

780 pH Meter / 781 pH/Ion Meter



Manual

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Metrohm AG
CH-9100 Herisau
Switzerland
+41 71 353 85 85
info@metrohm.com
www.metrohm.com

780 pH Meter / 781 pH/Ion Meter

Program Version 5.780.0020 and 5.781.0020

Manual

Technical Communication
Metrohm AG
CH-9100 Herisau

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1 Introduction

This Manual provides you with a comprehensive overview of the installation, working principles and operation of the **780 pH Meter** and **781 pH/Ion Meter**. As these two instruments are identical as far as the three measuring modes of the 780 pH Meter are concerned (pH, temperature and potential) and their operation in these modes is also identical, the Manuals for both have been incorporated in a single document. The special measuring mode of the 781 pH/Ion Meter – the measurement of concentration – is, like the other measuring modes, described in separate sections. These sections, which apply only to the operation of the 781 pH/Ion Meter, are marked accordingly.

Information about the use of Metrohm pH or ion-selective electrodes can be found in the appropriate leaflet and the ISE Manual that is included with the electrode.

Additional theoretical principles can be found in the Metrohm Monograph "Electrodes in Potentiometry".

You can also request our descriptions of applications involving pH and ISE measurements in the form of **Application Notes** and **Application Bulletins** from your local Metrohm agency or download them from the Internet under www.metrohm.com.

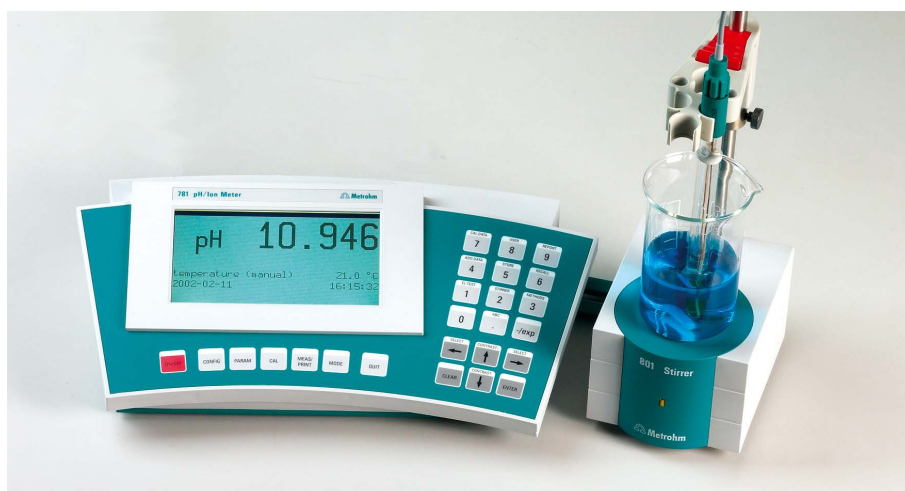


Fig. 1: 781 pH/Ion Meter connected to 801 Magnetic Stirrer

1.1 Instrument description

Both instrument versions, the **781 pH/Ion Meter** and the **780 pH Meter**, are used for measuring pH, temperature and potential reliably and at high resolution. The **781 pH/Ion Meter** differs from the **780 pH Meter** by having an additional operating mode for the potentiometric determination of the concentration by using ion-selective electrodes (**Conc mode**).

Both instruments have comprehensive monitoring functions (for calibration, validation and service intervals), diagnostic functions and an au-

automatic pH electrode test. Up to 100 values can be stored in the memory together with the most important additional data; these can be viewed and outputted as a report. All the parameter settings for a measuring mode can be permanently stored as a method.

All stored information (measured values, configuration, parameters, etc.) can be transmitted via the RS 232 interface to a printer or computer for output as a report.

Both instruments have the following features:

- Dot-matrix display for both the continuous display of the measured value and for showing the user dialog.
- High-impedance measuring input for pH, redox or ISE sensors, a connection for a separate reference electrode and an input for temperature sensors (Pt1000 or NTC).
- MSB connection (Metrohm Serial Bus) for a stirrer and for a Dosimat Plus.
- RS 232 connection for a serial printer or a computer.
- A connection for an external keyboard or a barcode reader.

The **781 pH/Ion Meter** has an additional **Conc mode** which allows the measurement of the concentration by using ion-selective electrodes, either directly after calibration or by standard or sample addition methods. Such a **calibration** or **standard addition** can be carried out either manually or automatically. In the latter method a standard solution is added automatically by a Dosimat Plus included in the system. The calibration concentrations or the standard additions are calculated automatically according to the given conditions and these are added with great accuracy.

1.2 Parts and controls

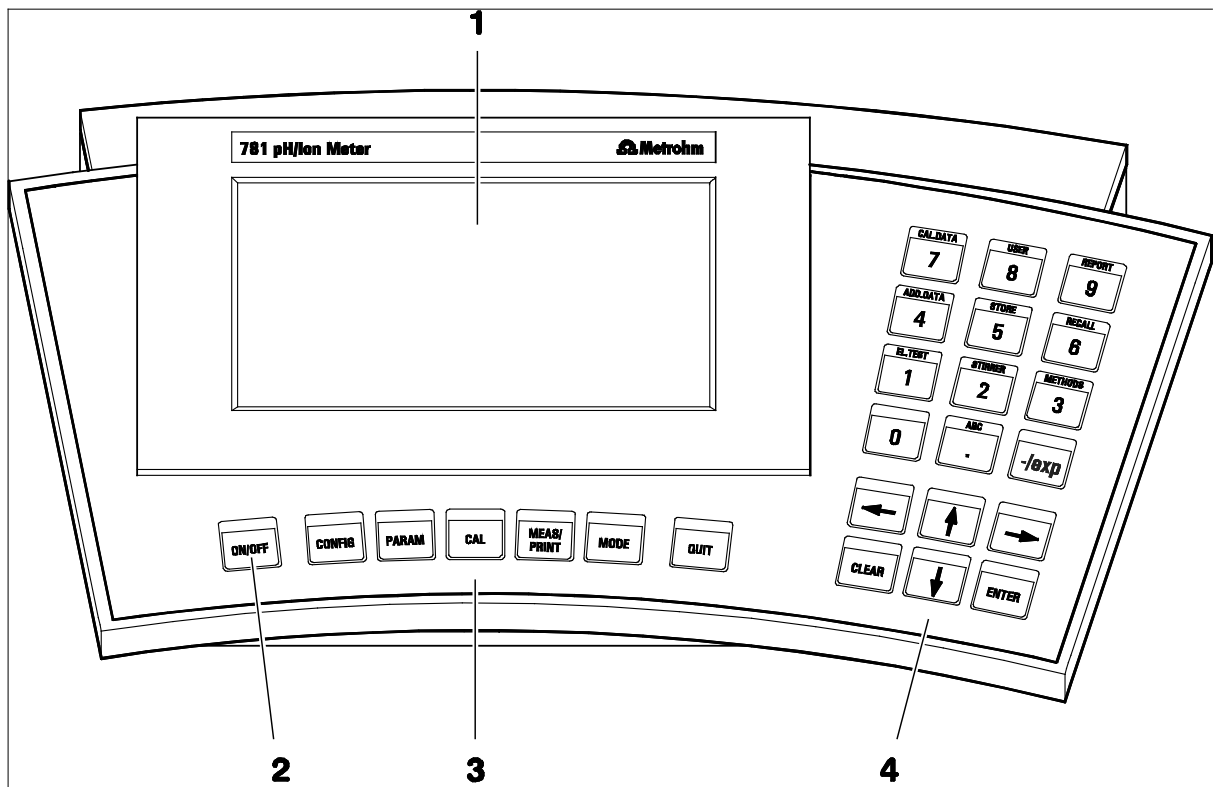


Fig. 2: Front view of the 780 pH Meter or 781 pH/Ion Meter

1 LCD display

3 Main function keys

2 On/Off key
Key for switching the instrument on and off

4 Input, navigation and function keys
Each key has several functions; the particular function depends on the work status of the instrument

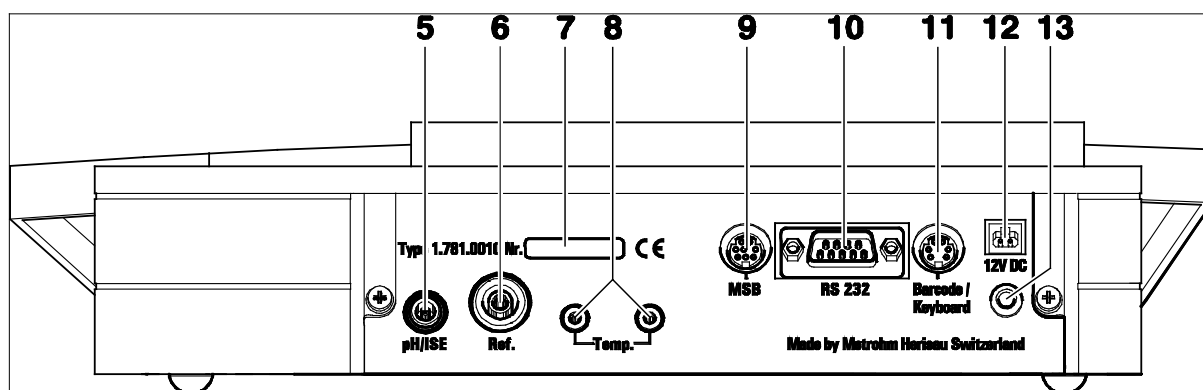


Fig. 3: Rear view of the 780 pH Meter or 781 pH/Ion Meter

<p>5 Connection for potentiometric electrodes pH, ISE, redox or silver electrodes with built-in or separate reference electrode; socket type F</p>	<p>10 RS232 interface Connection for printer or PC</p>
<p>6 Connection for separate reference electrode 4 mm socket type B</p>	<p>11 Barcode reader/ Keyboard connection</p>
<p>7 Serial number</p>	<p>12 12V power connection</p>
<p>8 Connection for temperature sensor Pt1000 or NTC, for connection with two 2 mm B-plugs; 6.2103.130 and 6.2103.140 Adapters are included for use with 4 mm banana plugs</p>	<p>13 Grounding connection For measurements in grounded solutions, grounding of the instrument may be advantageous to avoid interferences; 4 mm socket type B</p>
<p>9 MSB connection (Metrohm Serial Bus) for connecting a stirrer and/or Dosimat Plus, directly or via the optional Remote Box (6.2148.010)</p>	





1.3 Information about this Manual



Please study this Manual carefully before you start to use the instrument. The Manual contains information and warnings that must be observed by the user in order to guarantee the safe use of the instrument.

1.3.1 Notation and pictograms

The following notations and pictograms (symbols) are used in this Manual:

Range	Menu item, parameter or input value
<MODE>	Key
12	Operating element
	Danger This symbol indicates a possible risk of death or injury if the given information is not properly observed.
	Warning This symbol indicates a possible risk of damage to the instrument or its components if the given information is not properly observed.
	Attention This symbol indicates important information. Please read it carefully before you continue.
	Information This symbol indicates additional information and tips.
TIP !	TIP This symbol indicates information that may be of particular use to you.

1.4 Safety information



Warning!

This instrument should only be used in accordance with the information given in this Manual.

1.4.1 Electrical safety

Please observe the following guidelines:

- Only qualified Metrohm technicians should carry out service work on electronic components.
- Do not open the pH/Ion Meter housing. This could destroy the pH/Ion Meter. Inside the housing there are no components that the user can service or exchange.

Electrical safety when handling the 780 pH Meter and the 781 pH/Ion Meter is guaranteed within the framework of the IEC 61010 Standard. The following points must be observed:



Please make sure that the external power supply is always kept dry. Protect it against direct liquid contact.



Electronic components are sensitive to electrostatic charges and can be destroyed by a discharge. Always switch off the pH/Ion Meter before making or breaking electrical connections on the rear panel of the instrument.

1.4.2 General handling rules

Handling solutions



When working with water or other solutions in the immediate vicinity of the pH/Ion Meter please avoid excessive liquid splashes on the instrument housing or power supply. Any such splashes must be removed as quickly as possible in order to prevent the liquid from entering the instrument or the power supply.

2 Installation

2.1 Instrument setup

2.1.1 Packaging

The 780/781 pH/Ion Meter and its specially packed accessories are supplied in very protective special packaging made of shock absorbing polypropylene foam. Please store this packaging in a safe place; it is the only way in which the safe transport of the instrument can be guaranteed. Should you wish to dispose of it please consider suitable disposal or recycling processes.

2.1.2 Checks

Please check that the delivery is complete and undamaged immediately on receipt (compare with delivery note and list of accessories given in *Section 9.6*).

2.1.3 Location

Place the instrument on a suitable vibration-free laboratory bench, protected from corrosive atmospheres and contact with chemicals.

2.2 Connecting the accessories

Both the stand for attaching the stirrer, clamping ring and electrode holder as well as the pH/Ion Meter itself can be mounted on the supplied **stand base**.

You can choose between the arrangements shown in Fig. 4 to suit your own particular working preference.

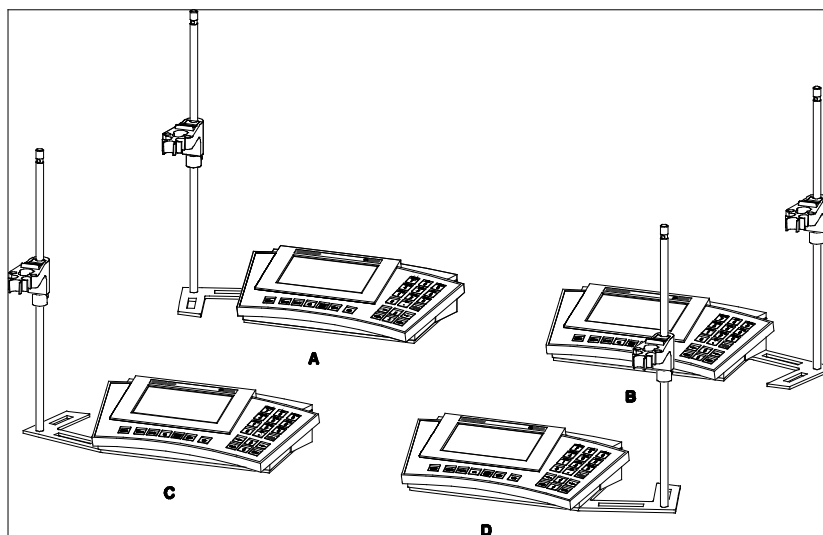


Fig. 4: Possible arrangements for mounting the base plate

Versions **A** and **B** are intended for mounting an 801 Magnetic stirrer on the left- and right-hand side of the pH/Ion Meter respectively. If you frequently work without such a permanently attached stirrer then you can mount the base plate so that you have space for the sample vessel directly in front of the support rod (versions **C** and **D**).

Attach the base plate with the screws provided as shown in Fig. 5. The rubber feet included prevent the system from slipping about on the work bench and should therefore be stuck on to the base plate.

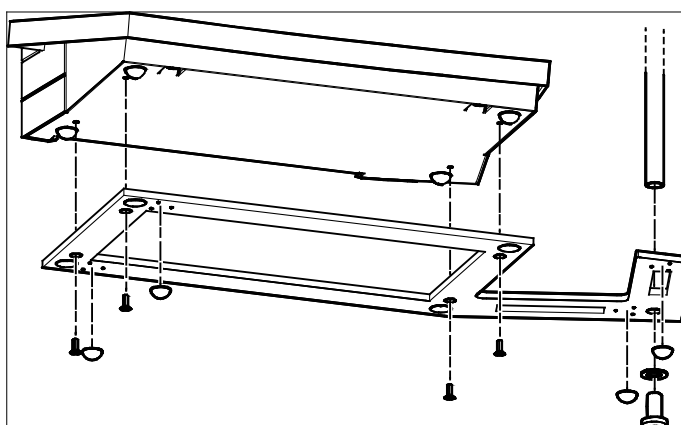


Fig. 5: Attaching the support rod and base plate

2.3 Connecting optional devices

Devices which are to be remotely controlled from the pH/Ion Meter (e.g. Metrohm stirrers or Dosimat Plus devices) are connected to MSB connection **9**. This can be carried out either directly (**801 Magnetic Stirrer** or **802 Rod Stirrer** with **804 Ti-Stand**) or via the optionally available 6.2148.010 Remote Box (e.g. Dosimat Plus).

2.3.1 Connecting the 801 Magnetic Stirrer

Mount the magnetic stirrer on the support rod before attaching the clamping ring (6.2013.010) and the electrode holder (6.2021.020). Further details are given in the corresponding Manual.

For example, the ready-mounted system could look like this:

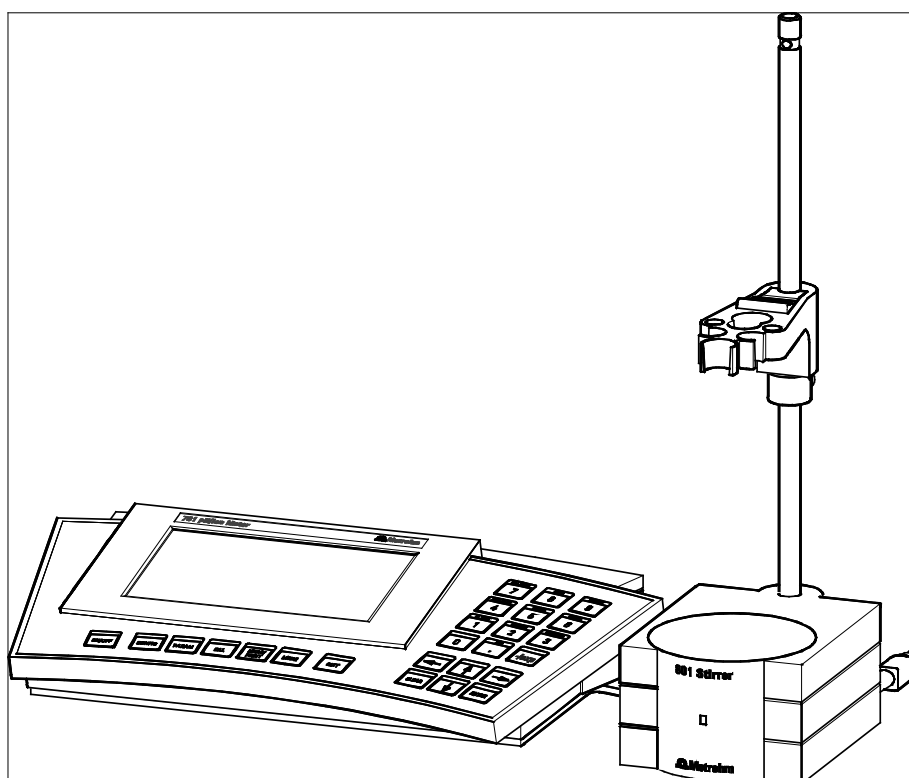


Fig. 6: Ready-mounted pH/ISE measuring system

The **801 Magnetic Stirrer** is controlled via MSB connection **9**. The stirrer is connected to it directly:

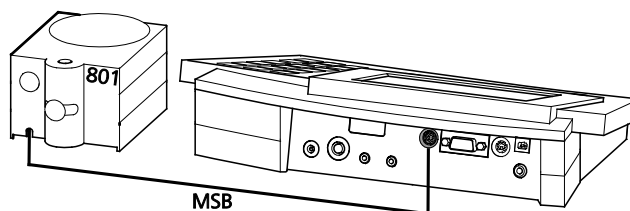


Fig. 7: 780 pH Meter / 781 pH/Ion Meter – 801 Magnetic stirrer

2.3.2 Connecting the 802 Rod Stirrer

The 802 Rod Stirrer, in combination with the 804 Ti Stand, can also be connected directly to the pH/Ion Meter. This is done by plugging the MSB connection cable of the 804 Ti Stand into MSB connection **9** of the pH/Ion Meter:

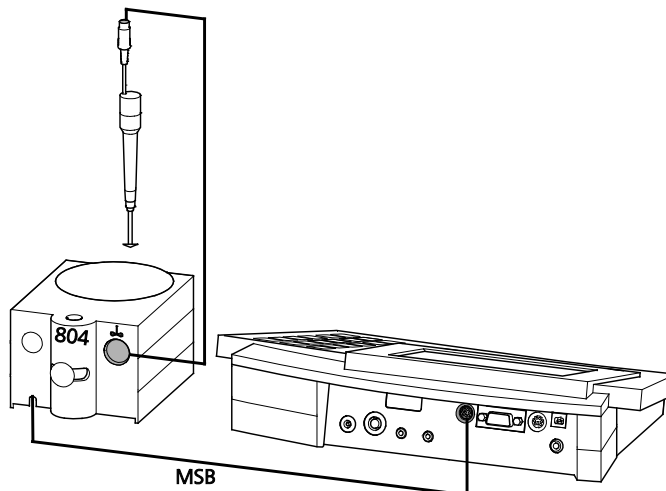


Fig. 8: 780 pH Meter / 781 pH/Ion Meter – 802 Rod stirrer

2.3.3 Connecting a Dosimat Plus (only 781)

Controlled addition of standard or sample solutions

For automatic calibration as well as for the addition of standard or samples in the Conc mode with the **781 pH/Ion Meter** the Metrohm **865** and **876** Dosimat Plus devices can be connected via the separately available 6.2148.010 Remote Box. Control is carried out via the 6.2141.350 cable:

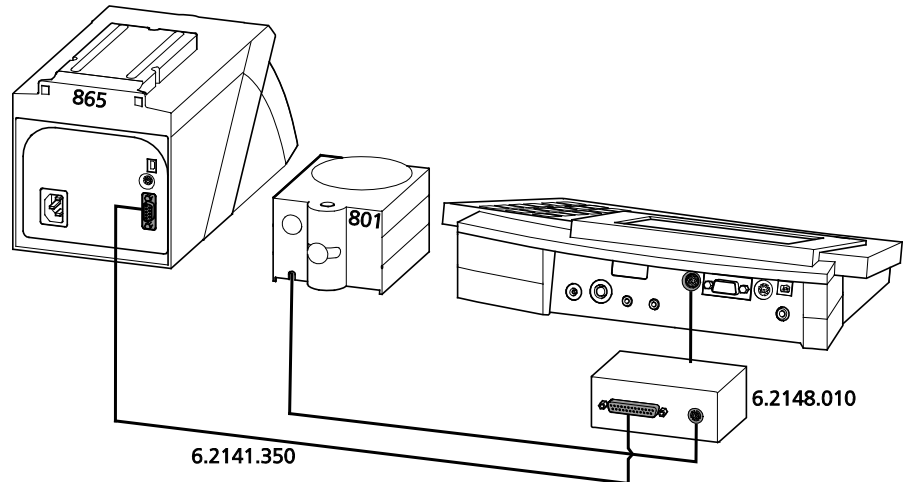


Fig. 9: 781 pH/Ion Meter – Dosimat Plus

If a Dosimat Plus is used then a stirrer is normally also required. This is then connected directly with the MSB connection of the 6.2148.010 Remote Box (stirrer: 801 or 802+804).



Note that the "DOS" dosing mode is set with the following parameters for standard addition at the Dosimat plus:

- Dosing parameter > Mode: "Dosing ramp"
- Pulse control: "on"

Furthermore, the Dosimat Plus must be in the status "HOLD". You can set the status to "HOLD" by pressing the "Go" key once (check: the display of the Dosimat Plus shows "HOLD" in the top right-hand corner).

2.3.4 Connecting a sample changer

For simple automated measurement of several samples and standards with the pH/Ion Meter the Metrohm **Compact Sample Changer 869** can be connected. Communication takes place via the 6.2148.010 Remote Box, i.e. the measurements are triggered by the sample changer and their completion is also transmitted by the pH/Ion Meter via the remote connection. The individual steps for processing a series of samples or standards are defined as a method in the sample changer.

Please note that when work is carried out in this way that no sample data is transferred between the sample changer and the pH/Ion Meter. This means that the assignment of the report outputs is only possible by using the consecutive run number (see *Section 5.4*).

The connection of a Compact Sample Changer 869 and a Dosimat Plus 865 for automatic calibration with standard addition is described here as an example. A detailed description of how to program a method in the Compact Sample Changer 869 is given in the corresponding Manual of the instrument.

