale represents a 10-fold increase in acidity (degree of alkalinity). Today pH measurement is used in wide areas of industry, medicine, pharmaceutical industry and research.

### How does an electronic pH meter work?

A glass measuring probe is immersed in the water to be examined. The probe is linked by a cable to a battery-operated measuring instrument. The electrical voltage generated by the probe depends on the pH. A high-sensitivity amplifier processes this measuring signal and passes it to the digital display. The accuracy of the instrument can be checked at any time by using two precisely adjusted calibration solutions (buffer solutions).

### How long does a pH measurement take?

The time required by a pH electrode to provide a stable measurement extends from a few seconds to several minutes. It depends on the construction and on the age of the electrode, as well as on the consistency and the temperature of the solution tested.

### What is redox potential and what is the purpose of redox measurement?

The concept "redox" is an abbreviation for the simultaneous reactions of reduction and oxidation. Oxidation is understood to be not only the absorption of oxygen but also quite generally the absorption of a positive charge or the loss of negative charges. Reduction is understood to be the reversal of these processes.

### How is the redox potential measured?

This requires a platinum electrode and a pH meter with a mV range. The platinum electrode is immersed in water like a pH electrode and the result of the measurement is readable after some time.

### What is conductivity?

Conductivity generally is measured as specific conductivity. Liquids conduct an electric current through ions. The more ions, the higher the conductivity. Units:  $\mu\text{S}/\text{cm}$  (micro-Siemens per centimetre) or  $\text{mS}/\text{cm}$  (milli-Siemens per centimetre).

### What is the significance of conductivity?

Most of the ions contained in water are parts of dissolved salts. For example, common salt (formula: NaCl) is divided into a positive sodium ion ( $\text{Na}^+$ ) and a negative chlorine ion ( $\text{Cl}^-$ ). Both ion types conduct the electrical current. Simplified, conductivity is a measurement for the quantity of dissolved salts in water.

### Reference temperature list:

Specific conductivity ( $\kappa$ ) of KCl solutions of different concentrations at different temperatures, in  $\text{R-1 cm}^{-1}$ .

Concentration	0°C	15°C	16°C	18°C	19°C	20°C	22°C	24°C	25°C
1,000n-KCl	0,065410	0,092520	0,094410	0,098220	0,100140	0,102070	0,105940	0,109640	0,111800
0,100n-KCl	0,007150	0,010480	0,010720	0,011190	0,011430	0,011670	0,012150	0,012640	0,012880
0,010n-KCl	0,000776	0,001147	0,001173	0,001225	0,001251	0,001278	0,001332	0,001386	0,001413

# APPENDIX

## pH and redox electrodes

General note:

People talk about electrodes, or combination electrodes. Most of the time they talk about combination electrodes, i.e. a combined electrode in which the reference electrode is also the reference system.

### 1. Combination electrodes:

Electrodes for measuring electrochemical potentials always consist of a measuring electrode and a reference electrode. The measuring or indicator electrode provides the voltage in relation to the concentration. The voltage of the reference electrode however is constant and is not influenced by the medium.

Combination electrodes are constructions consisting of a glass electrode and a reference electrode. The reference electrode is arranged concentrically around the glass electrode.

#### 1.1 Reference electrode system:

Reference electrode systems are predominantly constructed with a silver/silver oxide reference system. Reference systems with liquid electrolyte should always contain sufficient liquid; if necessary they are topped up with 3 mol potassium chloride solution. Reference electrodes with gel reference electrolyte can not be topped up. During measurement the filler opening should be open to ensure pressure equilibration. The liquid column inside the electrode should be a few centimetres higher than the level of the measured solution in order to produce a positive hydrostatic pressure which ensures a steady flow of KCl solution through the diaphragm out into the measured solution. The result is a continuous self-cleaning action of the diaphragm and besides it prevents, that eventually poison of electrode are diffusing inside the electrode, which would destroy the drawing off system.

#### 1.2 Diaphragmas:

Reference electrodes are in contact with the measured solution through a diaphragm. This diaphragm must be porous and permeable for liquids. Among diaphragms one can distinguish between a ceramic and a pinhole diaphragm.

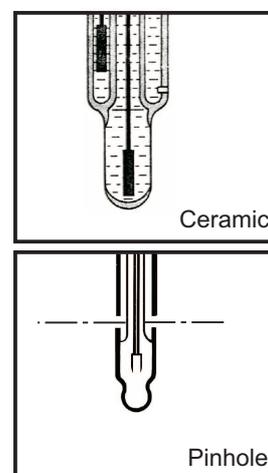
Combination electrodes with ceramic diaphragm (glass)

e.g. combination pH electrode Inlab 412  
Use in the range 0 - 14 pH.  
Laboratory electrode for universal use.

Combination electrodes with pinhole diaphragm (glass)

e.g. pH-120

Combination electrodes with pinhole diaphragms are a further development in the research on pH measurement. They have an excellent zero position.