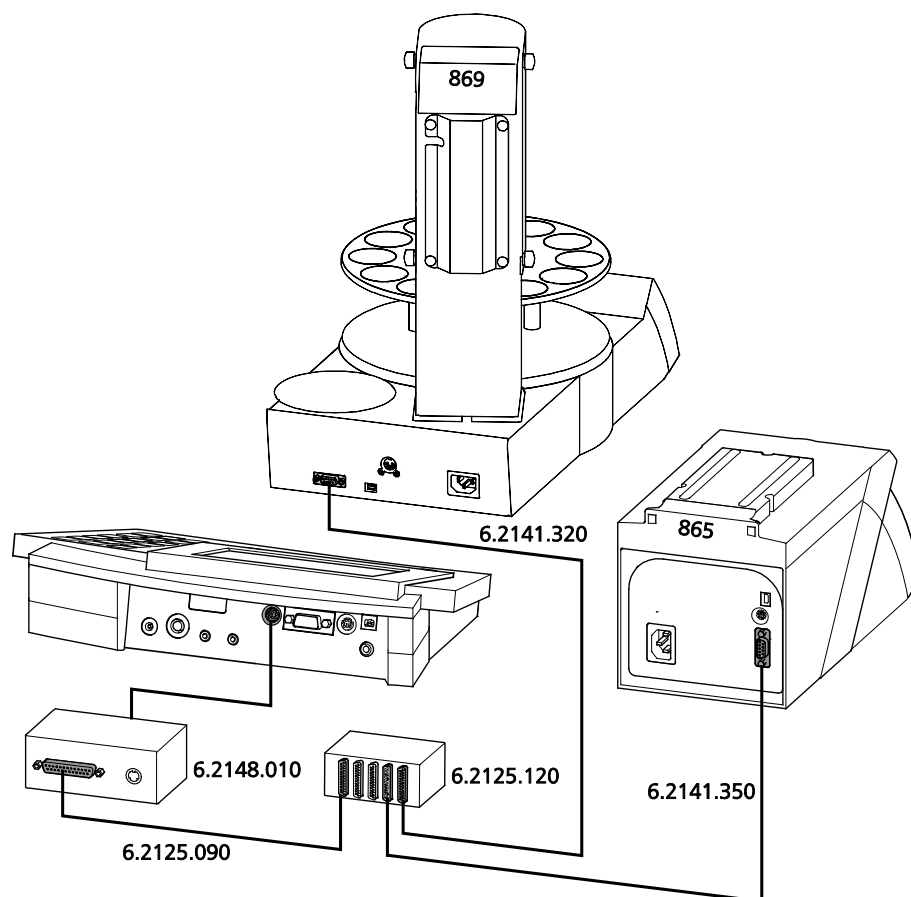


Fig. 10: 781 pH/Ion Meter – Dosimat Plus – Sample changer

2.3.5 Connecting a printer

A printer with a serial or parallel interface can be connected to the RS232 interface for printing out reports.

The connection of the 40-character Custom DP40-S4N printer (Metrohm ordering number: 2.140.0200) with the serial 6.2134.110 Cable is described as an example:

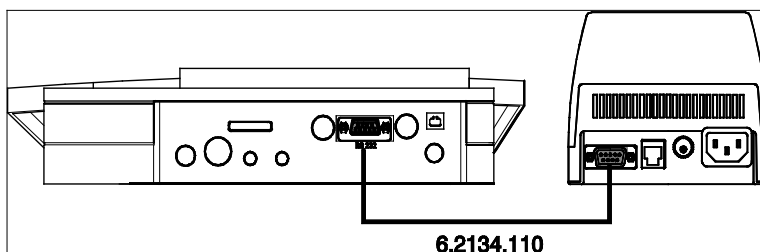


Fig. 11: 780 pH Meter / 781 pH/Ion Meter – Printer

The transmission parameters for the pH/Ion Meter and the printer must be the same. On the pH/Ion Meter these are set under

CONFIG/peripheral units/character set: (see *Section 5.6*)

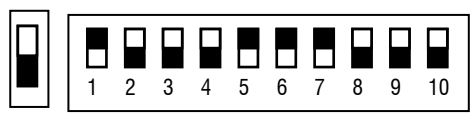


and under

CONFIG/RS232 settings (see *Section 5.7*).

These settings and other possible printer connections are given in the following table. If you wish to connect a printer which is not mentioned here then make sure that it emulates the Epson mode or uses the international character set according to IBM Standard Table 437 and IBM-compatible graphics control characters.

Please observe the paper feed settings after each report printout (see *Section 5.1*).

The settings for graph sizes in the printer output are accessible in the setup of the pH/Ion Meter and are described in *Section 7.5.3*. This can particularly be necessary for single sheet printers (i.e. HP Desk Jet).

Printer	Cable	780/781 settings	Printer settings
Custom DP40-S4N	6.2134.110	Character Set: Citizen Baud Rate: 9600 Data Bit: 8 Stop Bit: 1 Parity: none Handshake: HWs	IDP-560 EMULATION FONT MAP = ENGLAND * PRINT = REVERSE LITTLE CR CODE = VOID CR AFTER B. FULL = VOID CR ON B. EMPTY = VALID BUFFER 1K BYTE BAUD RATE = 9600 PROTOCOL = 8,N,1 FLOW CONTROL CTS-RTS (*) FRANCE also for Italian, Spanish and Portuguese, GERMANY also for Swedish.
Seiko DPU-414	6.2134.110	Character Set: Seiko Baud Rate: 9600 Data Bit: 8 Stop Bit: 1 Parity: none Handshake: HWs	none
Citizen iDP562 RS	6.2134.050	Character Set: Citizen Baud Rate: 9600 Data Bit: 8 Stop Bit: 1 Parity: none Handshake: HWs	ON  SSW1
Epson LX-300+	6.2134.050	As above, but Character Set: Epson	see Printer Manual
HP Desk Jet with serial interface	6.2134.050	Character Set: HP Baud Rate: 9600 Data Bit: 8 Stop Bit: 1 Parity: none Handshake: HWs	A:  A4 Paper B: 
HP Desk Jet with parallel interface	2.145.0330 RS232/ Parallel Converter	Character Set: HP Baud Rate: 9600 Data Bit: 8 Stop Bit: 1 Parity: none Handshake: HWs	see Printer Manual

2.3.6 Connecting a computer

The report output via the RS232 interface can be made to either a printer or a PC. With the program Metrodata Vesuv 3.0 for Windows it is possible to implement automatic data acquisition and evaluation.

This is done by connecting RS232 interface **10** of the pH/Ion Meter using the optionally available 6.2134.040 Cable (9-pin/9-pin) with a free serial COM port on the PC. If only a 25-pin COM port is available then the optionally available 6.2125.110 Cable (9-pin/25-pin) or a commercially available adapter must be used.

Settings

The RS232 interface must be configured with identical settings on both the connected instruments (PC and pH/Ion Meter). You should select the standard values for the pH/Ion Meter configuration under **CONFIG/RS232 settings** (see Section 5.7):

Baud Rate: 9600
Data Bit: 8
Stop Bit: 1
Parity: none
Handshake: HwS



Please note that, before starting the program 'Vesuv Datalogger', the pH/Ion Meter must have been configured correctly, connected up and switched on. When the Vesuv program is started it automatically checks the configuration of the connected instrument and makes the corresponding settings for the report output so that data acquisition functions properly.

As well as the data acquisition function described above, the 780/781 pH/Ion Meter also has numerous remote control possibilities that allow the complete control of the instrument via the RS232 interface. However, as the utilization of this option only makes sense in very special situations, you can obtain detailed information about the remote control language of the pH/Ion Meter from your local Metrohm agency in a separate document (780/781 pH/Ion Meter Operation via RS232; 8.781.1113).

2.4 Connecting the electrodes and sensors

On its rear panel the 780/781 pH/Ion Meter has connections for a potentiometric electrode **5**, a separate reference electrode **6** and a temperature sensor **8**.

Connect your electrodes and sensors according to the following diagram to the **switched off** pH/Ion Meter:

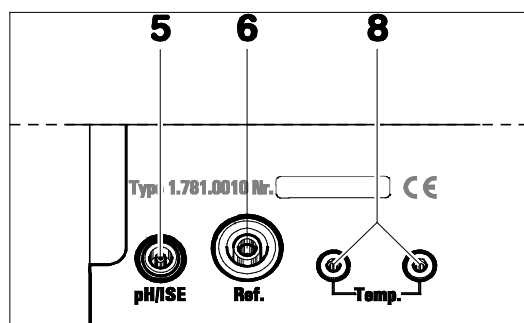


Fig. 12: Connecting sensors

-
- 5** **Connection for potentiometric electrodes**
pH, ISE, redox or silver electrodes with built-in or separate reference electrode; plug F
-
- 6** **Connection for separate reference electrode**
plug B, 4 mm
-
- 8** **Connection for temperature sensor**
Pt1000 or NTC, connected via two 2 mm banana plugs, reducing adapters for 4 mm plug B may be necessary (6.2103.130 / 6.2103.140). Please observe color classification for shielding purposes.
-

To help you choose the optimal potentiometric electrode for your particular application Metrohm can provide you with a range of information material:

Catalog: *Metrosensor Electrodes*
 Product booklet: *Electrodes for pH Measurement*
 Monograph 8.015.5003: *Electrodes in Potentiometry*

You can obtain these documents from your local Metrohm agency or under www.metrohm.com.

2.5 Mains connection

The pH/Ion Meter has an external power supply (6.2153.000) providing 12V (DC). This is connected to 12V mains connection **12**.

Mains cable

One of the following cables is supplied with the instrument

- 6.2154.000 Mains cable 2 Pol (C7) – EU (XVI)
- 6.2154.010 Mains cable 2 Pol (C7) – US (N1/15)
- 6.2154.020 Mains cable 2 Pol (C7) – GB (BS89/3)
- 6.2154.030 Mains cable 2 Pol (C7) – AUS (SAA/2)

and is connected to the external power supply.



Please make sure that the power supply is always kept dry. Protect it against direct liquid contact .

2.6 Switch on



After the selected accessories have been connected switch on the pH/Ion Meter with the <ON/OFF> key (see also *Section 4.3*). The instrument will start in the last operating mode to have been used for measuring pH, temperature, potential or concentration (781 only).

During the switch-on process an instrument checking routine is carried out automatically. If an error message is displayed here (**Err x**) then please contact your local Metrohm agency.

2.7 Initial configuration

The pH/Ion Meter is delivered with standard settings for the configuration and method parameters. Many of these can be reset at any time by pressing the **<CLEAR>** key during input (see also *Section 4.3*). If it should ever be necessary to reset the configuration of the instrument to its original condition then this can be carried out by a re-initialization of the instrument memory (see *Section 8.5*).

Before you start to make measurements please check the following configuration settings and, if necessary, alter them according to your own requirements. If you first want to make yourself familiar with the operation of the pH/Ion Meter and the various editing possibilities then please read *Sections 4.1, 4.2 and 4.4*. More detailed explanations of the individual configuration settings are given in *Section 5*.

Dialog language: english

CONFIG/Verschiedenes/Dialog:english

After this choice has been confirmed with **<ENTER>** the dialog language changes immediately. For example, this item would then appear.

CONFIG/auxiliaries/dialog:english

Please switch the instrument off and on if this setting has been changed.

Date and time

CONFIG/auxiliaries/date and /time

Please check that the date and time are correct.

Temperature sensor and unit

CONFIG/auxiliaries/Temp.sensor and /Temp.unit

Enter the type of temperature sensor that is connected. If no temperature sensor is connected and you always want to enter the measuring temperature manually then you can ignore this setting.

3 Short operating tutorial

In this section the necessary steps for carrying out a simple pH and ion measurement with calibration are described. The instructions are limited to those steps that are absolutely necessary and will enable you to carry out your first measurements with the pH/Ion Meter directly. The operating principles are described in *Section 4.4*.

3.1 pH measurement

3.1.1 Requirements

The following instruments, accessories and solutions are required for carrying out the pH calibration and measurement described below:

- 780 pH Meter (2.780.0010) or 781 pH/Ion Meter (2.781.0010)
- 801 Magnetic Stirrer (2.801.0010)
Other stirrers can also be used (see *Section 5.6*).
- pH electrode (enclosed)
Or another pH electrode with Pt1000 temperature sensor, e.g.:
6.0258.600 Unitrode, LL pH glass, with cable 6.2104.600, 2 mm temp. plug
6.0257.000 Aquatrode Plus for ion-deficient water, 4 mm temp. plug
6.0228.000 Solitrode, LL pH glass, PP shaft, 4 mm temp. plug
- Calibration buffers
Metrohm buffer solutions pH 4.00, 7.00 and 9.00 (6.2307.230)

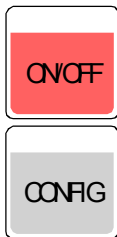
3.1.2 Preparations

Before you start this short tutorial you must ensure that the instrument and accessories have been correctly installed as described in *Section 2*. The most important points concerning the installation are briefly given again below (please refer to the Section mentioned for details). If you are not certain whether all the settings (**CONFIG** and **PARAMETER pH**) correspond to the original conditions you can first reset any alterations by initializing the memory (**RAM Initialization**) (see *Section 8.5*).

The calibration parameters for the pH mode are set for a calibration using two Metrohm buffers as default (see *Section 6.2.2*). If you want to use other buffers then the corresponding buffer type must be entered.

1 pH/Ion Meter installation

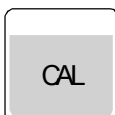
- | | |
|---------------------|----------------------|
| • Set up instrument | <i>Section 2.1</i> |
| • Connect stirrer | <i>Section 2.3.1</i> |
| • Connect electrode | <i>Section 2.4</i> |
| • Mains connection | <i>Section 2.5</i> |



2 Initial configuration

- Switch on pH/Ion Meter *Section 5.4*
- Set dialog language *Section 5.4*
- Set date/time *Section 5.4*
- Set temperature sensor *Section 5.4*

3.1.3 pH calibration



1 Start calibration with first buffer

- Immerse pH electrode in buffer solution pH 7
- Switch on stirrer with <STIRRER>
- Start calibration with <CAL>
- If no temperature sensor is connected:
enter the temperature and exit with <ENTER>

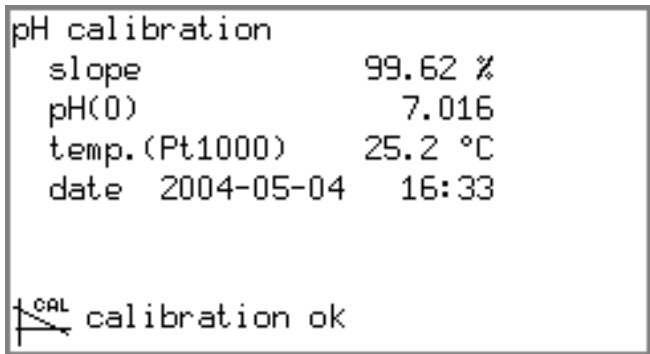


2 Continue calibration with second buffer

- Remove pH electrode from first buffer, rinse with water and blot off gently with a lint-free tissue
- Immerse pH electrode in second buffer solution pH 4 and continue calibration sequence with <ENTER>

3 Result

- Wait for potential measurement, result will be displayed:



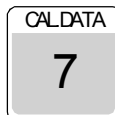
- After 30 s the pH/Ion Meter will switch back automatically to the measurement display. This can also be done immediately with <ENTER>.

4 Poor calibration data

- If the calibration data are outside the calibration parameters defined as the limits (see Section 6.2.2) then a corresponding message will be shown:

```
pH calibration
slope          93.80 %
pH(0)          7.027
temp. (Pt1000) 25.2 °C
date 2004-05-04 16:48

yes: <ENTER> no: <MODE>
! cal.data out of limits
```



- You can still accept the calibration data with <ENTER>, or reject it with <MODE>.

4 Show calibration data

- You can now display the calibration data with <CAL.DATA>. If you move the selection bar to the end of the list with <↓>, then in the line

Curve <->>

you can activate the calibration curve display with <->>.



4 Print calibration report

- With <REPORT> you can now output a calibration report to a printer or a PC.
- With <CAL.DATA> you can jump directly to the short calibration report in the report selection list (calib short); this contains all the data except the calibration curve itself.
- The Select key <->> offers the further option 'calib full'; this also outputs the calibration curve.

3.1.4 pH measurement



1 Select printout criterion

- If the obtained measured value is to be printed out directly as a measuring point report or transferred to a PC then the required printout criterion must be set (see Section 5.2):

```
CONFIG/print meas.value/print crit.: drift
```



2 Start measurement

- Immerse the pH electrode in the sample.
- Switch on stirrer with <STIRRER>.

3 Determine measured value

- You can read off the actual pH of the sample from the display. It is stable when the drift display (small double arrow on the left-hand side) no longer blinks.



4 Print measurement

- With <MEAS/PRINT> you can start the output of a measuring point report on a printer or PC. The recording of the measurement and its output depend on the printout criterion 'Drift' and take place only when the current drift condition is fulfilled (see Section 6.2.1):

```
'mp
781 pH/Ion Meter      01104  5.781.0020
date 2004-05-12 16:57:55
pH      *****      run number   5
electr.id
#5   pH =   5.875      20.2 °C Pt1000
=====
```

3.2 Determination of an ion concentration (only 781: Conc mode)

3.2.1 Requirements

Carrying out a calibration followed by the direct potentiometric determination of fluoride is described as an example. As this tutorial is only intended to provide a first introduction to ISE measurement with the 781 pH/Ion Meter, the automatic addition of the standard solutions is omitted in order to limit the number of accessories required. Further possible ways of carrying out a potentiometric fluoride determination, such as the automatic addition of the standard for calibration or standard addition, are described in Application Bulletin 82.

The following instruments, accessories and solutions are required:

- 781 pH/Ion Meter (2.781.0010)
- 801 Magnetic Stirrer (2.801.0010)
Other stirrers can also be used (see *Section 5.6*).
- Fluoride ISE (6.0502.150) with cable (6.2104.020)
- Ag/AgCl reference electrode (6.0726.100) with cable (6.2106.020)
Electrolyte filling: inner and outer $c(\text{KCl}) = 3 \text{ mol/L}$
- Temperature sensor (e.g. Pt 1000, 6.1110.100) with cable (6.2104.140)
- Fluoride standard solution (6.2301.030)
 $c(\text{NaF}) = 0.1000 \text{ mol/L}$ (1900 ppm F^-)
- TISAB solution
NaCl, Na-acetate buffer pH 5.5; for preparation see below

3.2.2 Preparations

To prepare the TISAB solution dissolve 58 g NaCl in approx. 500 mL dist. water and add 57 mL glacial acetic acid. Adjust the pH of the buffer with 5 M NaOH to 5.5. Then make up the solution to 1 L with dist. water.

Prepare the following five fluoride standard solutions from the stock solution: 0.5, 2.5, 5.0, 25.0 and 50.0 ppm. All standards should consist of a 1:1 mixture of dist. water and TISAB buffer.

Before you start this tutorial you must ensure that the instrument and accessories have been correctly installed as described in *Section 2*. The most important points concerning the installation are briefly given again below (please refer to the Section mentioned for details). If you are not certain whether all the settings (**CONFIG** and **PARAMETER Conc**) correspond to the original conditions you can first reset any alterations by initializing the memory (**RAM Initialization**) (see *Section 8.5*).

1 pH/Ion Meter installation

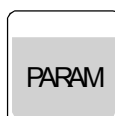
- Set up instrument *Section 2.1*
- Connect stirrer *Section 2.3.1*
- Connect electrodes *Section 2.4*
- Mains connection *Section 2.5*



2 Initial configuration

- Switch on pH/Ion Meter *Section 5.4*
- Set dialog language *Section 5.4*
- Set date/time *Section 5.4*
- Set temperature sensor *Section 5.4*

3.2.3 Calibrating the fluoride ISE



1 Set method parameters in the Conc mode

- Press <MODE> to enter the Conc mode
- In the ion parameters (<PARAM>) set the concentration unit to ppm with <SELECT>:

PARAMETER Conc

> ion parameters

conc.unit: ppm

- In the calibration parameters set the number of standards to 5 and define the concentrations:

PARAMETER Conc

> calibration parameters

```
no. of standards      5
addition:            manual
conc.1                0.5 ppm
conc.2                2.5 ppm
conc.3                5.0 ppm
conc.4                25.0 ppm
conc.5                50.0 ppm
```



2 Start calibration with first standard

- Immerse electrodes in the standard with the lowest F⁻ concentration
- Start calibration with <CAL>
- If no temperature sensor is connected: enter the temperature and exit with <ENTER>
- Confirm standard concentration with <ENTER> or – if necessary– correct it
- Wait for measurement of the potential



3 Continue calibration with increasing standard concentrations

- When the request 'Change std. <ENTER>' appears, remove the electrodes from the first standard, rinse them with water and blot them gently with a clean lint-free tissue
- Immerse electrodes in the next standard and continue the calibration sequence with <ENTER>
- In each case conform the standard concentration with <ENTER> or – if necessary – correct it
- Repeat procedure for each remaining standard

4 Result

- Wait for potential measurement, result will be displayed:

```

calibration
slope          -59.9 mV
E(0)           120.8 mV
c(blank)       0.00 ppm
temp.(Pt1000)  22.7 °C
date 2004-05-05 08:49

CAL calibration ok
    
```



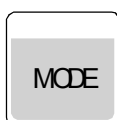
- After 30 s the pH/Ion Meter will switch back automatically to the measurement display. This can also be done immediately with <ENTER>.

5 Poor calibration data

- If the calibration data lies outside certain limits (slope $\leq 80\%$ or $\geq 105\%$ of the theoretical slope of 59.16 mV (25°C) per ionic charge) or the sign of the slope does not agree with the selected ion type a corresponding message will be shown:

```

calibration
slope           59.2 mV
E(0)            138.8 mV
c(blank)        3.85E-06 mol/L
temp.(Pt1000)   20.2 °C
date 2004-05-06 08:57
yes: <ENTER> no: <MODE>
! cal.data out of limits
  
```



- You can still accept the calibration data with <ENTER>, or reject it with <MODE>.



6 Show calibration data

- You can now display the calibration data with <CAL.DATA>. If you move the selection bar to the end of the list with <↓>, then in the line

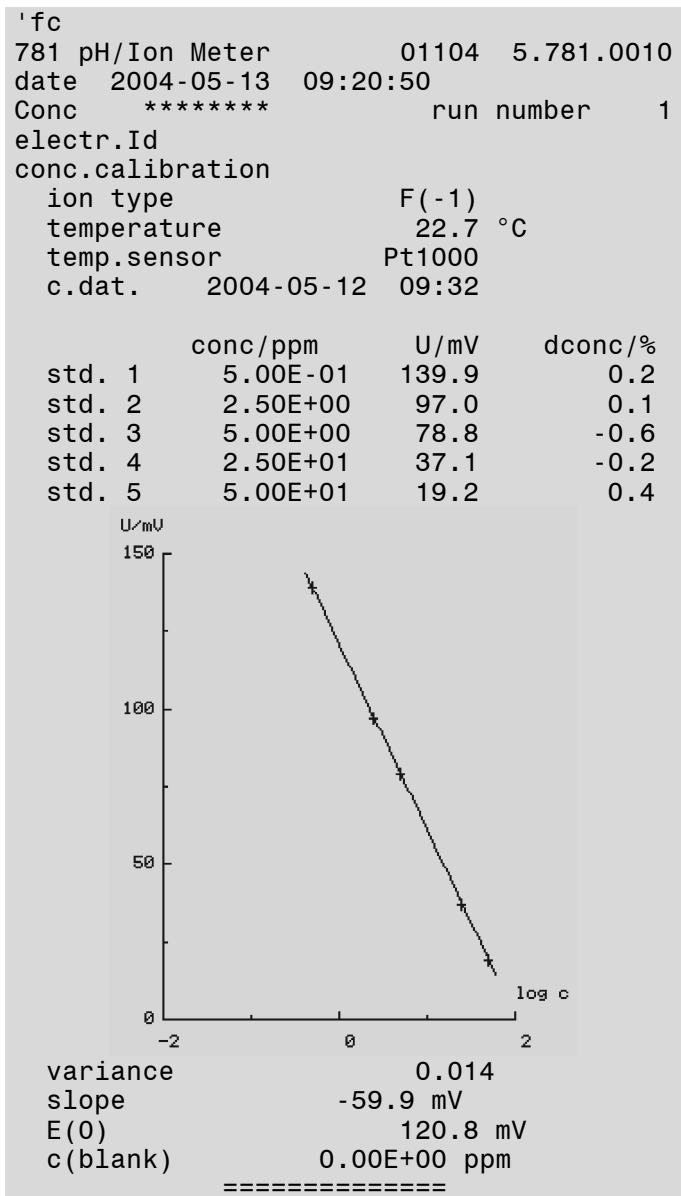
Curve <->>

you can activate the calibration curve display with <->>.



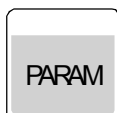
7 Print calibration report

- With <REPORT> you can now output a calibration report to a printer or a PC.
- With <CAL.DATA> you can jump directly to the short calibration report in the report selection list (calib short); this contains all the data except the calibration curve itself.
- The Select key <->> offers the further option '**calib full**'; this also outputs the calibration curve (see Section 7.2.4).



3.2.4 Direct measurement of fluoride

10 mL of the sample solution (e.g. 10 g table salt in 100 mL dist. water) is also treated with 10 mL TISAB solution. This should first be diluted 1:1 with dist. water. This produces the calculation parameters which are to be defined (see Section 6.5.4). As the measurement of the ions is carried out unstirred, the stirrer is only used before the measurement to ensure that the sample solution is properly mixed.



1 Set method parameters

- In the Conc Mode define the stirrer control as a measuring parameter (<PARAM>). Additionally the stirrer can also be switched on and off manually before the measurement with <STIRRER> .

PARAMETER Conc

```

:
> measuring parameters
:
  stirrer:           control
  stirring rate      5
  prestir pause     0 s
  stir time         15 s
  poststir pause    5 s

```

The stirring rate can only be set when a Metrohm 8XX Stirrer is connected to the MSB interface.

- The calculation parameters (<PARAM>) are then:

PARAMETER Conc

```

:
> calculation parameters
:
  smp1.size         10.0 mL
  V total           20.0 mL
  factor            1.0
  smp1.size unit:   mL

```



2 Determine measured value directly

- Immerse electrodes in the sample.
- Switch on stirrer with <STIRRER> and – after sufficient time has elapsed – off again.
- Wait until the electrodes have stabilized; i.e. until the drift signal in the display no longer blinks.
- Read off the value. This gives the fluoride concentration of the sample solution without the addition of TISAB.



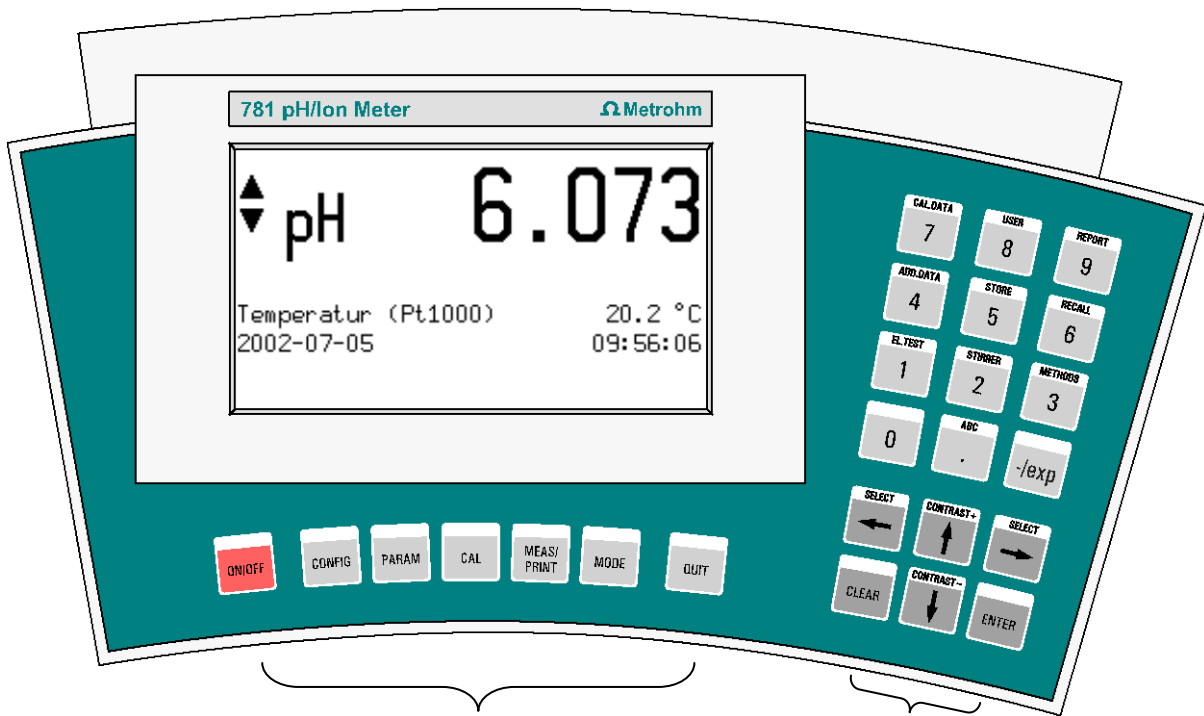
3 Print out measured value

- With <MEAS/PRINT> you can start the measuring sequence (controlled stirring) and the output of a measuring point report on a printer or PC. The recording of the measurement and its output depend on the printout criterion 'Drift' and take place only when the current drift condition is fulfilled (see Section 6.2.1):

```
'mp
781 pH/Ion Meter      01104  5.781.0010
date 2004-05-13 09:45:24
Conc *****          run number 12
electr.id
smpl.size            10.0 mL
ion      F(-1)
#1   c =      25.7 ppm    23.6 °C Pt1000
=====
```


4 Operation

4.1 The keypad



- Universal functions

- Input of numbers and text
- Navigation
- Special functions

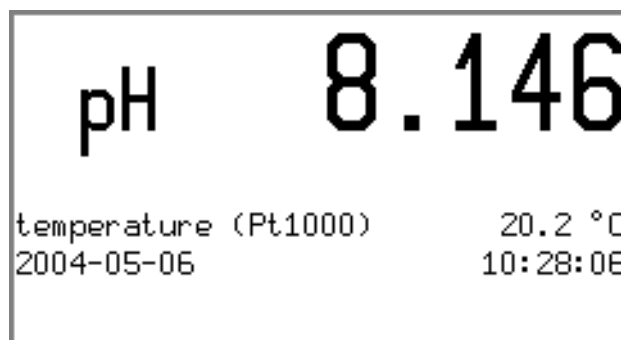
The keys beneath the display can be triggered from the measured value display irrespective of the mode.

Most of the keys on the right-hand side have two functions: The numbers to be entered and the navigation functions are shown in the center of the keys; the additional functions at their upper margin.

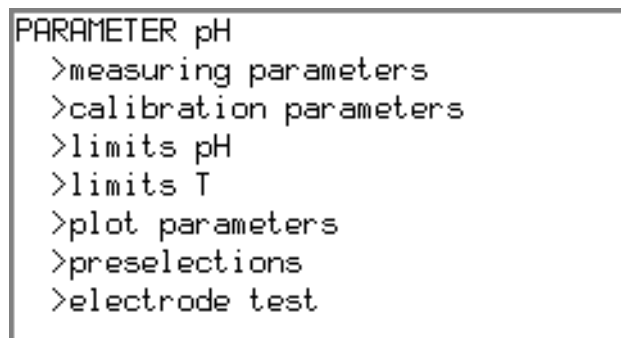
4.2 Operating concept

The pH/Ion Meter provides two types of display:

1. The **measured value display**.
This is the normal instrument display.



2. The **menu display**
This is used for editing various settings.














In the directly measuring working modes the current measured value is shown together with the date and time in the **measured value display**. In the **Conc** mode the method name and the type of ion selected are also shown. If the result is to be printed out, or if a stirring sequence or the entry of sample identifications (**Id**) are intended for recording a measured value, then this is started with **<MEAS/PRINT>**. In the Conc mode with standard or sample addition or subtraction the last result to be determined is always shown. In this case a measuring sequence is started with **<ENTER>**. The measured value display changes when the operating mode of the pH/Ion Meter is changed with **<MODE>**. You can easily see which mode is set from the measuring unit or the prefix 'pH' shown in the display.







In each operating mode you can switch from the measured value display to the **menu display** with **<CONFIG>** or **<PARAM>**. This allows the instrument configuration and the method parameters to be edited. In the direct measuring modes measurement recording and evaluation (e.g. automatic printing and limit monitoring) continues in the background. In the menu display it is also possible to change directly from the configuration to parameter input with **<PARAM>** and vice versa with **<CONFIG>**.

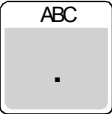

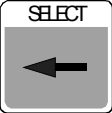
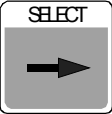
4.3 All key functions at a glance





The functions of all the keys are described below both for the measured value display and the menu display:

Key	Measured value display (normal operation)	Menu display (editing)
	<p>On/Off switch</p> <ul style="list-style-type: none"> The <ON/OFF> key switches the instrument on and off This applies even if the lamp of the LCD display is switched off! (see Section 5.4) After switch-on the pH/Ion Meter is in the normal operation display of the last mode to have been used 	<p>On/Off switch</p> <ul style="list-style-type: none"> The <ON/OFF> key switches the instrument off at any time.
	<p>Opens configuration menu</p> <ul style="list-style-type: none"> <CONFIG> opens the selection menu for the instrument configuration. These configuration settings remain unchanged until they are edited or the permanent memory of the instrument configuration is initialized (see Section 8.5). <p>Report selection</p> <ul style="list-style-type: none"> Direct selection of the configuration report after <REPORT>. 	<p>Changes to configuration menu</p> <ul style="list-style-type: none"> The <CONFIG> key can be used to switch directly from the parameter menu to the selection menu for instrument configuration.
	<p>Opens parameter menu</p> <ul style="list-style-type: none"> The <PARAM> key opens the selection menu for the method parameters. All parameter settings belong to a method and are stored method-specifically with this method. <p>Report selection</p> <ul style="list-style-type: none"> Direct selection of the configuration report after <REPORT>. 	<p>Changes to parameter menu</p> <ul style="list-style-type: none"> With the <PARAM> key you can switch directly from the configuration menu to the parameter menu.
	<p>Starts calibration</p> <ul style="list-style-type: none"> In the pH and Conc (direct) modes the <CAL> key starts a calibration. 	
	<p>Starts measurement / Prints out measured value</p> <ul style="list-style-type: none"> In the pH, T, U and Conc(direct) modes the <MEAS/PRINT> key triggers a measuring sequence. Depending on the configuration (see 	

Key	Measured value display (normal operation)	Menu display (editing)
	Section 5.2), the <MEAS/PRINT> key prints out the measured value as a measuring point report.	
	Operating mode selection <ul style="list-style-type: none"> In the pH, T and U modes (780 pH Meter) and the pH, T, U and Conc modes (781 pH/Ion Meter) the <MODE> key changes the mode. 	 Cancels sequence <ul style="list-style-type: none"> With the <MODE> key working sequences are terminated without direct transfer of the data.
	Message acknowledgement <ul style="list-style-type: none"> Displayed messages are normally acknowledged with <QUIT>. (Exceptions: see Section 8.2) If cause of the message has not been remedied then it will appear again at the next check. 	 Cancels working step <ul style="list-style-type: none"> Queries are exited with <QUIT>. In this way it possible, e.g. to skip individual steps within a working sequence without accepting the data. In menus <QUIT> causes a jump to the next higher level.
	Displays calibration data <ul style="list-style-type: none"> In the pH and Conc(direct) modes the <CAL.DATA> key shows the current calibration data. Report selection <ul style="list-style-type: none"> Direct selection of the configuration report after <REPORT>. 	Enters the number '7'
	User selection <ul style="list-style-type: none"> With <USER> a user name can be newly entered, selected or deleted. 	Enters the number '8'
	Report selection and printout <ul style="list-style-type: none"> With <REPORT> a report can be selected and printed out. The selection of the report from those available is made either with <SELECT> or directly by pressing the corresponding key (e.g. <CAL.DATA>, see right-hand column: Report selection). 	Enters the number '9'
	Shows addition data (781 pH/Ion Meter only) <ul style="list-style-type: none"> In the Conc Mode <ADD.DATA> shows the data of the last measurement for standard and sample addition methods. Report selection (781 pH/Ion Meter only)	Enters the number '4'

Key	Measured value display (normal operation)	Menu display (editing)
	<ul style="list-style-type: none"> Direct selection of the short result report after <REPORT>. 	
	<p>Stores measured value</p> <ul style="list-style-type: none"> In the pH, T, U and Conc(direct) modes the <STORE> key triggers a measuring sequence and stores the measured values in the memory in a similar manner to <MEAS/PRINT>. The storage criterion must have been previously defined under CONFIG /Store meas. value. 	<p>Enters the number '5'</p>
	<p>Opens measured value memory</p> <ul style="list-style-type: none"> The measured value memory is opened with the <RECALL> key. The stored measured values can then be viewed or deleted. <p>Report selection</p> <ul style="list-style-type: none"> Direct selection of the measured value memory report after <REPORT>. 	<p>Enters the number '6'</p>
	<p>Starts electrode test</p> <ul style="list-style-type: none"> In the pH mode you can start an electrode test with the <EL.TEST> key. <p>Report selection</p> <ul style="list-style-type: none"> Direct selection of the pH electrode test report after <REPORT>. 	<p>Enters the number '1'</p>
	<p>Stirrer on/off</p> <ul style="list-style-type: none"> A connected stirrer can be switched on and off manually with the <STIRRER> key. 	<p>Enters the number '2'</p>
	<p>Method selection</p> <ul style="list-style-type: none"> With the <METHODS> key the selection for loading, saving or deleting a method is opened (see Section 6.1). <p>Report selection</p> <ul style="list-style-type: none"> Direct selection of the method memory report after <REPORT>. 	<p>Enters the number '3'</p>
		<p>Enters the number '0'</p>

Key	Measured value display (normal operation)	Menu display (editing)
		<p>Enters a decimal point '.'</p> <ul style="list-style-type: none"> The <.> key enters a decimal point in the input field. <p>Exception: open text editor</p> <ul style="list-style-type: none"> If the <ABC> key is first pressed in an input field where text input is possible then a text input box for editing the text will be opened.
		<p>Enters a minus sign '-'</p> <ul style="list-style-type: none"> If you start a numerical input with <- /exp> then the numerical value to be entered will receive a minus sign. <p>Enters an exponent 'E'</p> <ul style="list-style-type: none"> When a numerical input has been started then the <- /exp> key will provide an exponential notation.
 <p>and</p> 		<p>Selects predefined entries</p> <ul style="list-style-type: none"> For menu parameters which offer a fixed choice of settings (recognizable by the final colon) the selection list can be viewed with the <SELECT>- keys. The arrows determine the selection direction. <p>Cursor control for text input</p> <ul style="list-style-type: none"> In the text editor the arrow keys are used to select the character to be entered and the <ENTER> key to enter it.

 <p>and</p> 	<p>Alters display contrast</p> <ul style="list-style-type: none"> • The contrast of the LCD display can be altered with the <CONTRAST+> and <CONTRAST-> keys during the measured values display. • This setting is retained after the instrument has been switched off and on. The default value is only reset after the memory has been initialized. 	<p>Controls the menu bar</p> <ul style="list-style-type: none"> • In each menu display the <↑> and <↓> keys can be used to move the selection bar up and down by one line. <p>Cursor control for text input</p> <ul style="list-style-type: none"> • In the text editor the arrow keys are used to select the character to be entered and the <ENTER> key to enter it. <p>Leafing between entries in the measured values memory</p> <ul style="list-style-type: none"> • Leafs between the entries in the measured values memory display: starting from the last measured value to be stored you can access older entries with <↑> and vice versa. • At the beginning and end of the list you can use the corresponding arrow key to jump directly to the other end of the list.
		<p>Deletes text input</p> <ul style="list-style-type: none"> • Before opening the text editor during text input the <CLEAR> key will delete the complete entry. Within this box <CLEAR> deletes the character to the left of the cursor. <p>Shows special value</p> <ul style="list-style-type: none"> • If a special value exists for an entry or selection then this can be shown with the <CLEAR> key. <p>Shows standard value</p> <ul style="list-style-type: none"> • All other entry and selection possibilities provide the standard value with the <CLEAR> key.
		<p>Confirms entry</p> <ul style="list-style-type: none"> • The <ENTER> key is used to complete each entry with the selection bar moving on to the next parameter. If an entry is exited without this confirmation then the entered value will be rejected.

4.4 Operating principles

4.4.1 Configuration and method parameters

Instrument configuration and method parameters are each contained in menus with a tree structure. These menu structures are shown in the Annex in *Section 9.3*.

The instrument configuration of the pH/Ion Meter is described in the **CONFIG** menu. This contains the basic settings that apply for all the selected working modes and methods. The method parameters are stored under **PARAMETERS**. In contrast to the configuration, the method parameters depend on the measuring mode which has been set.

The change from the measured value display to the menu display is made by using the **<CONFIG>** or **<PARAM>** keys. The title of the submenu appears first, and is shown with an '>' (e.g. **>Measuring parameters**). You can now move the selection bar up and down with the **<↑>** and **<↓>** arrow keys. Each underlying level in the menu structure is opened with **<ENTER>** and exited with **<QUIT>**. Alterations to individual entries must be confirmed with **<ENTER>**. If such alterations are exited with **<QUIT>** then they remain ineffective.

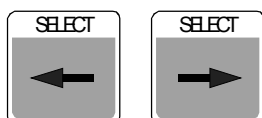
If an entry is confirmed with **<ENTER>** then the selection bar will move to the next entry. At the end of a submenu it will finally change to the next point of the superior menu selection.

In this way you can run through the complete menu structure for the configuration and parameters by repeatedly pressing the **<ENTER>** key. This can be helpful when carrying out checks.

Not all parts of the menu structure described below are visible in the display at all times. Only the specific possible settings of the option which is currently activated are shown. For example, the various settings for printing out the measured values under **CONFIG/print meas. values/print crit.** are not visible when printing has been deactivated completely (**OFF**). If one of the other printing criteria is selected then the particular settings it requires will appear in the display.

4.4.2 Editing menu entries

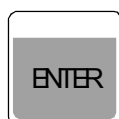
A basic differentiation is made between two types of menu entry.



Entries with a fixed selection are indicated by a colon:

dialog: **english**, deutsch, français, español

The selection is then made with the **<SELECT>** keys and confirmed with **<ENTER>**. The default setting, which is normally shown in bold print, can be shown by pressing **<CLEAR>**.



Entries which can be edited are altered by entering a new value and confirming it with **<ENTER>**.

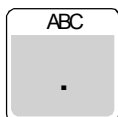
Numbers are entered directly with the number keys. Exponential notation can be activated directly with the **<-/exp>** key.

Values outside the valid range of limits for the particular entry will not be accepted by the instrument. This is indicated by the invalid entry blinking. You can now either enter a new value or retain the original value by exiting with **<QUIT>**.

Special entries exist for some numerical entries; these cannot be seen directly and cannot be edited (e.g. 'OFF' for the measuring parameter Drift). These can be shown with **<CLEAR>** and confirmed with **<ENTER>**.

Text entries are made using the text editor and are described in the following section.

4.4.3 Entering text



You can use **<ABC>** to open a text editor for entering texts; this allows the input of alphanumeric characters:



This text editor must be called up right at the start of a new entry after the old entry has been completely deleted with **<CLEAR>**, if necessary. If a text input is started directly with numbers from the number block of the keyboard then the subsequent opening of the text editor is no longer possible.

The required characters are selected with the arrow keys. The cursor movement can be accelerated by keeping the arrow keys pressed down. The marked character is accepted in the input field with **<ENTER>**. A requirement is that a blinking cursor in the input field indicates that there free places are available. Otherwise you can delete individual characters from the back with **<CLEAR>**.

Text input is terminated by exiting the text editor with **<QUIT>** and confirming the entry with **<ENTER>**. However, if the whole entry is to be rejected then **<QUIT>** must be activated a second time.

5 Configuration



With the **<CONFIG>** key you can access the configuration menu. This contains all the instrument settings for the pH/Ion Meter. These are independent of both the mode and the method. This means that they cannot be stored separately like the method parameters (see *Section 6*). They continue to exist until they are edited or the permanent memory containing the instrument configuration is re-initialized (see *Section 8.5*).

All the settings of this menu are described in this section. English is used as the dialog language. For each point you will find all the possible entries or the valid entry range together with the default value. This will always be reset when the permanent memory of the pH/Ion Meter is re-initialized. During the input you can also deliberately call up the default value with **<CLEAR>**. It is shown in bold type below.

Example:

```
time interval    1,2,3...365...9999 d
```

This setting defines a time interval in days. In this example it is the time after which the validation of the instrument is to be carried out (**>monitoring/validation**). You can either enter whole numbers between 1 and 9999 or call up the default value of 365 days with **<CLEAR>**.

5.1 Report



```

CONFIG
  | report
  | id1
  | :
  | id2
  | report id
  | instrument id
  | date & time
  | method
  | electrode id
  | signature
  | line feed
    
```

In the configuration menu **report** you can define the output format of the report header. This describes the first lines of a measuring point report (see also *Section 7.2.3*) and can be either placed in front of each measured value to be printed out or before a series of measured values (see following section).

A report header containing all the elements described here could look like this:

```

Report Id: 'mp
Instrument Id: 781 pH/Ion Meter          5.781.0020
Date, Time: Datum 2004-05-24  09:50:56
User *: user                            C. Weber
Mode / Method / Run number: pH          pH-1          run number 9
Electrode Id: electr.id                pH electr.1
Sample Id1: id1                        batch 21
Sample Id2: id2                        sample A01

Signature: Signature
    
```

*The **'user'** line is not configured here. The entry of a user name takes place automatically when a user has been defined with the **<USER>** key. The name remains active until it is deleted or another user name is selected (see *Section 4.3*).

id1, id2 (max. 16 characters)

This is where you can define short texts as additional information for the report header. Each of these entries will be printed out in a single line in each report. In addition, you can also request these Ids before each measurement as a preselection (see method parameter **preselections** in *Section 6*), e.g. in order to mark each sample specifically.

report id: ON, OFF

This setting defines whether the report Id is to be printed out in the first line of the report header. It is used to identify the report.

instrument id: ON, OFF

You can include the instrument identification in the report header if you want to. It consists of the exact type name of the pH/Ion Meter with the version number of the instrument software.

An additional way of assigning report printouts to a particular instrument is by using an individual instrument name under **CONFIG/auxiliaries/device label** (see Section 5.4). This will then be printed out automatically in a separate line in the report header after the instrument Id.

date & time: ON, OFF

This setting defines whether the date and time of the report printout are to be printed. The date and the exact time of the measurement can additionally be printed with each successive measured value (see following section).

method: ON, OFF

As well as the mode name, the name of the method used can also be printed out in the report header if required. You can define this previously by storing the method parameters used with **<METHODS>**. If no method name has yet been defined then the character sequence ********* will appear.

electrode id: ON, OFF

You can include the electrode name in the report header if you have defined an electrode ID for the currently valid calibration. Otherwise this field in the report header will remain empty.

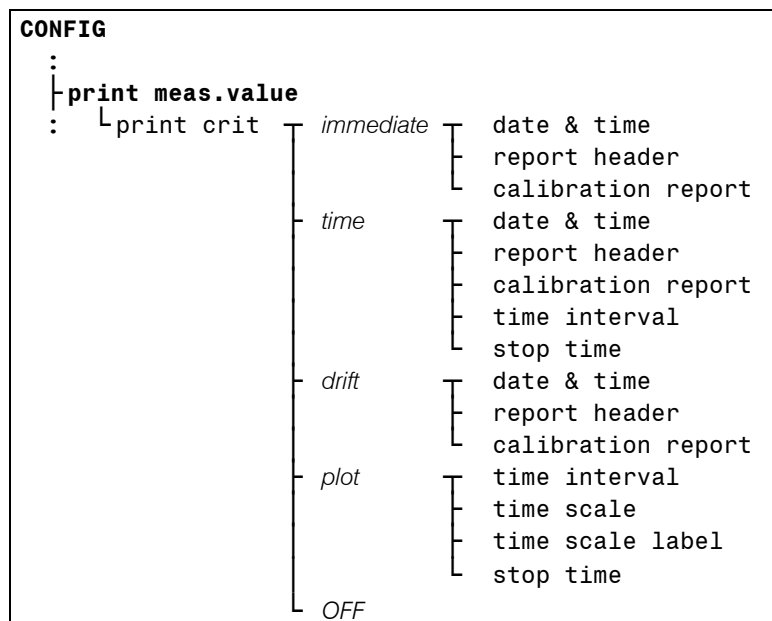
signature: ON, OFF

Reports which contain measuring data (measuring point, addition, calibration and electrode test reports) can, depending on the configuration, have a signature line added on. In this way the result can be provided with a signature.

line feed form, 0,1,2,3...999

The paper feed of the printer at the end of a report can be set here. With continuous paper printers (e.g. Custom) you can select the number of empty lines so that after the report has been printed out you can tear off the printed paper directly at a suitable point. For single page printers (e.g. HP DeskJet) you can enter the special value **'form'** with **<CLEAR>** so that the printed page will automatically be produced by the printer after each report.

5.2 Printing out measured values



In the configuration menu **print meas.values** the output form of measured values, triggered by **<MEAS/PRINT>**, is defined. This is only possible for the direct measuring modes pH, T, U and Conc(direct).

print crit: **immediate, time, drift, plot, OFF**

Depending upon the print criterion a measured value report will be transmitted via the RS232 interface to a printer or PC either **immediately**, at defined **time** intervals or only when a **drift** condition has been fulfilled. If a stirring sequence is intended before the measurement (**PARAMETERS/measuring parameters/stirrer: control**, see Section 6), then these print criteria will only be effective when the stirring sequence has been concluded.

A further way of documenting the measured values is to output a graphical **plot** of the measured value signals.

print crit.: **immediate**

With this setting a measured value report will be produced when **<MEAS/PRINT>** is activated from the normal instrument display. The following options can be used:

date & time: **ON, OFF**

Here you can choose whether the date and time at which the measured value was recorded are to be included with each individual measured value. This can take place irrespective of whether a report header is used.

report header: **once, always, OFF**

Normally each measured value is accompanied by the report header for documentation purposes. The exact contents of the report header are defined under **CONFIG/Report** (see above).

With a larger series of manually triggered measurements it may be advisable to print out the report header only once with the first measured value. In this case all the measurements should be made under the same conditions. The report header will only appear again when the run number has been reset to zero by switching the instrument off and on.

calibration report: ON, OFF

You have the possibility of providing each measured value with the associated calibration data of the electrode used, e.g. within the context of a GLP documentation.

print crit: time

With this print criterion you can automatically record and output the measured values at fixed intervals. The following options are used:

date & time: ON, OFF
report header: once, always, OFF
calibration report: ON, OFF

These settings correspond to those of the print criterion 'immediate' (see above).

time interval: 0.1...4.0...99999.0 s

Automatic measuring value recording can be carried out at time intervals of down to 0.1 s. Please note that if small time intervals are used then the amount of data for each measured value must be adapted accordingly, as otherwise the buffer memory of the connected printer or PC would be filled too quickly. This means, for example, that the report header should only be printed out once at the start of a series of measurements. Otherwise data could be lost at the RS232 interface of the receiver. In this case you should consider matching the measured value recording interval to the measured value memory (see *Section 5.3*).

stop time: OFF, 1...999999 s

The time after which an automatic series of measurements is to be terminated can be entered in whole seconds. You can also let a series of measurements run indefinitely without a fixed stop time and then stop it manually with **<QUIT>** if you select 'OFF' for this setting.