**The following points must be observed:**

- Use in the range 2 - 12 pH.
- The pinholes of diaphragm must not become clogged.

#### 1.3 pH measurement of soil:

For pH measurement of soil, approx. 100 cm<sup>3</sup> soil is mixed thoroughly with 100 cm<sup>3</sup> distilled water. Immerse the combination pH electrode and move it slightly. The pH can be read when the indication no longer changes. Clean the pH electrode after use only by rinsing with ordinary water and shake off any water adhering to it. After use, please pull the soaking cap filled with KCl solution back over the electrode tip. The KCl solution should be renewed frequently.

# APPENDIX

## **2. Plastic electrodes:**

e.g. pH 60

Plastic electrodes represent a compromise design. Their advantage is that they are nearly unbreakable and have a closed, maintenance-free system which does not require refilling. Their disadvantage is larger errors, up to a few tenths pH, in case of measurements differing from ambient temperature.

The following measurement procedure has proved successfully:  
Immerse the electrode in the medium, move it gently and take the measurement when the reading has become stable. If immersion period of electrode is exceeded (several minutes) the zero position begins to drift (this is due to the design).

## **3. Metal electrodes (redox electrodes):**

The metal surface must be free of any form of contamination. Apart from mechanical cleaning processes (supersonic, grinding, polishing) it is also possible to use cleaning detergents listed under item 6; also chrome-sulfuric acid for removing fatty films.

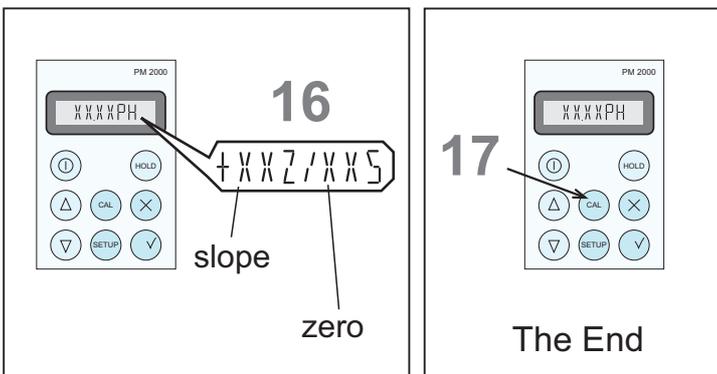
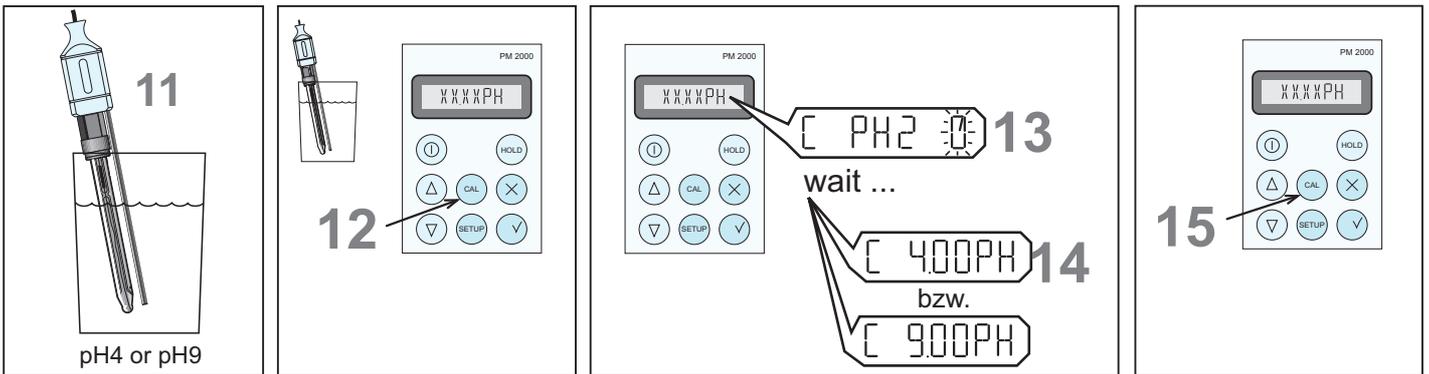
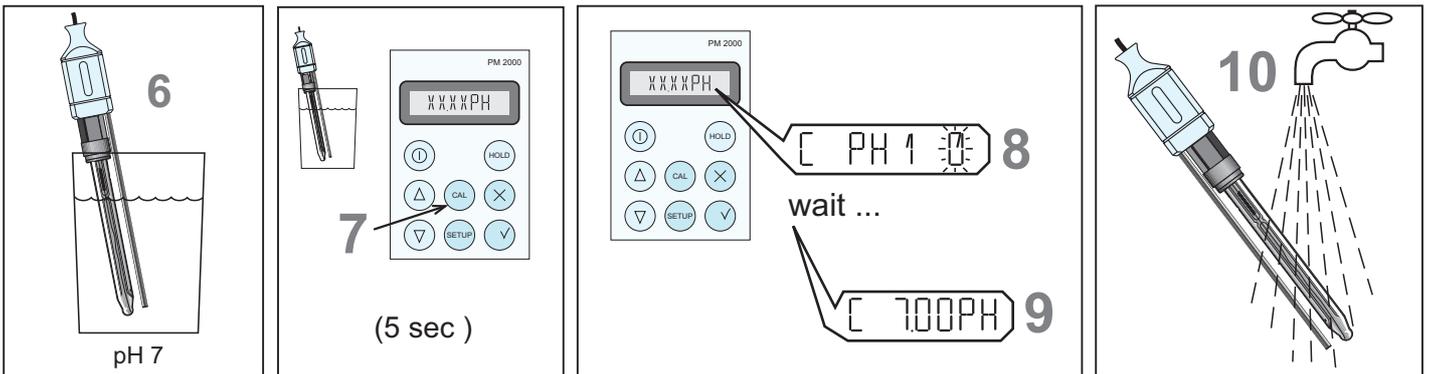
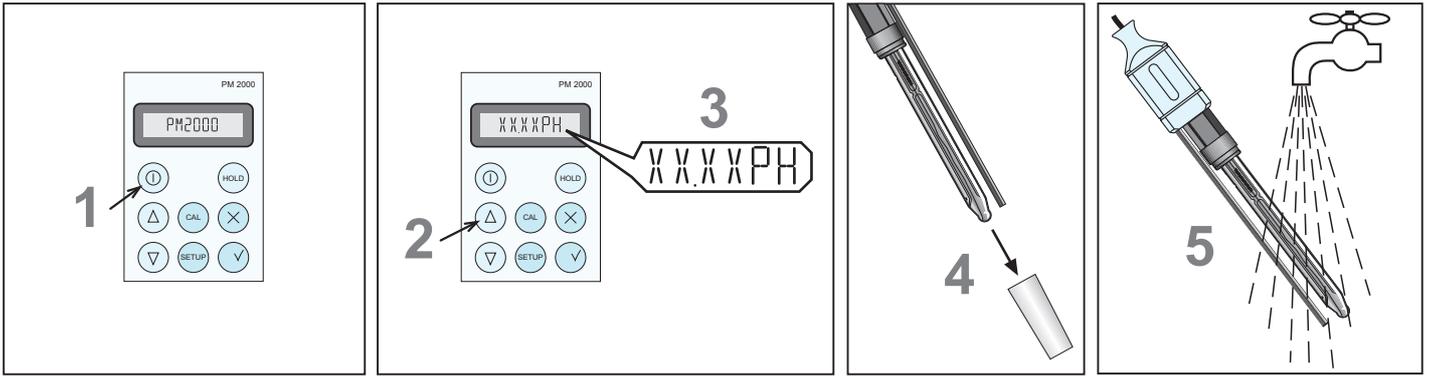
## **4. Electrode mounting:**