`print crit.: drift`

If this print criterion is used then a measured value will only be documented when the drift condition defined under **PARAMETERS/measuring parameters/drift** has been fulfilled.

`date & time: ON, OFF`
`report header: once, always, OFF`
`calibration report: ON, OFF`

These settings correspond to those of the print criterion '**immediate**' (see above).

`print crit.: plot`

The directly recorded values can be outputted graphically as a measured value/ time plot.

`time interval: 0.1...4...99999.0 s`

In a similar way to the print criterion '**time**' a time interval can be defined for graphical measured value recording.

`time scale: 5,10,30,60,120,180..99960 s/cm`

This is the time axis scale. The reciprocal value of the quantity entered corresponds to the paper feed rate. This means that, e.g., for a required feed rate of 2 cm/min a time scale of 1/2 min/cm = 30 s/cm must be entered.

`time scale label.: rel, abs`

The time axis scale can use the relative time in minutes and seconds (start = 0 s). The current time can also be used with '**abs**'.

`stop time: OFF, 1...999999 s`

The graphical plot is terminated when the stop time has elapsed or will continue indefinitely ('**OFF**'). In both cases termination is possible with **<QUIT>**.

5.3 Storing measured values



```

CONFIG
:
| store meas. value
: | store crit | immediate, drift, OFF
| | time | time interval
| | | stop time
    
```

In the direct measuring modes pH, T, U and Conc(direct) you can use **<STORE>** to store up to 100 measured values with additional information in the instrument memory (see *Section 7.3*). The functions of the settings to be defined under **CONFIG/store meas. value** correspond to those made under **CONFIG/print meas. value**:

store crit: immediate, time, drift, OFF

This storage criterion also only becomes effective when an optional stirring sequence has been concluded.

In contrast to the report output, the combination of the information stored together with each measured value is fixed.

store crit: immediate

The current measured value is stored with **<STORE>**.

store crit: time
time interval: 0.1...4.0...99999.0 s
stop time: OFF, 1...999999 s

You can automatically record and save the measured values at fixed time intervals until the stop time has been reached.

store crit: drift

A measured value can also be stored when the drift condition defined under **PARAMETERS/measuring parameters/drift** has been fulfilled.

After 100 measured values have been stored, and each time a further storage attempt is made, the pH/Ion Meter will produce a corresponding warning:

⚠ **measured value memory full**

You now have the possibility of using **<RECALL>** to view the stored measured values, of deleting individual measured values or of clearing the whole measured value memory (see *Section 7.3*). It is also possible to output all measured values as a report via the RS232 interface (see *Section 7.2.8*).

5.4 Auxiliaries

```

CONFIG
:
| auxiliaries
: | run number
  | last digit
  | dialog
  | display
  | LCD off after
  | date
  | time
  | time zone
  | temp.sensor
  | temp.unit
  | device label
  | beep
  | program

```

Various basic settings for the configuration of the pH/Ion Meter are made in this submenu.

run number **0, 1, 2, 3...999, OFF**

The run number is included in the report. It is increased by one after each measuring process. This applies to both the storage of measured values and to the calibration or pH electrode test and makes the later chronological assignment of such different measuring processes easier.

When the instrument is switched on the run number is automatically set to '0'. The first measuring process begins with '1'.

last digit: **ON, OFF**

This setting can be used to conceal the last decimal place of the measured value display. The displayed value is rounded off accordingly. This can be useful in improving the readability of a rapidly changing measured value. Please note that this setting does not influence the drift control of a measurement.

dialog: **english, deutsch, français, español**

The dialog language covers both the language shown on the display and that used in the report. Switch the instrument off and on if this setting has been changed.

display: **positiv, negativ**

You can choose whether you want to have a positive or negative display presentation, e.g. in order to adapt it to the local lighting conditions.

LCD off after **1,2...999 min, OFF**

The display of the pH/Ion Meter has an illuminated background. In order to increase the working life of the lamp you can switch off the display automatically when the instrument has not been used for a certain time. Please note that, if the lamp is switched off and on too frequently then its working life will also be reduced. This means that times of about 30 min can be recommended.

The fact that the LCD illumination is switched off does not affect the functioning of the pH/Ion Meter in any way. It continues to work normally. The lamp can be activated again with any key except **<ON/OFF>**. Please note that the **<ON/OFF>** key switches the instrument off. All other keys only have the function of activating the LCD illumination. This means, for example, that runs will not be terminated when the **<QUIT>** key is used to reactivate the background illumination.

date **YYYY-MM-DD**
time **hh:mm:ss**

You can set the date and time here. The program will only accept numbers which make sense.

time zone 12 ASCII characters

For complete documentation you can add details of the time zone to the time information for output in the report header. The input of up to any 12 characters is possible. Examples: 'MEZ', 'UTC-05:00' (*Coordinated Universal Time* minus 5 h) or location of the measurement.

temp.sensor: **Pt1000, NTC**

The 780/781 pH/Ion Meter supports the use of two different types of temperature measuring techniques T: Pt1000 (platinum resistance thermometer) and NTC ('Negative Temperature Coefficient' semiconductor). This means that the configuration must be adapted accordingly. If NTC sensors are used then it is also necessary to enter two sensor characteristics; these can be found in the specification of the sensor:

R(25 °C)	10000...30000...100000
B value	1000...4100...9999

The standard values $R(25\text{ °C}) = 30000\text{ ohm}$ and $B\text{ value} = 4100\text{ K}$ apply to the use of a Metrohm electrode with NTC sensor (e.g. 6.0228.010 LL Solitrode NTC), where the B value refers to 25 °C and 50 °C. B values of other NTC sensors are frequently based on different reference temperatures (usually 25 °C / 50 °C – 100 °C). When entering your own sensor characteristics the effect of the second reference temperature on the measuring accuracy of an NTC sensor is negligible.

temp.unit: **C, F**

The pH/Ion Meter can work with temperature information in both °C and °F units.

Please note that, when changing this setting, the default value of the measuring parameter drift in the T mode has the unit °C and, if necessary, must be converted as follows:

$$T_F = 32 + 1.8 \cdot T_C \quad \text{or} \quad T_C = (T_F - 32)/1.8$$

T_F : temperature in °F

T_C : temperature in °C

device label 12 ASCII characters

If apart from the instrument Id you wish to assign a further name to a particular pH/Ion Meter for inclusion in the report then you can enter your text here, e.g. '**Lab 2.01**' or '**Works 2**'. This will then be included in the report header in a separate line inserted after the instrument Id.

beep: **OFF, 1, 2, 3**

Messages on the display of the pH/Ion Meter are accompanied by a beep. This can be switched off completely or just limited to a sequence of 2 or 3 beeps.

program

This is the version number of the instrument software and cannot be altered. It is included in the report header as part of the instrument Id.

5.5 Monitoring

```

CONFIG
:
| monitoring
: | validation
  | service
  | system test report
    
```


The 780/781 pH/Ion Meter can inform you automatically about reoccurring quality monitoring tasks.

```

validation: ON, OFF
    time interval    1...365...9999 d
    time counter     0 d
    
```

If this option is active then you can enter a time interval in days and, when it has elapsed, the instrument will request you to carry out a validation process.

In addition, the time counter shows the elapsed time in days since the last time that this option was switched on. When the time counter reaches the set number of days then the following message will appear:

 **validate instrument**

This will also be included in the report header. It can only be removed in the following ways:


- Resetting the time counter to zero under **CONFIG/monitoring/validation** with **<CLEAR>**
- Extending the time interval and then switching the instrument off and on again
- Switching off the validation monitoring option

In order to prevent unauthorized removal of the message the **<CONFIG>** key can be disabled under the instrument **SETUP** (see Section 7.5.1), so that the settings described above are no longer accessible.

```

service:          ON, OFF
    next service    YYYY-MM-DD
    
```

At a particular time the instrument can remind you about the date when a service is due. When the set date has been reached the following message appears on the display:

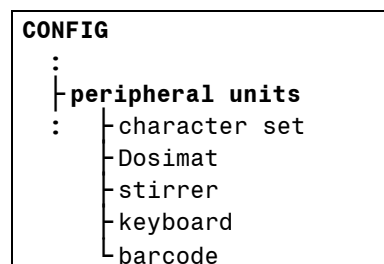
 **service is due**

This is also included in the report header and can be switched off by either entering a new and later service date or by switching this monitoring function off.

system test report: **ON, OFF**

When it is switched on the 780/781 pH/Ion Meter automatically carries out a system diagnosis. The result can be outputted as a system test report (see *Section 8.4.1*).

5.6 Peripheral units



Various peripheral units can be connected to the 780/781 pH/Ion Meter. The corresponding configurations must be carried out here.

character set: **IBM, Epson, Seiko, Citizen, HP**

The type of printer chosen for the report printout is selected here. If you have connected a PC to the RS 232 interface for data reception then set this parameter to '**IBM**'.

Dosimat: **665, 725, 765, 776**

The 781 pH/Ion Meter can be used to control a Metrohm Dosimat Plus, e.g. for the automated production of standard solutions for the calibration of ion-sensitive electrodes. Analyses involving the addition of standard and sample solutions can also be automated in this way. In order to control an 865 or 876 Dosimat Plus, make sure that the Dosimat 665 is selected. Please note the required settings at the Dosimat Plus (see Ch. 2.3.3).

stirrer: **8xx, 7xx**

Metrohm stirrers of the series 8xx and 7xx can be connected to the pH/Ion Meter. In order to connect 7xx series stirrers the use of a remote box (6.2148.010) at the MSB connection of the pH/Ion Meter is necessary (see *Section 9.5*). For example, both types of stirrer can be switched on and off from the pH/Ion Meter with **<STIRRER>**. With 8xx series stirrers the stirring rate can also be controlled from the pH/Ion Meter (see **PARAMETERS/measuring parameters/Stirrer**). If you are using a stirrer of another manufacturer, then you must select '**7xx**'.

keyboard: **US, deutsch, français, español, schweiz.**

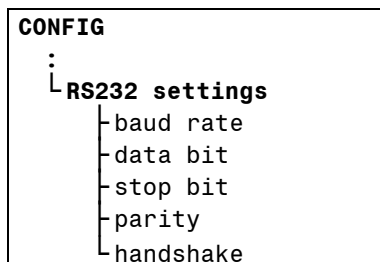
If texts have to be entered frequently it may be a good idea to connect a PC keyboard. The language-specific keyboard layout is then set here. Older PC keyboards may possibly have a too-high power consumption, which could result in the cancellation of the system test when the in-

strument is switched on. In such a case remove the connected keyboard and switch on the instrument again.

barcode: **input, id1, id2**

For data input you can also use a barcode reader which provides a PS/2 connection. Older barcode reader may possibly have a too-high power consumption, which could result in the cancellation of the system test when the instrument is switched on. In such a case remove the connected keyboard and switch on the instrument again.

5.7 RS232 settings



For communication with instruments (printer, PC) connected to the serial RS232 interface the correct setting of these parameters is required:

baud rate: 38400, 19200, **9600**, 4800, 2400, 1200,
 600, 300
 data bit: 7, **8**
 stop bit: 1, 2
 parity: even, **none**, odd
 handshake: **HWs**, SWChar, SWline, none

Please refer to the manual of your printer for the exact settings. When a computer is connected the corresponding configuration can usually be carried out in the terminal program used.

6 Methods / Parameters

The exact measuring method of the pH/Ion Meter is described by method parameters which, like the instrument configuration, are arranged in a tree structure in the menu display. The complete tree is shown in the Annex (see Section 9.3) to provide a better overview.

The parameters are set in a similar way to the instrument configuration. In contrast, however, the administration of the method parameters is mode-specific. The selection of the method parameters also varies with the selected mode. For this reason the method parameters for each mode are described separately in this section.

This means that one of the following subsections, together with the instrument configuration, forms a complete description of all the settings which are important for the operation of the pH/Ion Meter in a particular measuring mode.

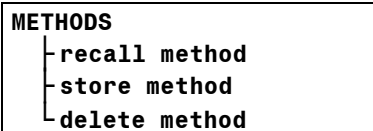


Please note that editing numerical values with more than 7 digits can result in rounding effects. In this case, consider the exponential notation or a different concentration unit (see Section 6.5.2, 781 only).

6.1 Method management



Press <METHODS> if you want to save all current parameter settings as a method. You can also load or delete methods within this dialog.



For each selection you can edit a method name with <ABC> or select one with <SELECT>.

All saved methods are accessible in all modes. If you load a method which requires a different mode than the actual, the pH/Ion Meter will switch to this mode automatically.

6.2 pH measurement (pH mode)

6.2.1 Measuring parameters

PARAMETER pH	
	measuring parameters
:	electr.id
	drift pH
	temperature*
	method
	delta measurement
	stirrer

(* only appears if no temperature sensor is connected)

The **measuring parameters** describe the settings which are of direct importance for the measurement.

electr.id: 12 ASCII characters

You can assign any name you like to the connected pH electrode. During a calibration the resulting calibration data will be assigned to this entered electrode Id and stored. The electrode Id will then be included in the report header for the output of measured values.

In this way you can enter several electrode Ids. This allows you to switch between various pH electrodes with their associated calibration data. However, a requirement is that each new electrode Id is linked with a new calibration. Then you can use **<SELECT>** under the measuring parameter **Electr. Id** to select one of the stored electrode Ids.

In order to delete an electrode Id and its linked calibration data this must be reset under **<CAL.DATA>** (**Reset cal.**, see *Section 7.1.1*).

drift pH 0.001...0.050...9.999/min, OFF

A measuring signal which changes as a function of time is regarded as being sufficiently constant when its drift drops below the value defined here. This can be used as criterion for the pH/Ion Meter if a displayed measured value is to be stored or documented by printing a report (see print criterion and storage criterion in *Section 5.2* and *Section 5.3*). Please note that for a drift-controlled measured value recording this drift parameter must not be set to 'OFF', as otherwise no result will be exported.

If the drift condition is not fulfilled then this is indicated by two constantly blinking triangles in the display.

An active drift control increases the reproducibility of the measurements as a constant condition is used to define the measured result. A smaller value for the measuring parameter Drift pH requires a more stable measuring signal than a larger one. The set measuring parameter is also proportional to the measuring uncertainty of the measured value obtained.

Please note that the drift condition defined here and the temperature parameter described below do not apply to the calibration and, if necessary, must be set separately under the calibration parameters.

temperature -999.9...25.0...999.9 °C

This menu item only appears when no temperature sensor is connected. In this case you can enter the temperature of the sample solution here. If the measuring and calibration temperatures are different then it is necessary to record the temperature for the automatic correction of the electrode slope (temperature compensation, see *Section 9.2.1*). Information about the measuring temperature is also absolutely necessary for the complete documentation of a pH value. In the report printout of the measured value this manually determined temperature is indicated by the suffix '**manual**'.

method 8 ASCII characters

All parameter settings can be stored together or loaded as a method (see *Section 6.1*). The name of the current method is then given here. This field is only used for information here and cannot be edited directly.

delta measurement ON, OFF

The delta measurement permits the display of the measured value relative to a freely selectable constant reference value:

reference pH -19.999...0.000...19.999

This reference value is subtracted from the measured value itself. The modified measured value is shown together with this value and is taken into consideration, for example, in checking the limit values (see **PARAMETER pH/limits pH**). The reference value is not included in the report. However, should you still want to document it then you should also produce a parameter report (see *Section 7.2.7*).

stirrer: ON, OFF, control

You can choose whether the pH measurement is to be made while stirring is being carried out or not. A requirement is that a Metrohm stirrer is connected with a suitable cable (see *Section 2.3*). If an 8xx series stirrer has been connected and the settings made under **CONFIG/peripheral units** then the stirring rate can also be selected:

stirring rate 1...5...15

If you want your measurement to be made without stirring but still want to stir the solution before the measurement then you should select the **control** setting. In this way you can trigger a stirring sequence before the start of each measurement with <MEAS/PRINT>:

prestir pause 0...99999 s
stir time 0...99999 s
poststir pause 0...99999 s

The prestir and poststir pauses represent waiting periods in which stirring does not take place. The measurement itself only starts when the complete stirring sequence has ended.

Please note that this parameter is binding for the report output and for storing a measured value. Therefore when you start a measurement with <MEAS /PRINT> the stirrer will be switched on and off accordingly. This is why you should preferably carry out **drift-controlled** measurements (see *Section 5.2* and *Section 5.3*).

6.2.2 Calibration parameters

PARAMETER pH	
:	
	calibration parameters
:	temperature*
	drift
	report
	cal. interval
	no.of buffers
	buffer type
	low lim.slope
	up lim.slope
	low lim.pH(0)
	up lim.pH(0)
	offset Uoff state

(*only appears if no temperature sensor is connected)

The calibration parameters describe the most important settings for the calibration such as buffer types and tolerance values. The evaluation of the pH calibration is described in *Section 9.2.1*.

temperature **0.0...25.0...99.9 °C**

Just as for the measuring temperature, the calibration temperature should also be entered when no temperature sensor is connected. If the measuring and calibration temperatures are different then this is absolutely necessary for the automatic temperature correction of the electrode slope. The temperature is also stored with the suffix '**manu-
al**' and marked in this way in the calibration report.

The exact temperature recording is also important for the pH calibration as the pH/Ion Meter works with automatic buffer recognition (see below: **buffer type**).

drift **0.1...0.5...9.9 mV/min**

Just as in the pH measurement, the potential measurement for the pH calibration is drift-controlled. However, this drift control cannot be switched off. Please note that, in contrast to pH measurement, the drift for the pH calibration is entered in mV/min. It is therefore inevitably different from the drift for pH measurement (see *Section 6.2.1*).

report: OFF, short, full

After the calibration it is possible to output the calibration data automatically in the form of a report. You should choose between the 'short' version which contains all the relevant data and the 'full' version which additionally shows the calibration curves in the form of a graph (see *Section 7.2.4*).

Such a report can also be exported at a later date with the calibration data of each stored electrode Id.

cal. interval OFF, 1...999 h

The pH/Ion Meter can automatically remind you about any recalibration of the pH electrode which is due. This means that if a calibration is carried out with a preset calibration interval then, when this interval has elapsed, a message will appear on the display:

 **cal.interval expired**

This message remains and will be printed out on every measuring point report until a new calibration has been carried out.

no. of buffers 1, 2...9

Up to 9 buffers can be used for the pH calibration. If calibration is carried out with only one buffer then the program will use the theoretical value of 100.0% for the slope. This also applies when a calibration with several buffers is canceled with **<MODE>** or **<QUIT>** after the first buffer has been measured and then confirmed with **<ENTER>**.

If three or more buffers are used then the variance will be included in the calibration data. More detailed information about the evaluation is given in *Section 9.2*.

buffer type: Metrohm, NIST, DIN, Fisher, Fluka-BS, Mettler, Merck Tit., Merck Cer., Beckman, Radiometer, Baker, Hamilton, Precisa, special, own, mixed

For the automatic temperature-specific buffer recognition during the calibration and for the electrode test, information about the type of buffer used is required. In the pH/Ion Meter the temperature-dependent pH values of reference buffer solutions and technical buffer solutions from some suppliers are stored. Such a buffer table for Metrohm buffers looks like this:

Metrohm buffers			
T [°C]	pH 4.00	pH 7.00	pH 9.00
0	3.99	7.11	9.27
5	3.99	7.08	9.18
10	3.99	7.06	9.13
15	3.99	7.04	9.08
20	3.99	7.02	9.04
25	4.00	7.00	9.00
30	4.00	6.99	8.96
35	4.01	6.98	8.93
40	4.02	6.98	8.90
45	4.03	6.97	8.87
50	4.04	6.97	8.84
55	4.06	6.97	8.81
60	4.07	6.97	8.79
65	4.09	6.98	8.76
70	4.11	6.98	8.74
75	4.13	6.99	8.73
80	4.15	7.00	8.71
85	4.18	7.00	8.70
90	4.20	7.01	8.68
95	4.23	7.02	8.67


The other stored buffer tables are described in *Section 9.4*. During the calibration the pH/Ion Meter shows the type and temperature-specific pH value of the recognized buffer. For temperatures within the 5 °C steps the pH value is linearly interpolated.

buffer type: special

If you would like to use different buffers from those described, then you require the exact pH value of each buffer at the temperature used for calibration. These pH values can be entered here. During the calibration they can again be adapted before each measurement.

buffer type: own


If further temperature-specific pH values are known for such buffers then under **own** you can enter up to five such pH(T) series at steps of 5 °C. The query starts at 0 °C and finishes at 95 °C or earlier, if **OFF** is entered with **<CLEAR>**.

If you do not know the pH values for individual temperatures just enter zero. However, you can also calculate these values by linear interpolation and enter them. Missing pH definitions will otherwise be shown during the calibration by **negative** values; the calibration will then be interrupted with the error message  **buffer not defined**.

buffer type: mixed

A further way of using the stored buffer table is to combine a maximum of five different buffer types to form a new series. You can make your selection from all the stored buffers described in *Section 9.4*.

A general rule is that you can only calibrate in defined temperature ranges, as otherwise the error message:

 buffer not defined

appears. If you use more than two buffers for the calibration then you can use certain buffers several times in order to give them a better statistical weight.

low lim.slope	0.1... 95.00 ...999.9 %
up lim.slope	0.0... 103.0 ...999.9 %
low lim.pH(0)	-99.999... 6.40 ...99.999
up lim.pH(0)	-99.999... 8.00 ...99.999

)The most important calibration data such as slope and pH(0) must lie within the limits defined here in order for them to be automatically adopted. The given default values for the slope correspond to the quality criteria of a "passing electrode" in the electrode test (see *Section 8.6*).

If one of the values of the calibration data lies outside these limits then at the end of the calibration the following message will appear: **cal. data out of limits**; you can then accept or reject the results.

offset Uoff state: **OFF, ON**
 offset Uoff -2200.0...**0.0**...2200.0 mV

The automatic buffer recognition of the pH/Ion Meter assumes an offset potential of 0 ± 30 mV for the electrode used. Ag/AgCl reference electrodes normally meet this requirement. If other reference systems are used, e.g. a calomel electrode, then the offset potential may be outside this range. This means that for correct buffer recognition this variation must be compensated by entering the specific offset potential Uoff. For the pH measurement itself this parameter is unimportant.

6.2.3 Limits pH

```

PARAMETER pH
:
| limits pH
:  Lstate

```

In the direct measuring modes the pH/Ion Meter has a limits function which allows the control of the parameter to be monitored. The control signals are transmitted via the MSB connection to the optional remote interface (6.2148.010) (see *Section 9.5*). Out of limits conditions are also shown on the display and documented in the report.

```

state:                ON, OFF
  u.limit pH          -19.999...14.000...19.999
  u.hyst. pH          -19.999...0.020...19.999
  l.limit pH          -19.999...0.000...19.999
  l.hyst. pH          -19.999...0.020...19.999

```

The exact way in which the limits function works is described in *Section 7.4* independent of the mode.

6.2.4 Limits T

```

PARAMETER pH
:
| limits T
:  Lstate

```

As well as the primary measuring quantity pH, the temperature can also be controlled by the limits function. However, you should only activate the limits function for the temperature when a temperature sensor is connected, as otherwise an error message will appear.

```

state:                ON, OFF
  u.limit             -999.9...100.0...999.9 °C
  u.hyst.             -999.9...0.2...999.9 °C
  l.limit             -999.9...0.0...999.9 °C
  l.hyst.             -999.9...0.2...999.9 °C

```

A detailed description of the remote lines is given in *Section 9.5*. The exact way in which the limits function works is described in *Section 7.4* independent of the mode.

6.2.5 Plot parameters

```
PARAMETER pH
:
| plot parameters
: | left mar. pH
  | right mar. pH
  | left marg.T
  | right marg.T
```

The two directly recorded measuring quantities pH and temperature can be printed out as a function of time in a plot. Under **CONFIG/print meas. value** the print criterion 'plot' must be selected (see Section 5.2). The scales of the measured values axes are determined by the following limits.

left mar. pH	-19.9...0.0...19.9
right mar. pH	-19.9...14.0...19.9
left marg.T	-999...20...999 °C
right marg.T	-999...30...999 °C

TIP !

The value for the right-hand limit of a plot must not necessarily be the larger one. By exchanging the limits the plot of the particular quantity can be mirrored.

6.2.6 Preselections

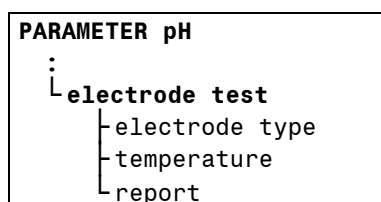
```
PARAMETER pH
:
| preselections
: | req.ident
```

req.ident.: id1, id1 & id2, **OFF**

For sample identification you can document each measured value with two Ids in the report header. These can either be predefined under **CONFIG/report** and included in each report or, depending on the preselections setting, they can be requested before each measurement.

Please note that sample identifications requested as a preselection before the measurement will also be stored as an entry under **CONFIG/report**. This means that they are again available for the next measurement.

6.2.7 Electrode test



The pH/Ion Meter can carry out a pH electrode test, which permits the quality of the electrode used to be evaluated. A detailed description of the electrode test is given in *Section 8.6*.

electrode type: standard, gel, non-aq., own

Various types of pH electrodes have different evaluation criteria. For the three most commonly used Metrohm pH electrode types the tolerances are stored in the pH/Ion Meter: standard electrodes, gel electrodes and non-aqueous electrodes.

electrode type: own

If you wish to define your own tolerances then select '**own**'. You can now enter the limits for the quality features '**excellent electrode**', '**good electrode**' and '**passing electrode**'. An explanation of the individual limits is given in *Section 8.6.3*.

Regardless of the electrode evaluation, if '**own**' is selected as the electrode type then you can also edit the limits for the offset potential U_{off} . This allows the electrode test to be carried out with pH electrodes which, even with an Ag/AgCl reference electrode, show a clearly shifted zero potential (e.g. antimony electrode). The use of other reference electrodes can also result in changed zero potentials.

temperature 0.0...25.0...99.9 °C

If no temperature sensor is connected then enter the temperature at which the buffer will be measured here.

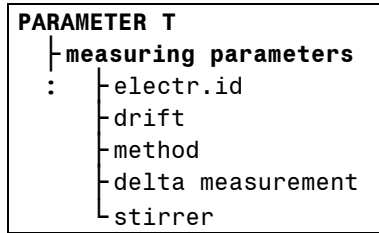
report: OFF, short, full, line

After the electrode test you can automatically output the result in the form of report. You can choose between the 'short' version containing all the relevant data and the 'full' version, which also shows the measuring curves as a graph. If you are only interested in the evaluation of the electrode itself then select '**line**'. Only the result will be printed out, e.g. '**excellent electrode**'. If no printer is connected then please select '**OFF**'.

The report of the last pH electrode test can also be printed out later with **<REPORT>** (see *Section 4.3*).

6.3 Temperature measurement (T mode)

6.3.1 Measuring parameters



The measuring parameters describe the settings of direct importance for the measurement.

electr.id 12 ASCII characters

You can assign any name you want to the connected temperature sensor. This sensor Id is then contained in the report header for measured values.

drift 0.5...1.0...999.9 °C/min, OFF

A measuring signal which changes as a function of time is regarded as being sufficiently constant when its drift drops below the value defined here. This can be used as criterion for the pH/Ion Meter if a displayed measured value is to be stored or documented by printing a report (see print criterion and storage criterion in *Section 5.2* and *Section 5.3*). Please note that for a drift-controlled measured value recording this drift parameter must not be set to **'OFF'**, as otherwise no result will be exported.

If this drift condition is not fulfilled then this is indicated by two constantly blinking triangles in the display.

An active drift control increases the reproducibility of the measurements as a constant condition is used to define the measured result. A smaller value for the measuring parameter Drift requires a more stable measuring signal than a larger one. The set measuring parameter is also proportional to the measuring uncertainty of the measured value obtained.

method 8 ASCII characters

All parameter settings can be stored together or loaded as a method (see *Section 6.1*). The name of the current method is then given here. This field is only used for information here and cannot be edited directly.

delta measurement: ON, OFF

The delta measurement permits the display of the measured value relative to a freely selectable constant reference value:

reference -999.9...0.0...999.9 °C

This reference value is subtracted from the measured value itself. The modified measured value is shown together with this value and is taken into consideration, for example, in checking the limit values (see **PARAMETER T/limits T**). The reference value is not included in the report. However, should you still want to document it then you should also produce a parameter report (see *Section 7.2.7*).

stirrer: **ON, OFF, control**

You can choose whether the pH measurement is to be made while stirring is being carried out or not. A requirement is that a Metrohm stirrer is connected with a suitable cable (see *Section 2.3*). If an 8xx series stirrer has been connected and the settings made under **CONFIG/peripheral units** then the stirring rate can also be selected:

stirring rate **1...5...15**

If you want your measurement to be made without stirring but still want to stir the solution before the measurement then you should select the **control** setting. In this way you can trigger a stirring sequence before the start of each measurement with **<MEAS/PRINT>**:

prestir pause **0...99999 s**
stir time **0...99999 s**
poststir pause **0...99999 s**

The prestir and poststir pauses represent waiting periods in which stirring does not take place. The measurement itself only starts when the complete stirring sequence has ended. Please note that this parameter is binding for the report output and for storing a measured value. Therefore when you start a measurement with **<MEAS/PRINT>** the stirrer will be switched on and off accordingly. This is why you should preferably carry out **drift-controlled** measurements (see *Section 5.2* and *Section 5.3*).

6.3.2 Limits T

```

PARAMETER T
:
| limits T
: | state

```

In the direct measuring modes the pH/Ion Meter has a limits function which allows the control of the parameter to be monitored. The control signals are transmitted via the MSB connection to the optional remote interface (6.2148.010) (see *Section 9.5*). Out of limits conditions are also shown on the display and documented in the report.

state: **ON, OFF**

u.limit **-999.9...100.0...999.9 °C**
u.hyst. **-999.9...0.2...999.9 °C**
l.limit **-999.9...0.0...999.9 °C**
l.hyst. **-999.9...0.2...999.9 °C**

The exact way in which the limits function works is described in Section 7.4 independent of the mode.

You should only activate this limits function for the temperature if a temperature sensor is connected, as otherwise the following message will appear

⚠ limit error

6.3.3 Plot parameters

```
PARAMETER T
:
├─plot parameters
:   └─left mar.
      └─right mar.
```

The measured temperature can be printed out as a function of time in a plot. Under **CONFIG/print meas. value** the print criterion 'plot' must be selected (see Section 5.2). The scales of the measured values axes are determined by the following limits.

left mar.	-999.9...0.0...999.9 °C
right mar.	-999.9...100.0...999.9 °C

TIP !

The value for the right-hand limit of a plot must not necessarily be the larger one. By exchanging the limits the plot can be mirrored.

6.3.4 Preselections

```
PARAMETER T
:
├─preselections
└─req.ident
```

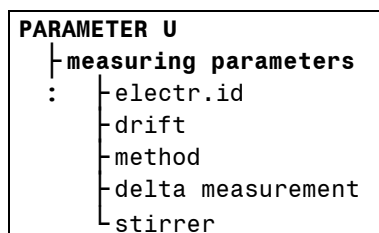
req.ident: id1, id1 & id2, **OFF**

For sample identification you can document each measured value with two Ids in the report header. These can either be predefined under **CONFIG/report** and included in each report or, depending on the Preselections setting, they can be requested before each measurement.

Please note that sample identifications requested as a preselection before the measurement will also be stored as an entry under **CONFIG/report**. This means that they are again available for the next measurement.

6.4 Potential measurement (U mode)

6.4.1 Measuring parameters



The measuring parameters describe the settings which are of direct importance for the measurement.

electr.id 12 ASCII characters

You can assign any name you like to the connected pH electrode. The electrode Id will then be included in the report header for the output of measured values.

drift 0.1...1.0...999.9 mV/min, OFF

A measuring signal which changes as a function of time is regarded as being sufficiently constant when its drift drops below the value defined here. This can be used as criterion for the pH/Ion Meter if a displayed measured value is to be stored or documented by printing a report (see print criterion and storage criterion in *Section 5.2* and *Section 5.3*). Please note that for a drift-controlled measured value recording this drift parameter must not be set to 'OFF', as otherwise no result will be exported.

If this drift condition is not fulfilled then this is indicated by two constantly blinking triangles in the display.

An active drift control increases the reproducibility of the measurements as a constant condition is used to define the measured result. A smaller value for the measuring parameter Drift requires a more stable measuring signal than a larger one. The set measuring parameter is also proportional to the measuring uncertainty of the measured value obtained.

method 8 ASCII characters

All parameter settings can be stored together or loaded as a method (see *Section 6.1*). The name of the current method is then given here. This field is only used for information here and cannot be altered directly.

delta measurement: ON, OFF

The delta measurement permits the display of the measured value relative to a freely selectable constant reference value:

reference -2200.0...0.0... 2200.0 mV

This reference value is subtracted from the measured value itself. The modified measured value is shown together with this value and is taken into consideration, for example, in checking the limit values (see **PARAMETER U/limits U**). The reference value is not included in the report. However, should you still want to document it then you should also produce a parameter report (see *Section 7.2.7*).

stirrer: ON, OFF, control

You can choose whether the pH measurement is to be made while stirring is being carried out or not. A requirement is that a Metrohm stirrer is connected with a suitable cable (see *Section 2.3*). If an 8xx series stirrer has been connected and the settings made under **CONFIG/Peripheral units** then the stirring rate can also be selected:

stirring rate 1...5...15

If you want your measurement to be made without stirring but still want to stir the solution before the measurement then you should select the **control** setting. In this way you can trigger a stirring sequence before the start of each measurement with **<MEAS/PRINT>**:

prestir pause 0...99999 s
 stir time 0...99999 s
 poststir pause 0...99999 s

The prestir and poststir pauses represent waiting periods in which stirring does not take place. The measurement itself only starts when the complete stirring sequence has ended. Please note that this parameter is binding for the report output and for storing a measured value. Therefore when you start a measurement with **<MEAS/PRINT>** the stirrer will be switched on and off accordingly. This is why you should preferably carry out **drift-controlled** measurements (see *Section 5.2* and *Section 5.3*).

6.4.2 Limits U

```
PARAMETER U
:
: |limits U
: |  Lstate
```

In the direct measuring modes the pH/Ion Meter has a limits function which allows the control of the parameter to be monitored. The control signals are transmitted via the MSB connection to the optional remote interface (6.2148.010) (see *Section 9.5*). Out of limits conditions are also shown on the display and documented in the report.

state:	ON, OFF
u.limit	-2200.0... 1000.0 ...2200.0 mV
u.hyst.	-2200.0... 2.0 ...2200.0 mV
l.limit	-2200.0...- 1000.0 ...2200.0 mV
l.hyst.	-2200.0... 2.0 ...2200.0 mV

The exact way in which the limits function works is described in Section 7.4 independent of the mode.

6.4.3 Plot parameters

PARAMETER U
⋮
└─plot parameters
⋮
└─left mar.
└─right mar.

The measured potential can be printed out as a function of time in a plot. Under **CONFIG/print meas.value** the print criterion '**plot**' must be selected (see Section 5.2). The scales of the measured values axes are determined by the following limits.

Left mar.	-2200.0...- 1000.0 ...2200.0 mV
Right mar.	-2200.0... 1000.0 ...2200.0 mV

TIP !

The value for the right-hand limit of a plot must not necessarily be the larger one. By exchanging the limits the plot can be mirrored.

6.4.4 Preselections

PARAMETER U
⋮
└─preselections
└─req.ident

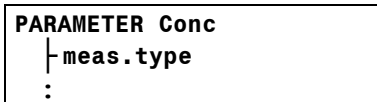
req.ident: id1, id1 & id2, **OFF**

For sample identification you can document each measured value with two IDs in the report header. These can either be predefined under **CONFIG/report** and included in each report or, depending on the Preselection setting, they can be requested before each measurement.

Please note that sample identifications requested as a preselection before the measurement will also be stored as an entry under **CONFIG/report**. This means that they are again available for the next measurement.

6.5 Direct ion measurement (781 only: Conc mode)

6.5.1 Type of measurement



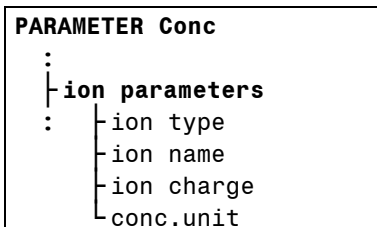
The type of measurement describes the analytical principle of ion measurement.

meas.type: **direct, std.add, smp1.add**

In general a differentiation is made between direct measurement and the standard or sample addition methods. The selection of the method parameters depends on the measurement type which has been chosen. All the method parameters for **direct ion measurement** are described in this section. The descriptions of the **ion parameters**, **measuring parameters** and **calculation parameters** which this section contains also apply to the **standard addition** and **sample addition** types of ion measurement. As a result the following explanation of the parameters for the standard and sample addition in *Section 6.6* is limited to the specific method parameters.

Please note that changing this Conc parameter **meas.type** does not include a change of the current method. Within the mode Conc a method contains all parameter settings.

6.5.2 Ion parameters



The ion parameters describe the name, charge and concentration units of the ion to be determined.

Ion: Ag(+1), BF4(-1), Br(-1), Ca(+2), Cd(+2), Cl(-1), CN(-1), Cu(+2), **F(-1)**, I(-1), K(+1), Na(+1), NH4(+1), NO2(-1), NO3(-1), Pb(+2), S(-2), SCN(-1), SO4(-2), own

The name of the analyte can be selected here. The additional option '**own**' allows the analyte to be determined to be given its own name and charge:

ion name	7 ASCII characters
ion charge	-9...-1, 1...9

measured value is to be stored or documented by printing a report (see print criterion and storage criterion in *Section 5.2* and *Section 5.3*). Please note that for a drift-controlled measured value recording this drift parameter must not be set to '**OFF**', as otherwise no result will be exported.

If this drift condition is not fulfilled then this is indicated by two constantly blinking triangles in the display.

An active drift control increases the reproducibility of the measurements as a constant condition is used to define the measured result. A smaller value for the measuring parameter Drift requires a more stable measuring signal than a larger one. The set measuring parameter is also proportional to the measuring uncertainty of the measured value obtained.

Please note that the drift condition defined here and the temperature parameter described below do not apply to the calibration of the direct concentration measurement and, if necessary, must be set separately under the calibration parameters (see *Section 6.5.5*).

temperature -999.9...25.0...999.9 °C

The correct recording of the measuring temperature is required for the automatic correction of the electrode slope. If no temperature sensor is connected you can enter the temperature of the solution under investigation here. Information about the measuring temperature also makes sense for the documentation of an ion-selective measurement. This manually determined temperature is then indicated by the suffix '**manual**' in the report header.

method 8 ASCII characters

All parameter settings can be stored together or loaded as a method (see *Section 6.1*). The name of the current method is then given here. This field is only used for information here and cannot be edited directly.

delta measurement: **ON, OFF** (only measurement type: direct)

The delta measurement permits the display of the measured value relative to a freely selectable constant reference value:

reference -1.00E+30...0.00...1.00E+30

This reference value is subtracted from the measured value itself. The modified measured value is shown together with this value and is taken into consideration, for example, in checking the limit values (see **PARAMETERS Conc/limits Conc**). The reference value is not included in the report. However, should you still want to document it then you should also produce a parameter report (see *Section 7.2.7*).

stirrer: **ON, OFF, control**

You can choose whether the pH measurement is to be made while stirring is being carried out or not. A requirement is that a Metrohm stirrer is connected with a suitable cable (see *Section 2.3*). If an 8xx series stir-

rer has been connected and the settings made under **CON-FIG/peripheral units** then the stirring rate can also be selected:

stirring rate 1...5...15

If you want your measurement to be made without stirring but still want to stir the solution before the measurement then you should select the **control** setting. In this way you can trigger a stirring sequence before the start of each measurement with **<MEAS/PRINT>**:

prestir pause 0...99999 s
 stir time 0...99999 s
 poststir pause 0...99999 s

The prestir and poststir pauses represent waiting periods in which stirring does not take place. The measurement itself only starts when the complete stirring sequence has ended.

Please note that this parameter is binding for the report output and for storing a measured value. Therefore when you start a measurement with **<MEAS /PRINT>** or an addition sequence with **<ENTER>** the stirrer will be switched on and off accordingly. This is why you should preferably carry out drift-controlled measurements for the direct determination of the concentration (see *Section 5.2* and *Section 5.3*).

6.5.4 Calculation parameters

```

PARAMETER Conc
:
| calculation parameters
:
| -smpl.size
| -V total
| -factor
| -smpl.size unit

```

The calculation parameters can be used for directly including sample preparation data for the automatic calculation of the analytical result. In this way the measured value shown will refer to the concentration of the ion in the original sample and not in the sample solution to be measured.

smpl.size 0.0001...99999.9 (mL or g), **OFF**
 V total 0.001...100.0...9999.9 mL
 factor -1.00E+30...1.0...1.00E+30
 smpl.size unit: mL, g

smpl.size describes the volume or weight of the sample under investigation, depending on the selected **smpl.size unit**. If you do not want to use this parameter then set it to **'OFF'**.

V total represents the volume of the sample solution at the start of the measurement, e.g. after the addition of a buffer (TISAB, etc.).

The calculation of the measured value is then carried out according to the following equation:

$$\text{Measured value(new)} = \text{factor} \cdot \frac{V_{\text{total}}}{\text{smpI.size}} \cdot \text{Measured value(old)}$$

Please note that the unit of the measured value is not altered in this calculation. The Meas. value(new) will therefore always have the same unit as Meas. value (old), i.e. the unit which has been set under **PARAMETER CONC/ion parameters** and with which the calibration has been carried out.

For example, if you use the **smpI.size unit: mL**, then the quotient $V_{\text{total}}/\text{smpI.size}$ will represent the dilution of the sample when it is larger than one. It can also describe the concentration of a sample if it is smaller than one.

You can also weight out your liquid sample before dilution and then select the sample size unit **g**. For a correct calculation the density of the sample in g/mL should be entered as the **factor**.

For a more individual input of the sample data you can also have the program automatically request the sample size and sample size unit directly before each measurement (see Preselections, Section 6.5.9 and Section 6.6.2).

6.5.5 Calibration parameters

(applies only for measurement type: direct)

```

PARAMETER Conc
:
| calibration parameters
: | temperature*
  | drift
  | report
  | cal.interval
  | no.of standards
  | addition | manual - conc.1...n
              | auto   | min.conc.
                      | max.conc.
                      | V init
                      | no.of Exchange Units
                      | conc.1...n
                      | V Exchange Unit 1...n
    
```

(* only appears if no temperature sensor is connected)

In the direct measurement of the concentration the calibration parameters primarily describe the exact presentation of the calibration standards. The evaluation of the calibration is described in Section 9.2.2.

temperature **0.0...25.0...99.9 °C**

Just as for the measuring temperature, the calibration temperature should be entered if no temperature sensor is connected. If the measuring and calibration temperatures are different then this is absolutely necessary for the automatic temperature correction of the electrode slope. The temperature is then stored and indicated by the suffix '**manual**' in the report header.

drift: 0.1...0.5...9.9 mV/min

Just like the ion measurement, the calibration is also drift-controlled. However, this drift-control cannot be switched off.

report: OFF, short, full

After the calibration you can automatically output the result in the form of report. You can choose between the '**short**' version containing all the relevant data and the '**full**' version, which also shows the measuring curves as a graph (see Section 7.2.4).

Such a report can also be printed out later together with the calibration for each stored electrode Id.

calibration interval OFF, 1...999 h

The pH/Ion Meter can automatically remind you about any recalibration of the pH electrode which is due. This means that if a calibration is carried out with a preset calibration interval then, when this interval has elapsed, a message will appear on the display:



cal.interval expired

This message is retained and will be printed out on every measuring point report until a new calibration has been carried out.

no.of standards 1, 2...19

Up to 19 standards can be used for the calibration of the ion selective electrode. If only a single standard is used for the calibration then the program will use the existing value for the slope. This will also be corrected accordingly if the calibration temperature changes. This adoption of the existing slope also applies when a calibration with several standards is canceled with **<MODE>** or **<QUIT>** after the first standard has been measured and then confirmed with **<ENTER>**.

However, please note that for the calibration of ion-selective electrodes **at least** two standards should be used. The possibility of using a single standard described above should only represent an absolute exception.

If three or more standards are used then the variance will be included in the calibration data. More detailed information about the evaluation is given in *Section 9.2*.

addition: manual, auto

For the **manual** addition of the standard you should enter in the next calibration parameter lines the concentrations of the standards used (**Conc.1**, **Conc.2**, ...). This data can still be modified during the calibration sequence.

With **automatic** standard addition the pH/Ion Meter carries out the calculation of the standard concentrations, the preparation of the standard solutions and their measurement automatically. A requirement is that a Metrohm Dosimat Plus is connected (connection and Dosimat Plus

configuration see *Section 2.3.3*, pH/Ion Meter configuration see *Section 5.6*).

```

min.conc          1.0E-30...0.1...1.0E+30
max.conc.         1.0E-30...1.0...1.0E+30
    
```

The standard concentrations to be calculated lie within the range of these minimum and maximum concentrations. Depending on the required number of standards (see above), the pH/Ion Meter will calculate the other concentrations. The expected resulting potential difference between all the standards remains constant.

```

V init           0.001...100.0...999.9 mL
    
```

The initial volume of a presentation (e.g. buffer, TISAB, etc.) is entered here.

```

no.of Exchange Units. 1...5
    
```

It is normally a good idea to calibrate ion-selective electrodes over several concentration decades. It is possible that a single Dosimat exchange unit may not be sufficient for this. In this case you can prepare several exchange units with the corresponding different concentrations of standard solutions:

```

conc.1...n       1.0E-30...100.0...1.0E+30
V Exchange Unit 1...n:  1, 5, 10, 20, 50 mL
    
```

For each exchange unit you must enter the concentration of the solution it contains and the volume of the dosing cylinder. Arrange the exchange units with increasing concentration of the standard solutions.

Please make sure that all exchange units have been prepared before the start of a calibration sequence (dosing cylinders freshly filled, air bubbles removed, etc.). The request for changing the exchange unit is given on the display. This message describes the required standard concentration and volume increment at the Dosimat Plus.

```

fill dosimat, dV/dt max.
dV = 1 uL, c = 2000.0 ppm
    
```

After mounting and filling the prepared exchange unit, continue with <ENTER>.

6.5.6 Limits Conc

(applies only to measurement type: direct)

```

PARAMETER Conc
:
| limits Conc
:  Lstate
    
```

In the direct measuring modes the pH/Ion Meter has a limits function which allows the control of the parameter to be monitored. The control signals are transmitted via the MSB connection to the optional remote

interface (6.2148.010) (see *Section 9.5*). Out of limits conditions are also shown on the display and documented in the report.

state:	ON, OFF
u.limit	-1.00E+30...1.00E+30
u.hyst.	-1.00E+30...2.00...1.00E+30
l.limit	-1.00E+30...0.00...1.00E+30
l.hyst.	-1.00E+30...2.00...1.00E+30

The exact way in which the limits function works is described in *Section 7.4* independent of the mode.

6.5.7 Limits T

(applies only for Conc measurement type: direct)

PARAMETER Conc
: limits T : Lstate

Just as in the pH mode, in the Conc mode the temperature can also be monitored via the limits function in addition to the primary measuring quantities. However, you should only activate this limits function for the temperature when a temperature sensor is connected, as otherwise an error message will appear.

state:	ON, OFF
u.limit	-999.9...100.0...999.9 °C
u.hyst.	-999.9...0.2...999.9 °C
l.limit	-999.9...0.0...999.9 °C
l.hyst.	-999.9...0.2...999.9 °C

A detailed description of the remote lines is given in *Section 9.5*. The exact way in which the limits function works is described in *Section 7.4* independent of the mode.

6.5.8 Plot parameters

(applies only to measurement type: direct)

PARAMETER Conc
: plot parameters : left mar. : right mar. : left marg.T : right marg.T

The directly measured quantities concentration and temperature can be printed out as a function of time in a plot. Under **CONFIG/print meas. value** the print criterion '**plot**' must be selected (see *Section 5.2*). The scales of the measured values axes are determined by the following limits.

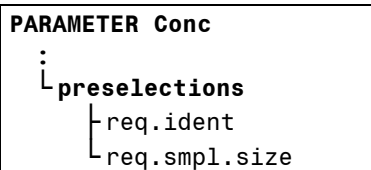
left mar.	-1.0E+30... 0.0 ...1.00E+30
right mar.	-1.0E+30... 1.00E+30
left marg.T	-999... 20 ...999 °C
right marg.T	-999... 30 ...999 °C

TIP !

The value for the right-hand limit of a plot must not necessarily be the larger one. By exchanging the limits the plot of the particular quantity can be mirrored.

6.5.9 Preselections

(applies only to measurement type: direct)



req.ident.: id1, id1 & id2, **OFF**

For sample identification you can document each measured value with two Ids in the report header. These can either be predefined under **CONFIG/Report** and included in each report or, depending on the Preselections setting, they can be requested before each measurement.

Please note that sample identifications requested as a preselection before the measurement will also be stored as an entry under **CONFIG/Report** (see Section 5.1). This means that they are again available for the next measurement.

req.smpl.size: value, unit, all, **OFF**

The parameters **smpl.size** and **smpl.size unit** described in the calculation parameters (see Section 6.5.4) can also be requested for each measurement. This allows an individual sample data input.

Just as in the request for the sample identifications, the sample size requested here will also be stored under **PARAMETER Conc/calculation parameters** and is available for the request before the next measurement.

6.6 Standard and sample addition (781 only: Conc mode)

In the ion measurement Conc mode a differentiation is made between direct measurement and the standard or sample addition and subtraction methods.