Electrodes must be arranged vertically from above or at an angle of up to 75° to the vertical. Horizontal electrodes or inverted electrodes are incapable of measurement. This requirement applies also during the calibration of electrodes.

### **Cable connection:**

**NOTE:** On plug connectors it is important to ensure that they are kept absolutely clean and dry; otherwise there may be creepage currents which reduce the measurement signal or cause it to collapse completely.

# BRIEF INSTRUCTIONS - pH CALIBRATION



- The calibration process can be cancelled at any time with .

**NOTE:** If the indication " +XXZ/XXS " flashes, there is a fault. (see also notes on faults/error messages).

Remove the fault and go ahead with step 1!

# BRIEF INSTRUCTIONS PM 2000 HP

 Switch on (1 sec sensor indication and 1 sec "CONTR".)

 Switch off (the instrument also switches off automatically 15 min after the last key operation)

   Adjust contrast (one of the keys must be pressed while the display shows "CONTR")

  Select operating mode e.g. pH- > REDOX- > EC- > TEMP-  
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 Freeze the indication (indication is flashing)  
pressing for app. 2 sec.: switch display illumination on/off (illumination switches off after 5 minutes)

 pH calibration 5 sec when the display shows "PH"  
Redox zero when the display shows "mV"  
Conductivity temperature coefficient when the display shows "µS/mS"  
Source of temperature measuring when the display shows "□"

 (2 sec.)	TC-XXX	Set conductivity compensation method and temperature coefficient.	   
	RT XX□	Adjust reference temperature.	   
	CC XXXXX	Adjust cell constant.	   
	PH/XX	Switch redox range on/off. Determine offset voltage of redox electrode. This requires a redox reference solution.	   
	TEMP XX	Select temperature probe for temperature indication	   
	ENGLISH	Select menu language.	   
	MANUFAC	Indication of version and serial number	

 Enter

 Cancel