All the method parameters for direct concentration determination are described in *Section 6.5*. The descriptions of the **ion parameters**, **measuring parameters** and **calculation parameters** given there also apply to the **standard addition** and **sample addition** types of ion measurement. This is why this section contains only the method parameters which apply only to these types of measurement.

PARAMETER Conc	
	meas.type
:	:

meas.type: **direct, std.add, smp1.add**

The measurement type describes the analytical principle of ion measurement. Select '**std.add**' if the analysis is to be carried out according to the standard addition method, i.e. by the addition of defined standard solutions to the sample. For the sample addition method, the multiple addition of the sample solution to a standard solution, select '**smp1.add**'.

Please note that changing this Conc parameter **meas.type** does not include a change of the current method. Within the mode Conc a method contains all parameter settings.

6.6.1 Standard / Sample addition

PARAMETER Conc	
:	:
	standard addition / sample addition
:	:
	type
	conc.std.
	report
	addition
	<i>manual</i>
	no.of additions
	increment 1...n
	stop V
	<i>auto dos</i>
	dos.rate
	no.of additions
	V Exchange Unit
	increment 1...n
	stop V
	<i>auto</i>
	delta U
	dos.rate
	no.of additions
	V Exchange Unit
	stop V

The exact technique of standard and sample addition in the Conc mode is described by the parameters selected under **standard addition** and **sample addition**:

type: **add, sub**

In general – and also in this Manual – when dealing with standard and sample addition techniques it is **addition** which is described. It is also possible to carry out a standard or sample **subtraction**, for example by precipitation reactions. The appropriate type is set here.

conc.std. **1.0E-30...1.0...1.0E+30**

The concentration of the standard solution used is to be entered here, regardless of whether it is to be added during standard addition or already present for sample addition.

report: **OFF, short, full, line**

After the addition run you can automatically output the result in the form of report. You can choose between the '**short**' version containing all the relevant data and the '**full**' version, which also shows the measuring curves as a graph (see *Section 7.2.5*). The '**line**' setting supplies reports with the most important data in the same form as in the measuring point reports for direct measurements.

The '**short**' and '**full**' reports can also be produced later under **<REPORT>**.

addition: **manual, auto dos, auto**

Standard or sample addition can be carried out in various ways:

manual

The standard or sample solution is added manually at defined volume increments.

no.of additions **1, 2, 3,...19**

The number of additions is entered here. If only one addition is made then the program will adopt for the slope the existing value from the current calibration data of the electrode used. This will also be corrected accordingly if measuring temperature changes in comparison to the calibration temperature. This adoption of the existing slope also applies when a standard or sample addition with several additions is canceled with **<MODE>** or **<QUIT>** after the first addition and then confirmed with **<ENTER>**.

However, please note that, as for the calibration of ion-selective electrodes, **at least** two additions should be made (three to five or even more would be better). The possibility of terminating the addition after a single standard or sample addition as described above should only represent an absolute exception.

increment **1...n** **1.0E-30...0.1...999.9 mL**

The volume increment for each addition is entered here.

TIP !

It is possible to alter this parameter during an addition run. For example, before confirming the volume increment you can add the solution during the run until a certain potential difference is shown on the display. Then confirm the volume to be added; the corresponding potential will be measured after each addition. This can be a great help, for example when checking the suitability of a standard for this method.

stop V **0...99.99...9999.9** mL

For the manual addition no check will be carried out whether the stop volume is exceeded or not in contrary to **auto dos** and **auto** (see below).

auto dos and **auto**


If a Dosimat Plus is used then the standard or sample addition can be carried out automatically (connection and Dosimat Plus configuration see *Section 2.3.3*, pH/Ion Meter configuration see *Section 5.6*). You can choose between two methods: under **auto dos** you can enter the individual volume increments for the added solution; under **auto** these additions are made automatically so that a constant potential difference always results.

The common parameters are:

dos.rate **fast, medium, slow**
no.of additions **1, 2, 3,...19**
V Exchange Unit **1, 5, 10, 20, 50** mL
stop V **0...99.99...9999.9** mL

The dosing rate can be set in three steps via **dos.rate**.

In '**auto dos**' the pH/Ion Meter checks at the start of the automatic standard and sample addition whether the sum of the volume increments exceeds the set stop volume **Stop V**. If this is the case then the following message will appear:

 **V add too large**

Under '**auto**' this check is carried out during the automatic addition and, if necessary, will cause the run to be stopped with the message:

 **check working cond.**

Depending on the automatic addition method the following parameters must also be defined:

auto dos

increment 1...n 1.0E-30...0.1...999.9 mL

The particular volume increment must be entered for each addition of the standard or sample solution.

auto

delta U 1...10...999 mV

Under **auto** the required potential difference must be entered.

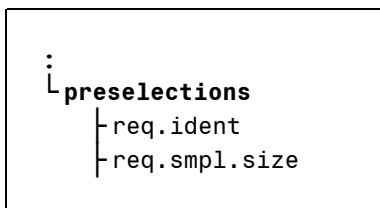
Please note that the Dosimat Plus must be properly prepared before the start of an addition run (cylinder freshly filled, air bubbles removed, etc.).

During an addition you can terminate the run prematurely with it <MODE>; only the additions which have already been measured will be used for the calculation of the result. This manual termination will be marked in the report.



Standard and sample addition with the Dosimat plus **865** and **876**: **Dosing ramp mode** must be used in the dosing parameters of Dosimat plus **865** and **876**.

6.6.2 Preselections



req.ident: Id1, Id1 & Id2, **OFF**

For sample identification you can document each measured value with two Ids in the report header. These can either be predefined under **CONFIG/Report** and included in each report or, depending on the Preselections setting, they can be requested before each measurement.

Please note that sample identifications requested as a preselection before the measurement will also be stored as an entry under **CONFIG/Report**. This means that they are again available for the next measurement.

req.smpl.size : value, unit, all, **OFF**

The sample size and sample size unit parameters described under the calculation parameters (see Section 6.5.4) can also be requested before each measurement. This allows a more individual input of the sample data.

7 Various functions

This section describes various functions of the pH/Ion Meter which cannot be assigned to individual modes.

7.1 Calibration and addition/subtraction data

The current pH calibration data can be called up at any time with the <CAL.DATA> key. For the 781 pH/Ion Meter the same applies to the concentration calibration (<CAL.DATA>) and the addition or subtraction data (<ADD.DATA>) in the Conc mode.

A detailed description of the evaluation of the calibration and addition/subtraction measurements for the calculation of this data can be found in Section 9.2.

An overview appears which, depending on the measuring mode and calibration data, can have a different composition.

For example, if no calibration has yet been carried out for a new electrode Id then only the theoretical calibration data slope = 100.00% and pH(0) = 7.000 will be shown and taken into account for the measurement.

7.1.1 pH calibration data



```

CAL . DATA
| electr.id
| method
| slope
| pH(0)
| temperature
| temp.sensor
| c.dat.
| cal.interval
| variance
| buffer type
| no.of buffers
| cal.table
| b1
| b2
| :
| bn
| curve
    
```

electr.id

If an electrode Id has been selected or entered under **PARAMETER pH/measuring parameters/electr.id** before the calibration then it will be shown here. The calibration data apply only to this electrode and will change when a new electrode Id is set under the above measuring parameters (see Section 6.2.2).

method

The calibration parameters set under **PARAMETER pH/calibration parameters** form part of the method parameters. The corresponding method name will be shown here if the calibration data has been obtained with this method and the resulting quantities **slope** and **pH(0)** have not been altered since. If no method name has been issued before the calibration (see *Section 6.1*) then '*****' will appear here.

slope

The slope of the linear calibration curve obtained during the calibration will be shown here as a percentage. This is a relative quantity which is based on the temperature-specific value of the Nernst constant (e.g. 59.16 mV at 25 °C). Without a calibration, or after a single buffer calibration, this is set to 100 %.

This value can be altered manually for test purposes. However, afterwards the information about the method will be missing from the list and from the calibration data report. The calibration date and time will be updated and the temperature information and the calibration table (see below) will be removed. In addition this action will be documented by the entry '**manual**' under **CAL.DATA/variance**.

pH(0)

This is the second characteristic quantity of the calibration curve. pH(0) is the pH value at 0 mV. It can also be altered manually for test purposes. The other entries under **CAL.DATA** will be altered in the same way as for a manual alteration of the slope (see above).

temperature

The calibration temperature is shown here.

temp.sensor

If the calibration temperature has been determined automatically by a connected temperature sensor then its type will be shown here ('**Pt1000**' or '**NTC**'). A manually entered temperature for the calibration will be indicated accordingly ('**manual**').

c.dat.

The date and time of the calibration is shown here.

cal.interval

If a calibration interval has been defined under **PARAMETERS pH/ calibration parameters/cal.interval** then it will be shown here. It can be used together with the calibration time given under **c.dat.** to estimate the time that the next calibration is due.

variance

If at least 3 calibration buffers have been used then the calibration function will be calculated as a compensation curve according to the principle of the smallest mean-square error (linear regression). The resulting variance will be given here. A more detailed explanation of these calculations is given in *Section 9.2.1*.

Each subsequent manual alteration of the calibration data pH(0) and slope will be documented by the entry '**manual**' against these parameters.

buffer type

The type of buffer defined in the calibration parameters at the time when calibration was carried out is shown here.

no.of buffers

The number of buffers actually measured is shown here. This can be lower than that given in the calibration parameters, as a calibration can be terminated prematurely with <QUIT>; only the buffers which have already been measured will then be used for the calculation of the calibration data.

cal.table: original, delete n, reset cal

This entry can be used to delete individual buffers from the calibration table ('**delete n**') or to delete all the calibration data of an electrode Id ('**reset cal**').

original

If you use <SELECT> to choose the option '**original**' then all the buffer data previously deleted with '**delete n**' will be reinserted in the calibration table and used for calculating the calibration data.

delete n

From a calibration list containing at least 3 buffer entries you can remove individual buffer data by selecting '**delete n**' and entering the number of the buffer to be deleted in the following line:

delete n: 1..9

The deleted buffer will then be indicated in the calibration table by '**deleted**'. The measuring points of deleted buffers are also indicated in the graphical display by an 'o' instead of a '+'.

You can reinsert all deleted buffers in the calibration table with the option '**original**'.

reset cal

With this option you can reject all the calibration data of an electrode Id. They are then in the same state as before the first calibration (slope = 100%, pH(0) = 7).

Although the electrode Id is retained, it cannot be selected under **PARAMETER pH/measuring parameters/electr.id** until it has been calibrated again.

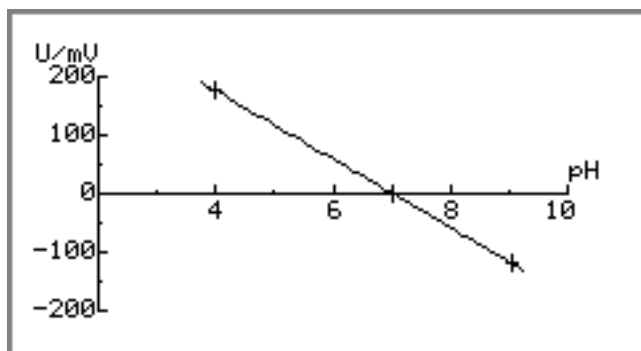
b1, b2...bn

For each calibration buffer the pH value used and the measured potential are given. The given value for the pH is taken from the stored series of buffers of the buffer type selected in the calibration parameters (see *Section 9.4*). The pH values for temperatures within the given 5 °C steps are calculated by linear interpolation.

A buffer which has been deleted by **cal.table: delete n** is shown here by '**deleted**'.

curve < -> >

If at least 2 calibration buffers have been used then the calibration curve will be shown as a graph here. The graphics display is accessed with <→>:



This display is exited with <QUIT>.

7.1.2 Conc calibration data (781 pH/Ion Meter only)



```

CAL.DATA
| ion type
| electr.Id
| method
| slope
| E(0)
| c(blank)
| temperature
| temp.sensor
| c.dat.
| cal.interval
| variance
| no.of standards
| cal.table
| st1
| st2
| :
| stn
| curve
    
```

ion type

The analyte ion which has been defined during the calibration under **PARAMETER Conc/ion parameters** is shown here. As with the following electrode Id, the current calibration data changes as the ion parameter changes.

electr.id

If an electrode Id has been entered or selected before the calibration under **PARAMETERS Conc/measuring parameters/electr.id** then it will be shown here. Electrode Ids can be defined for a particular type of ion. The calibration data will apply to this electrode only and will change when a new electrode Id is set under the above measuring parameters (see Section 6.5.5).

method

The calibration parameters set under **PARAMETER Conc/calibration parameters** form part of the method parameters. The appropriate method name will be shown here when the calibration data have been determined using this method and the resulting quantities **slope**, **E(0)** and **c(blank)** have not been altered since. If no method name has been assigned before the calibration (see Section 6.1), then '*****' will appear here.

slope

The slope of the calibration function obtained during the calibration will be shown here in mV. With no calibration this will be set to the theoretical value of +59.2 mV or -59.2 mV per ion charge at 25 °C.

This value can be altered manually for test purposes. However, afterwards the information about the method will be missing from the list

and from the calibration data report. The calibration date and time will be updated and the temperature information and the calibration table (see below) will be removed. In addition this action will be documented by the entry '**manual**' under **CAL.DATA/variance**.

E(0)

This is the second characteristic quantity of the calibration function. E(0) is the potential at $\log(c) = 0$, i.e. the U-axis intercept of the calibration function in the U/log c plot. A more detailed explanation of the calculation of the calibration data is given in *Section 9.2.2*.

E(0) can also be altered manually for test purposes. The other entries under **CAL.DATA** will then be altered in the same way as for a manual alteration of the slope (see above).

c(blank)

This is the third characteristic quantity of the concentration calibration function. To a certain extent it reflects the curvature of the otherwise linear calibration function at the lowest concentrations. It is only calculated when at least three standards have been measured (see also *Section 9.2.2*). If the value for c(blank) is sufficiently small, i.e. if the influence of this quantity on the later result can no longer be measured, then it will be set as zero. Instead the variance will then be calculated even when only three standards have been measured (see below).

c(blank) can also be altered manually for test purposes. The other entries under **CAL.DATA** will then be altered in the same way as for a manual alteration of the slope (see above).

temperature

The calibration temperature is shown here.

temp.sensor

If the calibration temperature has been determined automatically by a connected temperature sensor then its type will be shown here ('**Pt1000**' or '**NTC**'). A manually entered temperature for the calibration will be indicated accordingly ('**manual**').

c.dat.

The date and time of the calibration will be shown here.

cal.interval

If a calibration interval has been defined under **PARAMETER Conc/Calibration parameters/cal.interval** then it will be shown here. It can be used together with the calibration time given under **c.dat.** to estimate the time that the next calibration is due.

variance

If at least 4 standards have been measured then the calibration function will be calculated iteratively according to the principle of the smallest mean-square error. The resulting variance will be given here. However, if the value calculated for $c(\text{blank})$ is sufficiently small then the variance will be given after only three standards have been measured. A more detailed explanation of these calculations is given in *Section 9.2.2*.

Each subsequent manual alteration of the calibration data slope, $\text{pH}(0)$ and $c(\text{blank})$ will be documented by the entry **'manual'** against these parameters

no.of standards

The number of standards actually measured will be given here. This can be lower than that given in the calibration parameters, as a calibration can be terminated prematurely with **<QUIT>**; only the standards which have already been measured will then be used for the calculation of the calibration data.

cal.table: original, delete n, reset cal.

This entry can be used to delete individual buffers from the calibration table (**'delete n'**) or to delete all the calibration data of an electrode Id (**'reset cal.'**).

original

If you use **<SELECT>** to choose the option **'original'** then all the standard data previously deleted with **'delete n'** will be reinserted in the calibration table and used for calculating the calibration data.

delete n

From a calibration list containing at least 3 standard entries you can remove individual standard data by selecting **'delete n'** and entering the number of the standard to be deleted in the line:

delete n: 1..9

The deleted standard will then be indicated in the calibration table by **'deleted'**. The measuring points of deleted standards are also indicated in the graphical display by an 'o' instead of a '+'.

You can reinsert all deleted standards in the calibration table with the option **'original'**.

reset cal

With this option you can reject all the calibration data of an electrode Id. You are then in the same state as before the first calibration: slope = +59.2 mV or -59.2 mV per ion charge, $E(0) = 0$ mV, $c(\text{blank}) = 0$.

Although the electrode Id is retained, it cannot be selected under **PARAMETER Conc/measuring parameters/electr.id** until it has been calibrated again.

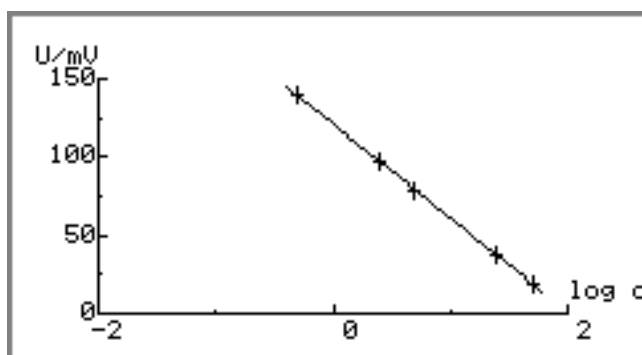
st1, st2...stn

For each calibration standard the concentration and the measured potential are shown.

A standard which has been deleted by **cal.table: delete n** is shown here by '**deleted**'.

curve < -> >

If at least 2 calibration standards have been used then the calibration curve will be shown as a graph here. The graphics display is accessed with <→>:



The display is exited with <QUIT>.

7.1.3 Addition/Subtraction data (781 pH/Ion Meter only)

ADD.DATA
4

```

ADD.DATA
- ion type
- meas.type
- electr.id
- variance
- slope
- E(0)
- c Ion
- date
- method
- temperature
- temp.sensor
- V total
- conc.std
- initial voltage
- factor
- smp1.size
- add1
- add2
-
- addn
- curve
    
```

The data of the last standard or sample addition and subtraction to have been carried out can be called up with <ADD.DATA> provided that the measurement type has been set to 'std.add' or 'smp1.add' under **PARAMETER Conc/measuring type**. The data are still present even if the last result has been replaced by '- - - - -' in the measured value display because the addition run was terminated prematurely. However, the production of a report of the last result is not possible then.

The term 'addition' is used below to include both standard and sample addition and subtraction.

ion type:

The analyte defined for the addition under **PARAMETER Conc/ion parameters** is shown here.

meas.type:

Whether the shown data come from an addition or subtraction run is shown here.

electr.id

If an electrode Id has been entered or selected before the calibration under **PARAMETER Conc/measuring parameters/electr.id** then it will be shown here.

Later alterations of the parameters **ion** and **electr.id** have no effects on the display of the addition data.

variance

With at least 3 additions the compensation curve for $U/\log(c)$ will be calculated according the principle of the smallest mean-square error. The resulting variance will be given here. A more detailed explanation of these calculations is given in *Section 9.2.2* and *Section 9.2.3*.

slope

The slope of the calibration function obtained during the addition will be shown here in mV. With a single addition the slope will be taken from the current calibration data (see <CAL.DATA>).

E(0)

E(0) is the potential at $\log(c) = 0$, i.e. the U-axis intercept of the compensation curve in the $U/\log(c)$ plot. A more detailed explanation of the calculations of the calibration data is given in *Section 9.2.2* and *Section 9.2.3*.

c ion

Here and in the measured value display the **final result** of the addition measurement, the required concentration of the analyte, is given.

The concentration of the ion to be determined in the sample solution is first calculated from the measured starting potential and the regression data. Please note that the result itself is calculated taking the **calculation parameters (smp1.size, V total and factor)** into account; see also *Section 6.5.4*.

date

The date and time of the addition are shown here.

method

The parameters set under **PARAMETER Conc/standard addition** form part of the method parameters. The appropriate method name will be shown here when the calibration data have been determined using this method. If no method name has been assigned before the calibration (see *Section 6.1*), then '*****' will appear here.

temperature

The temperature of the solution is shown here.

temp.sensor

If the calibration temperature has been determined automatically by a connected temperature sensor then its type will be shown here ('Pt1000' or 'NTC'). A manually entered temperature for the calibration will be indicated accordingly ('manual').

V total

This is the initial volume of the solution as defined under **PARAMETER Conc/calculation parameters** (see Section 6.5.4).

conc.std

The concentration of the standard used is shown here as defined under **PARAMETER Conc/standard addition**.

initial voltage

The initial potential measured in the solution is shown here.

factor

spl.size

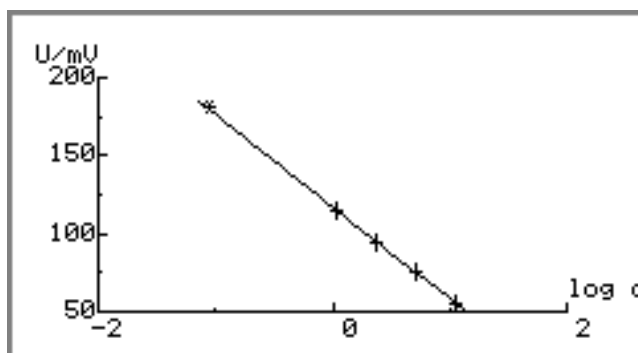
These are further calculation parameters defined under **PARAMETER Conc/calculation parameters** and used to calculate the final result (see Section 6.5.4).

add1, add2...addn

For each addition the volume increment, concentration and measured potential are shown.

curve < -> >

The calibration function can be viewed as a plot. The graphics display is accessed with <->>:



The first measuring point of the solution is marked by '*' and the additions with a '+'.
 This display is exited with <QUIT>.

7.2 Reports

A pH/Ion Meter report is produced by transmitting data to a printer or PC via the RS232 interface. In this way you can document e.g. measuring results, calibration data, method parameters or the configuration of the instrument in written form.

A requirement for a properly functioning report output is the input of the receiving instrument (see *Section 5.6*) and the correct setting of the RS232 transmission parameters (see *Section 5.7*).

The following reports can be automatically printed out after a measurement has been made: a **measuring point report** is produced directly with the **<MEAS/PRINT>** key. The automatic output of **calibration, electrode test and result reports** must be defined as such under method parameters.



Apart from the measuring point report, all reports can be triggered manually at a later date by the **<REPORT>** key. A dialog appears for the selection of the required report with the **<SELECT>** keys:

user memory	Report of the memory occupancy by methods and calibration data
calib short	Calibration report without graphical calibration function curve
calib full	Calibration report with graphical calibration function curve
config	Instrument configuration report
param	Current method parameters report
result short	Measuring result report for standard or sample addition without graphical presentation (781 pH/Ion Meter only)
result full	Measuring result report for standard or sample addition with graphical presentation (781 pH/Ion Meter only)
el.test	pH electrode test report (see <i>Section 8.6</i>)
mv memory	Output of all stored measured values
all	Output of all existing reports

During selection these reports can also be selected directly by using the key which has the corresponding function (e.g. **<CAL.DATA>** for a calibration report).

The following table shows the availability of all reports in the various modes together with the direct selection keys.

	pH	T	U	Conc	Direct key
user memory	✓	✓	✓	✓	-
calib short	✓	-	-	✓	<CAL.DATA>
calib full	✓	-	-	✓	-
config	✓	✓	✓	✓	<CONFIG>
param	✓	✓	✓	✓	<PARAM>
result short	-	-	-	✓	<ADD.DATA>
result full	-	-	-	✓	-
el.test	✓	-	-	-	<EL.TEST>
mv memory	✓	✓	✓	✓	<RECALL>
all	✓	✓	✓	✓	-



The report output can be terminated at any time with <QUIT> or <MODE>. For this reason you should wait for the report output to be finished before operating the pH/Ion Meter again. In this way you avoid the accidental cancellation of a report output.

The following pages show the arrangement of reports together with some types of reports. A description of an electrode test report is given in Section 8.6.

7.2.1 Arrangement of a report

The first lines of a report provide a general description. This report header is configured under **CONFIG/Report** (see *Section 5.1*):

```
Report Id: 'mp
Instrument Id: 781 pH/Ion Meter      01104  5.781.0020
Date, Time: date 2004-05-28  17:00:56
...
```

For the output of data as measuring points, results, calibration or electrode test reports further information about the mode, method, sample number and electrode Id is included:

```
Report Id: 'mp
Instrument Id: 781 pH/Ion Meter      01104  5.781.0020
Date / Time: date 2004-05-28  17:00:56
User: user                          C. Weber
Mode / Method / Run number: pH      pH-1      run number      9
Electrode Id: electr.id              pH electr.1
...

Signature: Visum
```

Depending on the configuration, in such measuring data reports a signature line can be added to the data.

The line 'user' appears, if a user is defined by **<USER>**.

If you have entered an instrument name under **CONFIG/auxiliaries/device label** then this will appear in the report header as an additional line between the Instrument Id and the Date/Time line.

In measuring point and result reports the report header contains additional information about the measured sample as **Id 1** and **Id 2**, if these have been defined under **CONFIG/report** or are requested before the measurement as a preselection (see **PARAMETER/pre-selections**).

Each report is concluded with a finishing line. For an **automatically** triggered **original report** (measuring points, results, calibration or electrode test reports) this is in the form of a **double line**:

```
=====
```

Each report to be triggered **manually** with **<REPORT>** is concluded with a **single line**:

```
-----
```

7.2.2 Report identification

The report identification, known here as Report Id, is an abbreviation describing the type of report and is primarily important for the remote control of the pH/Ion Meter via the RS232 interface. Computer programs such as Metrohm Vesuv[®] 3.0 for Windows[™] can identify the produced report by this identification and use it for further evaluation.

The following report Ids exist for the 780 pH Meter and 781 pH/Ion Meter:

Report Id	Report name	Availability
'mp	measuring points	780, 781
'co	configuration	780, 781
'pa	parameter	780, 781
'um	user methods	780, 781
'mv	measured values stored	780, 781
'cr	pH calibration report	780, 781
'fp	full pH calibration	780, 781
'di	diagnose	780, 781
'et	electrode test	780
'cc	conc. calibration	781
'fc	full conc. calibration	781
'ca	conc. addition	781
'fa	full conc. addition	781

7.2.3 Measuring point report



By pressing the <MEAS/PRINT> key in the directly measuring measurement types a measuring point report will be produced. The following examples show versions of this type of report, the various configurations of which are defined under **CONFIG/print meas.value** (see Section 5.2).

A typical version of a measuring point report is the output of a single measured value. The print criterion **'immediate'** or **'Drift'** must be selected.

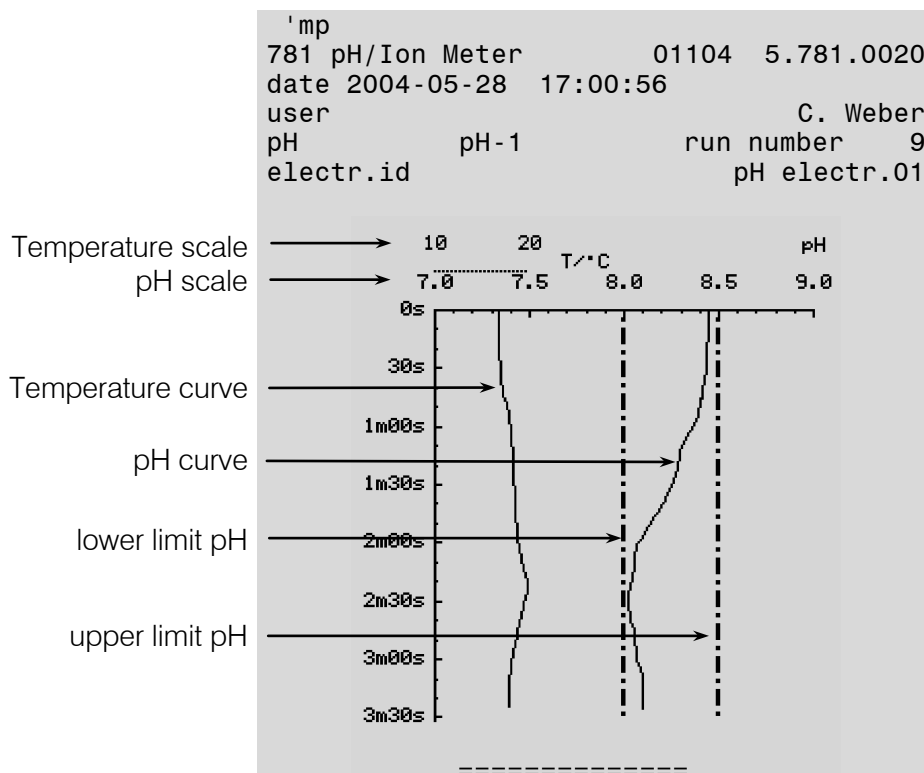
```
'mp
781 pH/Ion Meter          01104  5.781.0020
date 2004-05-28  17:00:56
user                                     C. Weber
pH      pH-1                run number   1
electr.id
id1          charge 21
id2          sample A01
#1   pH =    8.182          21.2 °C (Pt1000)
                2004-05-28  17:00:56
                =====
```

If a whole series of measured values is to be documented then this is done by selecting under **CONFIG/Print meas. values** the option **Report header: once**. In this way the report header will be printed out once with the first measured value. Each further time that the **<MEAS/PRINT>** key is pressed a further measured value will be printed out:

```
#2  pH =  8.185      21.2 °C (Pt1000)
      2004-05-28  17:01:56
#3  pH =  8.187      21.2 °C (Pt1000)
      2004-05-28  17:02:56
#4  pH =  8.188      21.2 °C (Pt1000)
      2004-05-28  17:03:56
#5  pH =  8.189      21.2 °C (Pt1000)
      2004-05-28  17:04:56
```

Such a series of measured values can also be produced automatically by selecting the print criterion **'time'**.

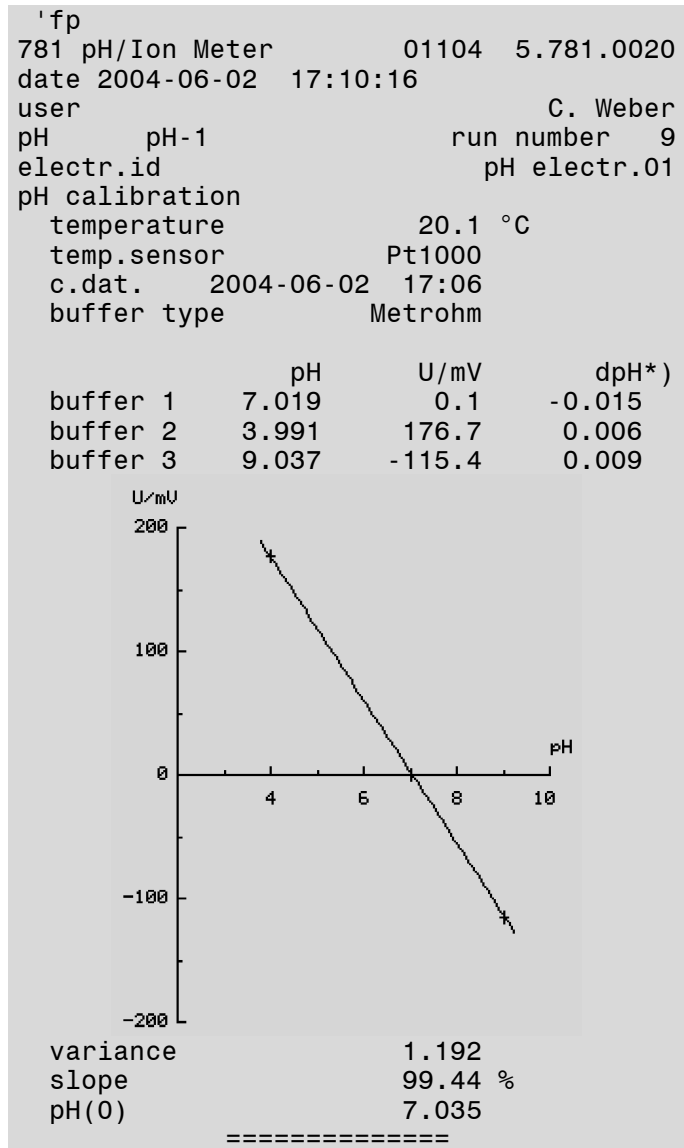
With the print criterion **'plot'** the measured values are given out as a graphical plot in the direct measurement types. As well as configuration under **CONFIG/print meas.value**, the scales of the measured values curves must be set under **PARAMETER/plot parameters** (see **plot parameters** in *Section 6.2 to Section 6.5*). In the pH and Conc(direct) modes the measured temperature can also be shown in the same plot as a secondary measured value in addition to the primary measured value, pH or concentration:



7.2.4 Calibration report



In the pH and Conc(direct) modes a calibration report can be produced after a calibration has been carried out. Under **PARAMETER/calibration parameters/report** you can define whether this report is to be produced automatically after the measurement. You can also choose between a short version containing all the important data and a long version which additionally contains a plot of the calibration function.



*) dpH: Nominal pH value of the buffer – pH value which, at the measured voltage, results from the regression analysis

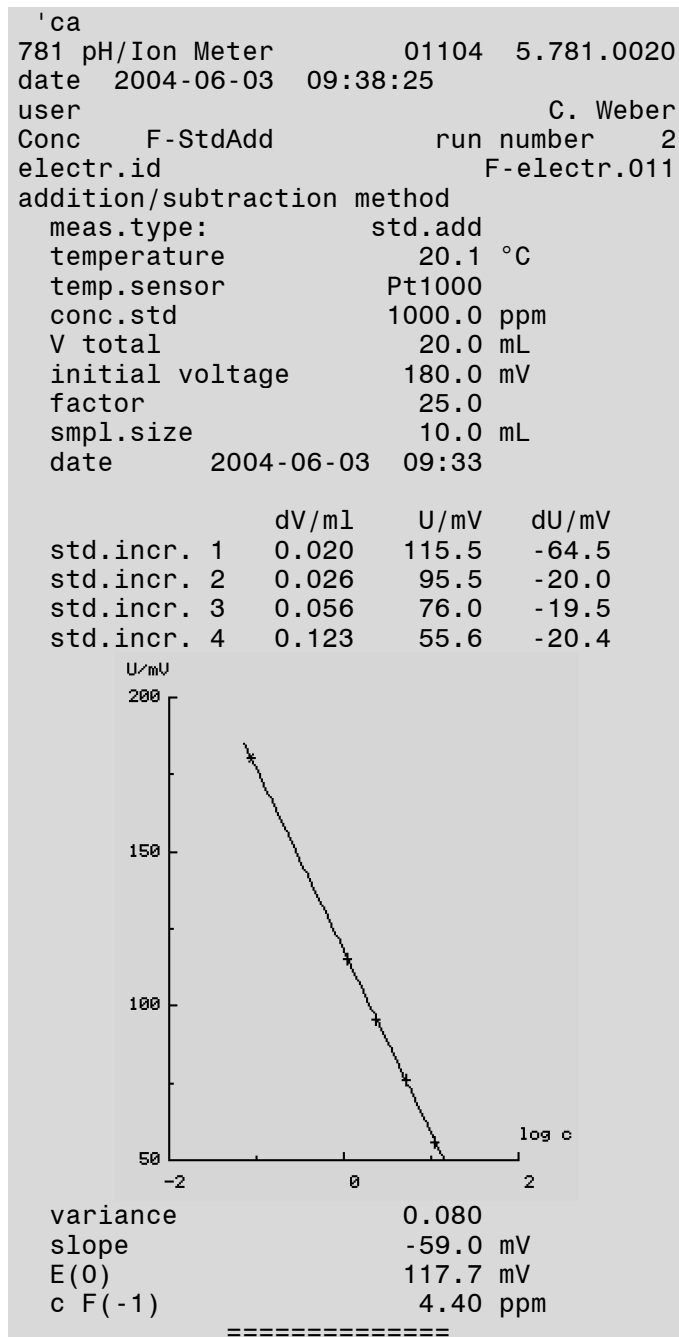
7.2.5 Result report (781 pH/Ion Meter only)



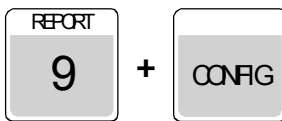
+



In the Conc mode for standard or sample addition the results can be produced as a result report. Under **PARAMETER Conc/Standard addition/Report** you can define whether this result is to be produced automatically after the end of the measurement. Just as for the calibration report, you can choose between a short version containing all the important data and a long version which additionally contains a graphical presentation of the evaluation.



7.2.6 Configuration report



A configuration report (CONFIG) could look like this:

```
'co
781 pH/Ion Meter          01104  5.781.0020
date 2004-06-03  10:03:55
CONFIG
>report
  id1
  id2
  report id:          ON
  instrument id:      ON
  date & time:        ON
  method:             ON
  electrode id:       ON
  signature:          OFF
  line feed           3
>print meas.value
  print crit:         immediate
  date & time:        OFF
  report header:      always
  calibration report: OFF
>store meas.value
  store crit:         OFF
>auxiliaries
  Run number          3
  last digit:         ON
  dialog:             english
  display:            positiv
  LCD off after       OFF min
  date                2004-06-03
  time                10:03:55
  time zone
  temp.sensor:        Pt1000
  temp.unit:          C
  device label
  beep:               1
  program             5.781.0020
>monitoring
  validation:         OFF
  service:            OFF
  system test report: OFF
>peripheral units
  character set:      IBM
  Dosimat:           765
  stirrer:           8xx
  keyboard:          US
  barcode:           input
>RS232 settings
  baud rate:         9600
  data bit:          8
  stop bit:          1
  parity:            none
  handshake:         HWS
-----
```

The settings shown for the instrument configuration correspond to the standard settings in the normal operating condition of the pH/Ion Meter after the configuration memory has been initialized (see *Section 8.5*) followed by conversion to English as the dialog language.

7.2.7 Parameter report

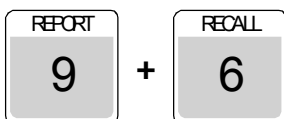


in order to document the parameter settings for the current method you can produce a parameter report:

```
'pa
781 pH/Ion Meter          01104  5.781.0020
date 2004-06-03 12:08:36
PARAMETER pH
>measuring parameters
  electr.id
  drift                0.050 /min
  method                *****
  delta measurement:    OFF
  stirrer:              OFF
>calibration parameters
  drift                0.5 mV/min
  report:              OFF
  cal.interval         OFF h
  no.of buffers        2
  buffer type:         Metrohm
  low lim.slope        95.00 %
  up lim.slope         103.0 %
  low lim.pH(0)        6.40
  up lim.pH(0)         8.00
  offset Uoff state:   OFF
>limits pH
  state:               OFF
>limits T
  state:               OFF
>plot parameters
  left mar.:           0.0
  right mar.:          14.0
  left marg.T           20 °C
  right marg.T          30 °C
>preselections
  req.ident:           OFF
>electrode test
  electrode type:      standard
  report:              OFF
-----
```

The standard parameters following a memory initialization in the current mode are shown; in this case the pH mode with a connected temperature sensor (see *Section 8.5*). Such parameters can be stored as a method (see *Section 6.1*).

7.2.8 Measured values memory report



In the direct types of measurement you can store up to 100 measured values with <STORE> (see Section 7.3). If you want to print out all the stored data then you can produce a measured values stored report:

```
'mw
781 pH/Ion Meter          01104  5.781.0020
date 2004-06-03 13:55:20

#1
pH                          7.254
temp. (Pt1000)             20.1 °C
id1                          smp1. 1-1
date 2004-06-03 13:54:10
method                       pH Demo

#2
pH                          6.923
temp. (Pt1000)             20.1 °C
id1                          smp1. 1-2
date 2004-06-03 13:54:22
method                       pH Demo

#3
pH                          6.575
temp. (Pt1000)             20.1 °C
id1                          smp1. 1-3
date 2004-06-03 13:54:36
method                       pH Demo
-----
```

The entries for id1, id2, user and method will only be included in the report if they contain data.

Please note that this is a simple and rapid method of producing measured values with their most important data. For the complete documentation of measured value results in the sense of the normal quality assurance requirements you should select the automatic measuring point report instead.

7.2.9 User method report

REPORT
9

+

METHODS
3

Method and calibration data occupy memory space in the pH/Ion Meter. The user method report gives an overview of the memory occupancy:

```
'um
781 pH/Ion Meter          01104  5.781.0020
date 2004-06-03  13:58:49
user memory
>methods
pH                pH-Demo          82
Conc F(-1)        F-Determ         64
>caldata
pH                pH 1.1           130
Conc F(-1)        F-Sens            146
                remaining bytes  4578
-----
```

The mode, method name and the occupied memory is given in bytes for each of the methods. For calibration data the mode, electrode Id and memory occupancy are given.

A total of 5000 bytes is available for this data. This means that you can store a maximum of approx. 50 methods or calibration data. This number can vary depending on the size of the individual data records.

The size of the measured value memory (see *Section 7.3*) is independent of this memory administration.

7.3 Measured values memory

In the direct measuring modes pH, T, U, and Conc(direct) the pH/Ion Meter can store up to 100 measured values with additional information. Depending on the storage criterion you can store the measured values **immediately**, at fixed **time** intervals or **drift**-controlled.

The appropriate instrument settings are made under **CONFIG/Store meas. value** and their functions correspond to the settings for printing the measured values. A more detailed description of the configuration is given in *Section 5.3*.

7.3.1 Save measured values



Saving measured values is triggered with <STORE>. Each storage process is indicated with a beep and a message, e.g.:

measured value 31 stored

After 100 measure values have been stored, and after each further attempt to store a measured value, the pH/Ion Meter will produce a warning message:

⚠ measured value memory full

You now have the possibility of using <RECALL> to view the stored data or of deleting individual measured values or the whole measured values memory (see *Section 7.3.3*).

7.3.2 Print measured values



The output of all stored measured values to a printer or computer via the RS232 interface is made as a measured values memory report (see *Section 7.2.8*). This is done by pressing <REPORT> when in the measured values display and then selecting the measured values stored report directly with <RECALL>.

7.3.3 Show measured values



With <RECALL> the menu for displaying or deleting stored measured values is called up:

```
measured value memory
>show measured values
del mv store:          no
```

Select the item **Show measured values** in order to access the corresponding **display**. The last measured value to have been stored with the highest number will always be shown first:

Measured value no. No. of stored MVs

mv memory	7 von	7	
pH		6.126	↑
temp. (Pt1000)		21.2 °C	
Id1			
Id2			
date	2004-05-26	14:21:11	
user			
method		*****	↓



You can now use the two arrow keys <↑> and <↓> to leaf between the measured values. With <↑> you can access older entries and with <↓> newer ones. You can also leaf beyond the first and last entries and can in this way access the first entry from the last one and vice versa.



By pressing <CLEAR> the displayed entry in the measured value memory will be deleted directly. In this way you can select any measured value in the list and **delete it individually**. The numbering of the other entries will be changed accordingly, i.e. all the following measured values will receive a lower number.

In order to **delete all** measured values you should use <SELECT> in the above measured values memory menu to select the second choice **del mv store:** and set it to '**yes**'; then confirm this and the following safety query **delete ?** with <ENTER>.

7.4 Limit monitoring

In all the direct measuring modes pH, T, U, Conc(direct) it is possible to monitor the current measured value with respect to certain upper and lower limits. In the modes pH and Conc(direct) the temperature can also be monitored.

Under **PARAMETERS/limits** you can activate limits monitoring. Depending on the measuring mode you may be able to monitor the limits of a secondary measured value in addition to the primary measured value. You can define the upper and lower limits and the particular hysteresis. A detailed description of the parameter settings in each measuring mode is given in *Sections 6.2 to 6.5*.

If a limit is exceeded then a beep will be heard and the following message will appear on the display:

⚠ **limit error**

This message cannot be removed with **<QUIT>**. It will vanish automatically as soon as the measured value again lies within the defined limits when the hysteresis is taken into account.

7.4.1 Uses

It is possible to use limit monitoring in the following ways:

1. Alarm

If a limit is exceeded then on the optionally available Remote Box a specific line will be switched to "active". This means that a connected signaller can be switched on in this way.

A detailed description of the connection lines at the 6.2148.010 Remote Box can be found in *Section 9.5*.

2. Control

If a limit is exceeded then on the optionally available Remote Box a specific line will be switched to "active". A connected instrument (e.g. Metrohm Dosimat Plus) can then be used to control the monitored process (see *Section 9.5*). You can also connect the 2.731.0010 **Relay Box** to the Remote Box to control different instruments.

3. Documentation

If **'time'** or **'plot'** has been selected as a print criterion under **CONFIG/print meas.value** then the displayed measured value will be transferred via the RS232 interface to a printer either as a measuring point report or as a plot. In the measuring point report each measured value which lies outside the defined limits will be indicated by the message ⚠ **limit error**. In the plot the limits are clearly shown as a dotted line. An example of a printout can be found in *Section 7.2.3*.

7.4.2 How it functions

The exact way in which limit monitoring functions and the effect on the remote outputs are shown in the following diagram.

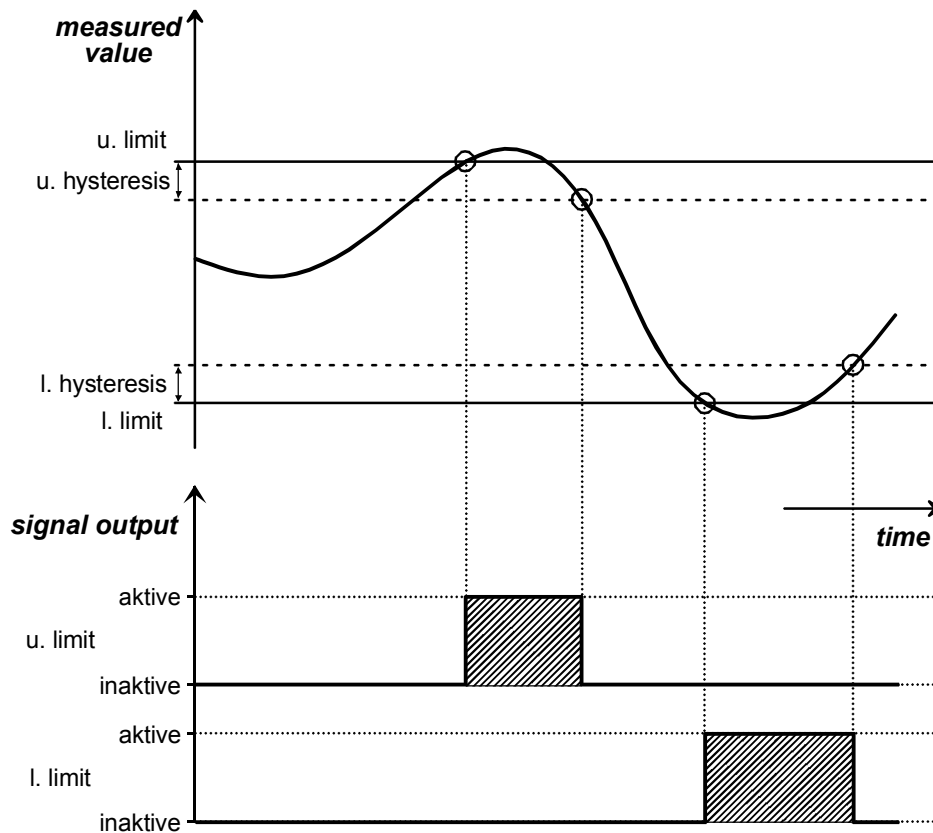


Fig. 13: Remote outputs in limit monitoring

The lower and upper limits and the associated hysteresis are the characteristic quantities for limit monitoring. They can be defined in the parameter settings for each measuring mode (see Section 6.2 to 6.5). The lower or upper limit is always the triggering point for the activation of the corresponding remote line or for the message on the display. If the upper limit is again undercut or the lower limit exceeded again then the activation will continue until the so-called hysteresis range has also been exited. This avoids the too frequent activation or deactivation of the alarm function when the measured value oscillates very closely around a limit. This means that the activation cancellation point is defined as the upper limit minus hysteresis and the lower limit plus hysteresis.

Set the hysteresis to zero, if you are just interested in an exact documentation of limit overruns.

7.5 Setup

Certain settings of the pH/Ion Meter can be found in the **Setup** menu. This menu cannot be accessed from the normal instrument display, as alterations to these settings have a great influence on the functions of the pH/Ion Meter.

The **Setup** menu is called up immediately after the instrument has been switched on by pressing down and holding down the <CONFIG> key.

```

setup
  | lock
  | input assign
  | graphics
  | instr.number
  
```



Be very careful when making alterations in this menu! Alterations have a very large influence on the functions of the instrument. Accidental alterations can be rejected by carrying out a deliberate memory initialization (see Section 8.5).

7.5.1 Locking

```

setup
  | lock
  : | all keys
  : | <CONFIG>
  : | <PARAM>
  : | <CAL>
  : | recall method
  : | store method
  : | delete method
  : | <CAL.DATA>
  : | <MODE>
  : | <EL.TEST>
  
```

You can disable certain keys and functions, e.g. to prevent unwanted alterations to the instrument settings or method parameters.

You can activate such a disablement by setting the corresponding parameter to '**ON**'. This does not affect access to the Setup menu in any way.

Please note that configuration settings (i.e. **CONFIG/report/id1** and **id2**) and parameters (i.e. manual calibration concentrations or standard additions), which are edited during a measurement or calibration procedure, are modified that way even if <CONFIG> or <PARAM> are locked. The advantage is that the requested settings and parameters only have to be confirmed during repeated procedures.

Please note that all disablements will be invalidated if a RAM-Init is carried out (see Section 8.5).

7.5.2 Input assignment

```

setup
:
| input assign
: | Mode pH           1
  | Mode T           2
  | Mode U           3
  | Start pH cal.    5
  | Start el.test    6
  | Mode conc.       8
  | Start conc.cal.  9
  | <ENTER>         15

```

The pH/Ion Meter can communicate with other Metrohm instruments via the optionally available Remote box (see *Section 9.5*). In special cases it may be a good idea to alter the assignments of the actions to be triggered to the signal impulses on input lines **Input 1** to **Input 4** (see *Section 9.5.2*).

The assignment described here represents the default setting.

7.5.3 Graphics

```

setup
:
| graphics
: | grid
  | frame
  | width
  | length

```

In order to provide the graphical plot of the report printout with a **frame** and a **grid** you should switch on the corresponding options.

You can adapt the **width** and **length** of this plot to the size of the printer paper used by altering the particular factor (**0.4 . . . 1.0**).

8 Troubleshooting – Messages – Maintenance

8.1 Troubleshooting

If problems occur during pH or ISE measurement then these can have various causes:

1. Application

Difficult sample matrices or interferences can prevent reliable measurements (e.g. insufficient ionic strength, presence of interfering ions in ISE measurements, etc.). Our **Application Bulletins** and **Application Notes** support you in correct selection of the analytical conditions and the configuration of the instrumental method.

2. Buffer / Standard solution

The precision of pH and ion measurements depends primarily on the correction calibration of the electrode. You should use clean and fresh buffer solutions and standard solutions. For example, a frequent cause of incorrect calibration is the use of an old pH 9 or pH 10 buffer, whose pH can vary considerably from the certified pH of a new buffer as a result of the absorption of atmospheric CO₂.

3. Measuring / Reference electrode

The electrodes are the most important element of the whole measuring system. The correct handling of the measuring and reference electrodes is described in the **leaflet** which accompanies the electrode and the **8.109.1476 Manual of Ion-sensitive Electrodes**.

4. pH/Ion Meter

If the pH/Ion Meter is thought to be the cause of a measuring problem then first check all the configuration and parameter settings. The diagnostic functions help you in searching for the fault (see *Section 8.5*).

The pH/Ion Meter will inform you directly about problems during the measurement. These **messages** are explained in the following *Section 8.2*.

A further possibility of carrying out a selective search for a pH electrode fault is the **electrode test**. This is described in *Section 8.6*, where you will also find specific measures for remedying any fault discovered during the test.







The following table lists general problems that can occur during pH and ISE measurements. Possible causes and appropriate remedies are also described.

<i>Problem</i>	<i>Possible cause</i>	<i>Remedy</i>
Measuring signal absent or very variable	Electrode not connected	<ul style="list-style-type: none"> • Connect electrode
	Air in or in front of the diaphragm	<ul style="list-style-type: none"> • Remove air
	Faulty electrode	<ul style="list-style-type: none"> • Replace electrode
Measured value remains unstable and does not fulfill drift criterion	Dirty pH or ISE membrane or diaphragm	<ul style="list-style-type: none"> • Clean membrane or diaphragm
	pH or temperature of the solution is not stable	<ul style="list-style-type: none"> • Measure under exclusion of air • Thermostat the solution
	Unsuitable electrode: <ul style="list-style-type: none"> • Conductivity too low • Organic solution 	<ul style="list-style-type: none"> • Use suitable electrode
	Electrode not connected	<ul style="list-style-type: none"> • Connect electrode
	Faulty electrode	<ul style="list-style-type: none"> • Replace electrode
Measured value reached slowly	Dirty pH or ISE membrane or diaphragm	<ul style="list-style-type: none"> • Clean membrane or diaphragm
Slope too small on calibration	pH or ISE membrane or diaphragm is dirty	<ul style="list-style-type: none"> • Clean membrane or diaphragm
	Glass membrane dehydrated after measurement in non-aqueous solution	<ul style="list-style-type: none"> • Immerse electrode in water between measurements
	Poor buffer/standard solutions	<ul style="list-style-type: none"> • Replace buffers or standards
	Electrode "used up"	<ul style="list-style-type: none"> • Replace electrode
Measured value obviously incorrect	Incorrect calibration	<ul style="list-style-type: none"> • Check / Repeat calibration • Check / Replace buffer/standard solutions
	Manual temperature input incorrect	<ul style="list-style-type: none"> • Enter correct temperature of the solution
	Dirty pH or ISE membrane or diaphragm	<ul style="list-style-type: none"> • Clean membrane or diaphragm
	Electrolyte or electrode too old	<ul style="list-style-type: none"> • Refill electrolyte or replace electrode
	Faulty electrode	<ul style="list-style-type: none"> • Replace electrode

<i>Problem</i>	<i>Possible cause</i>	<i>Remedy</i>
With standard addition 'auto' the potential step 'delta U' is not reached	Streaming potential of the measuring or reference electrode causes potential difference between addition in stirred and measurement in unstirred solution	<ul style="list-style-type: none"> • Lower dosing rate • Increase stirring rate • Increase 'delta U' • 'auto dos' instead of 'auto'
System test message: system error #X	Instrument fault	<ul style="list-style-type: none"> • Note error number and inform Metrohm Service

8.2 Messages

The pH/Ion Meter uses various messages to selectively inform you about possible errors or operating problems. These are shown in the bottom line of the display and illustrated by a symbol in front:













Type	Symbol	Example of a message
Error		same buffer
Warning		cal.data out of limits
Information		manual stop
		change buffer <ENTER>
		calibration OK
Monitoring		cal.interval expired










These messages can normally be removed by pressing the <QUIT> key. However, some messages will remain until their cause has been remedied. For example, this applies to a monitoring message or a warning message during a standard addition run. In the latter case it is necessary to carry out a new and successful analysis to remove such a warning message.




















Please note that you should not press <QUIT> to acknowledge a message while a report is being produced as this will cancel the report.

The following table lists all the messages which could appear on the display of the pH/Ion Meter.

Message	Situation	Cause	Remedy
 XXX bytes missing	Method storing	XXX bytes are missing for saving a method	Press <QUIT> to delete old methods
 V add too large	Conc calibration, standard addition	Standard volume to be added is larger than buret volume	<ul style="list-style-type: none"> • Use larger buret • Reduce start volume • Increase standard concentration
 V add too small	Conc calibration, standard addition	Standard volume to be added is too small	<ul style="list-style-type: none"> • Check parameters (see <i>Section 6.5.5</i> or <i>6.6.1</i>) • Reduce standard concentration • Use smaller buret
 check working cond.	Standard addition, sample addition	No change in potential after standard addition	Check standard addition
		Strongly drifting electrode signal	Check electrode
		Slope sign incorrect for type of ion	Check ion parameters under <i>Section 6.5.2</i>
 evaluation error	Conc calibration, standard addition, sample addition	Evaluation not possible	<ul style="list-style-type: none"> • Check parameters • Check standards
 please wait	Report output	New task was started during report output	Wait for report output
 delta T >2 °C	pH calibration, Conc calibration	Temperature difference between two buffers or standards is too large	<ol style="list-style-type: none"> 1. Match temperatures 2. Continue with <ENTER> or cancel with <MODE> and re-start
	Electrode test	Temperature difference between two buffers is too large	<ol style="list-style-type: none"> 1. Cancel electrode test with <MODE> 2. Restart with suitable buffers
 check electrode	Temperature measuring	Short circuit or interruption	Remedy fault or change mode
 electrode test not passed	Electrode test	Electrode test gives values outside the tolerances	see <i>Section 8.6.4</i>
 validate instrument	Instrument has been switched on	Set validation interval has expired	<ol style="list-style-type: none"> 1. Validate instrument 2. Reset time counter to zero (see <i>Section 5.5</i>)
 same buffer	pH calibration	Potential difference between 1st and 2nd buffer is too small	<ol style="list-style-type: none"> 1. Change buffer 2. Press <ENTER>
 same standard	Conc calibration	Pot. difference between 1st and 2nd standard < 6 mV	<ol style="list-style-type: none"> 1. Change standard 2. Press <ENTER>

Message	Situation	Cause	Remedy
 limit error	Direct measurement, all modes	Set limit for primary or secondary measured value exceeded	see <i>Section 7.4</i>
 cal. interval expired	pH and Conc modes	Set calibration interval has expired	Recalibrate electrode (see <i>Section 6.2.2</i> and <i>6.5.5</i>)
 cal.data out of limits	pH calibration	Determined calibration data are outside limits defined as calibration parameter	Accept calibration data with <ENTER> or reject them with <MODE> ; check electrode, buffer or limits under <i>6.2.2</i>
	Conc calibration	<ul style="list-style-type: none"> Determined slope is outside limits of 80 – 105 % of theoretical slope (59.16 mV per ion charge [25°C]) Sign incorrect for set type of ion. 	<ul style="list-style-type: none"> Accept calibration data with <ENTER> or reject them with <MODE> Check electrode, standards under <i>6.5.5</i> or check ion type under <i>6.5.2</i>
 calibration OK	pH calibration, Conc calibration	Calibration has been concluded successfully	Exit display with <QUIT> ; this happens automatically after 30 s; calibration data will be accepted
 manual stop	Various measuring runs	Measurement has been stopped manually	
 measuring range exceeded	Various measuring runs	<ul style="list-style-type: none"> Electrode not immersed in the solution Electrode not connected correctly 	Remedy fault or change mode
 measured value memory full	Saving measured values in a direct measurement	Attempt made to store a further measured value when 100 have already been stored	Delete measured values (see <i>Section 7.3</i>)
 plot data overflow	Report output	Data output is faster than printer processing speed	Press <QUIT> and <ul style="list-style-type: none"> Increase time interval between measurements Increase time scale Reduce graph width Only output primary measured value.
 buffer not defined	pH calibration	pH of a buffers has not been defined under Buffer type: own for the given temperature	Enter missing value in temperature table (see <i>Section 6.2.2</i>)

Message	Situation	Cause	Remedy
 buffers unsuitable	Electrode test	Electrode test has been started with a set of buffers that does not contain all the necessary buffers	<ul style="list-style-type: none"> • Change buffers • Check selected buffer type in the calibration parameters (see Section 8.6.1)
 change buffer <ENTER>	pH calibration	Instrument is waiting for new buffer	<ol style="list-style-type: none"> 1. Change buffer 2. Press <ENTER>
 buffer alloc. impossible?	pH calibration	<ul style="list-style-type: none"> • Buffer not recognized or not defined (buffer type 'special', 'own' or 'mixed') • Offset potential Uoff is set too high 	<ol style="list-style-type: none"> 1. Replace buffer 2. Press <ENTER> or <ol style="list-style-type: none"> 1. Stop calibration 2. Define buffer 3. Restart calibration or Enter Uoff (see Section 6.2.2) and restart calibration
 report output ...	Standard addition, sample addition	Instrument is busy with the output of a RS232 report	Wait until report output is finished
 RS error 36	RS232 remote control	RS receiver error: parity unmatched	<ol style="list-style-type: none"> 1. Press <QUIT> 2. Match the parities of both instruments (see Section 5.7)
 RS error 37	RS232 remote control	RS receiver error: stop bit unmatched	<ol style="list-style-type: none"> 1. Press <QUIT> 2. Match the stop bits of both instruments (see Section 5.7)
 RS error 38	RS232 remote control	RS receiver error: data overflow, at least one character cannot be read (incorrect baud rate)	<ol style="list-style-type: none"> 1. Press <QUIT> 2. Match the baud rates of both instruments (see Section 5.7)
 RS error 39	RS232 remote control	RS receiver error: internal receiver buffer overflow	<ol style="list-style-type: none"> 1. Press <QUIT> 2. Repeat process
 RS error 42	Report output	RS transmitter error: handshake not replied to for at least one second	<ol style="list-style-type: none"> 1. Press <QUIT> 2. Check reception readiness at other end
 RS error 43	Report output	RS transmitter error: transmission from the pH Meter has been interrupted by XOFF for at least three seconds	<ul style="list-style-type: none"> • Press <QUIT> • Send XON

<i>Message</i>	<i>Situation</i>	<i>Cause</i>	<i>Remedy</i>
 RS error 45	Report output	RS transmitter error: The receiver buffer of the pH Meter contains an incomplete character string (line feed missing); this has blocked pH Meter transmission	<ul style="list-style-type: none"> • Press <QUIT> • Send line feed
 stirrer not found	Various situations	An attempt has been made to control an 8xx series stirrer which is not connected	<ol style="list-style-type: none"> 1. Press <QUIT> 2. Switch off instrument 3. Check stirrer connection or <ul style="list-style-type: none"> • Check measuring parameters • If necessary, change stirrer connection configuration to a 7xx series stirrer (see Section 5.6)
 service is due	Instrument has been switched on	Set service date has been reached	Contact service (see Section 5.5)
 change std <ENTER>	Conc calibration	Instrument is waiting for a new standard	<ol style="list-style-type: none"> 1. Change standard 2. Press <ENTER>
 stop V reached	Standard addition, sample addition	Set stop volume has been reached	<ol style="list-style-type: none"> 1. Press <QUIT> 2. Check method parameters
system error #X	System test after switch on	pH/Ion Meter fault	<ol style="list-style-type: none"> 1. Note error number 2. Contact Metrohm Service
 ----.- °C or check T-sensor	Various runs with temperature measurement	Temperature sensor is faulty or has been unplugged during the run	Connect a properly functioning temperature sensor
	Mode T	Temperature sensor is faulty or not connected	Connect a properly functioning temperature sensor
 transmission error	PC keyboard connecte	Communication problem with PC keyboard	Check keyboard connection with instrument switched off

8.3 QM support

Metrohm AG can support you in your quality management (QM) measures:

Literature

Brochures in the series "Quality management with Metrohm" provide an overview of the topics of quality assurance and validation, help with the documentation of your validation activities and explain the quality management system at Metrohm AG, Herisau. You can request them under www.metrohm.com or from your local Metrohm agency.

Further information about the validation of Metrohm pH meters can be found in Application Bulletin No. 271.

Instrument-internal validation aids

The **system test** of the pH/Ion Meter checks that all the relevant assemblies are functioning properly when the instrument is switched on. The result can be produced directly as a system test report via the RS232 interface (see *Section 5.5*).

Calibration is a simple and necessary means of checking the functions of the pH/Ion Meter and the electrodes connected to it. The determined calibration data is checked according to certain criteria, can be assigned to a defined electrode identification and can be stored together with it. When a defined **calibration interval** has expired the instrument will inform you that the recalibration of the connected electrode is necessary. A description of the calibration parameters for the various modes can be found in *Section 6.2.2* (pH) and *Section 6.5.5* (Conc [781 only]).

You can use **monitoring** to have the instrument remind you automatically about tasks which are due for validation purposes or service measures. Just as for an expired calibration interval, these messages will also be protocolled with each output of a measured value which has been determined since the expiry of the due date even though the necessary measures have not yet been taken.

With **diagnose** you can subject the various assemblies of the pH/Ion Meter to further-going tests. This can help you to localize any faults which may occur. This function can also be integrated in your validation measures. It is described in detail in *Section 8.5*.

The **electrode test** is a programmed sequence of various measurements for checking the quality of the connected pH electrode. Sophisticated assessments help with the selective localization of an appearing problem. In *Section 8.6* you will find an exact description of how to carry out such an electrode test, a detailed interpretation of the possible test results as well as the appropriate measures for remedying the faults and preventing future ones.

Service contract

Under a separate service contract you can receive particular service performances within the framework of preventative maintenance. The documented specifications of the instrument will be checked by the service technician responsible at regular intervals; the technician will document the results and suggest any measures which may be necessary.

Certificates for Metrosensors and electrolytes

The validation of the pH/Ion Meter should always include the validation of the whole measuring system (instrument, electrodes, electrolytes and, if applicable, the stirrer). All Metrosensor pH electrodes, ion-selective electrodes, reference electrodes and temperature sensors are supplied with the corresponding certificates. The same applies for buffer solutions, which are supplied with batch-specific certificates.

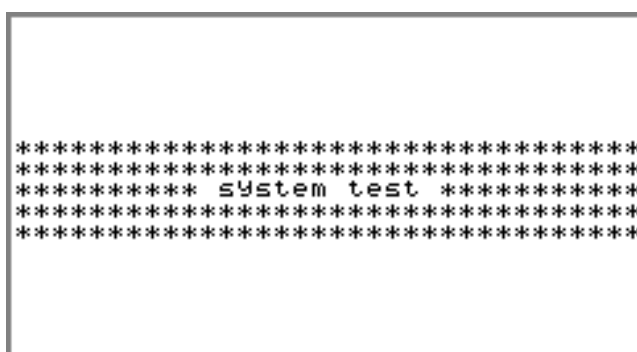
8.4 Validation

The checking and maintenance of the pH/Ion Meter can be carried out in 3 steps. This list can be extended by the measures described in *Section 8.3*.

1. Checking the electronic components when the instrument is switched on.
2. Validation of the whole analytical system by wet chemistry.
3. pH/Ion Meter maintenance by Metrohm Service.

8.4.1 Electronic tests

After the pH/Ion Meter has been switched on an electronic system test is carried out automatically. The following display is seen:



The tests are documented in the system test report; this can be printed out when the instrument is switched on: (see *Section 5.4*):

```

'di
781 pH/Ion Meter      01104  5.781.0020
date 2004-05-21  15:32:00
RAM test             OK
EPROM test           OK
real time clock      OK
COMPort              OK
A/D converter        OK
LCD display          OK
=====

```

If one of these tests is not concluded with '**OK**' then please contact Metrohm Service.

With a **real time clock** error you can try resetting the date and time. If the test is then '**OK**', you should check whether the stored methods and instrument configuration are still unchanged.

8.4.2 Wet tests


Quality assurance standards such as GLP (Good Laboratory Practice) require the regular validation of the analytical instruments. The reproducibility and accuracy of the instruments are checked.

Repeating the test at yearly intervals is normally adequate. However, depending upon the requirements, it may be necessary to carry out the test more frequently, e.g. every 3 months or every 6 months.

A basis for a test procedure (SOP, Standard Operating Procedure) is given in the following Metrohm Application Bulletin:


AB No. 271: Validation of Metrohm pH Meters.

The validation interval can be monitored by the pH/Ion Meter (see *Section 5.5*). When the interval has expired the pH/Ion Meter will show the following message:

 validate instrument

8.4.3 pH/Ion Meter maintenance

In the same way as monitoring the validation interval, the pH/Ion Meter can also remind you that maintenance is due, e.g. by Metrohm Service (see *Section 5.5*).

 service is due

8.5 Diagnosis

The pH/Ion Meter is equipped with a diagnosis program. This allows selective checks of the functions of individual assemblies.

The diagnosis can be carried out directly after the instrument has been switched on by pressing and holding down the <9> key. Only those tests that you can carry out yourself are described below; the other functions are reserved for Metrohm Service personnel.

If one of the following tests is concluded with an error message, please note it down and contact your local Metrohm agency.



You are expressly warned against triggering any other functions other than those listed and documented below. Improper use can disturb the correct functioning of the pH/Ion Meter and may render it unusable.

```

diagnose
  |RAM Initialization
  |RAM Test
  |AD-Converter Test
  |LCD Display Test
  |
  |Key Test
  |
  |

```

RAM Initialization

Select: **ACTMODE**, **MODES**, **SETUP**, **CONFIG**,
ASSEMBLY, **ALL**

The initialization of the instrument memory can be a good idea if you want to return parameter and configuration settings to their original condition. This does not affect the instrument software itself, but only the above selection of the corresponding user data. **ACTMODE** resets all method parameters of the current measuring mode, **MODES** affects the method parameters of all modes. With **SETUP** you can initialize the set-up settings, with **CONFIG** all the configuration data will be reset. **ASSEMBLY** functions, which can only be accessed via remote control, are reset here. The option **ALL** resets the whole instrument memory to its original condition.



A memory initialization should only be triggered after careful consideration! It will permanently delete all the affected user data which must then be reentered manually.

When only certain configuration settings or method parameters are to be reset to their default values then the manual version is more suitable. Except for a few special cases, all the corresponding default values can be set directly during input with the <CLEAR> key. In the other cases you will find the default settings in this Manual in Sections 5 and 6.

RAM Test

This test checks the condition of the instrument memory without altering its contents. A successful test is concluded with the message '**ram test ok**'.

AD-Converter Test

The electronic components of the analog-digital converter are checked. At the end the two messages '**ADC EEPROM Test ok**' and '**ADC Int. ok x mS**' should appear. Instead of '**x**' the message should contain a number between 15.0 and 25.0.

LCD Display Test

With this test you can check that the LCD display is functioning properly. It consists of a sequence of individual tests which can be switched forward with **<QUIT>**. The test can be halted with **<ENTER>** and canceled with **<MODE>**.

Key Test

The correct functions of all the instrument keys can be checked here. After the start a 3-fold beep will be heard (so that you can also test this straight away) after which the instrument will respond to the pressing of each key by displaying the corresponding key code. However, the **<ON/OFF>** key will still switch off the pH/Ion Meter. This test is terminated by pressing the **<CLEAR>** key twice.

8.6 pH electrode test



With the pH/Ion Meter you can carry out an automatic pH electrode test which allows the quality of the electrode used to be evaluated. As the result you will obtain various information about the characteristic measuring properties of your pH electrode (slope, response time, drift, streaming potential). The concluding evaluation of the electrode is carried out by checking the results obtained against preset tolerances.

These tolerances are stored in the pH/Ion Meter for the three most frequently used types of Metrohm pH electrodes: **standard electrodes**, **gel electrodes** and **non-aqueous electrodes**. You can also define your own limits. The specific classification of the electrode system is defined by the reference system used. You find overview for these electrode types and the corresponding tolerances on p. 130.

In the electrode test faulty electrodes frequently show certain combinations of measured results which lie outside the preset limits. This permits more detailed information to be given about possible causes and recommended measures.

8.6.1 Preparations

Buffers

You need faultless pH 4, pH 7 and pH 9 buffers for carrying out the electrode test. We recommend the use of suitable Metrohm buffers. In principle the electrode test can also be carried out with any of the stored sets of buffers which contain buffers with these values. The set of buffers used must be set in the calibration parameters (see also Section 6.2.2):

```

PARAMETER pH
:
| calibration parameters
:
:
| buffer type
:

```

If an electrode test is started with a set of buffers which does not contain the necessary buffers then the following error message will appear:

 buffers unsuitable



Particularly with buffer pH 9 you should make certain that it is in a faultless condition. By absorption of CO₂ from the atmosphere this buffer can easily vary from its specified pH values and therefore produce incorrect test results.

Stirrer

You require a stirrer for the test. We recommend the use of a Metrohm stirrer as this allows the electrode test to be carried out automatically. Information about the connection and configuration of such a stirrer is given in Section 5.6.

With a 801 Magnetic Stirrer the test is fully automated. You just have to change the buffers. Set the stirring rate at

PARAMETER pH/measuring parameters/stirrer:
stirring rate

The stirring rate should be set so that the stirring action is powerful but without the formation of air bubbles (avoidance of absorbing CO₂).

Metrohm stirrers which are connected to the pH/Ion Meter are switched on and off automatically when the measuring parameter **stirrer** (see above) is set to '**ON**'. If an unconnected stirrer is used then you will have to switch it on and off manually during the test. A request will be made at the appropriate places during the test. The measuring parameter **stirrer** must thereby be set to '**OFF**'.

Printer

If you want to print out either a full or short test report then a printer must be connected (see *Section 2.3*) and its configuration set properly (see *Section 5.6* and *5.7*).

Parameter settings

Before the start of the electrode test it may be necessary to adapt the electrode test parameters. These parameters are described in *Section 6.2.7*.

Temperature

Please ensure that the whole electrode test is carried out at a constant temperature. As the temperature has a great influence on the response time you should work at room temperature if possible. The preset tolerances are set for 25 °C.

In the following section the exact electrode test procedure is described. It is assumed that a temperature sensor is connected: if not, you must determine the measuring temperature manually and enter it at the start of the electrode test when the request for it appears on the display.

8.6.2 Procedure

The whole pH electrode test is dialog guided; this means that you will be requested to carry out any activity which is required. The sequence is as follows: the pH electrode is first immersed in the pH 9 buffer and its potential is measuring for three minutes under stirring followed by one minute without stirring. The same measurements are then repeated at pH 4 and pH 7. If no controllable stirrer is connected you will be requested to switch the stirrer on and off at the required times.

In order to obtain realistic response times the electrode should be immersed in each buffer at about the same time as the measurement is started and it should be positioned directly above the stirrer which has already been switched on.

The pH/Ion Meter in the pH mode should be in the normal working condition (measured value display). Otherwise switch to this mode with **<MODE>**.



1 Start pH electrode test

- The electrode test is started from the pH measured value display with <EL.TEST>.

2 (Enter temperature)

- If no temperature sensor is connected then the measuring temperature of the buffers must be entered here. This should be the same for all buffers.



3 Immerse electrode in pH 9 buffer

- Immerse the electrode in the pH 9 buffer and immediately press <ENTER>.
- The instrument now counts down from 239 to 0 seconds.
- If a Metrohm stirrer is connected and configured (see Section 8.6.1) then it will be switched off automatically after 3 minutes. Otherwise you will be requested to switch off the stirrer; this request must be confirmed with <ENTER>.
- If a temperature sensor is connected the temperature measurement will then be carried out.



4 Immerse electrode in pH 4 buffer

- Immerse the electrode in the pH 4 buffer and immediately press <ENTER>.
- Further procedure as for the pH 9 buffer.



5 Immerse electrode in pH 7 buffer

- Immerse the electrode in the pH 7 buffer and immediately press <ENTER>.
- Further procedure as for the pH 9 buffer.

6 Evaluation of the pH electrode and report output

- The electrode evaluation will then appear on the display. If applicable the report will also be printed out on a connected printer.
- If interference occurs the electrode test may be terminated. Such interference is also shown on the display and noted in the report (see Section 8.6.4)

8.6.3 Results

The following graph shows the potential of the pH electrode as a function of time during the electrode test for a buffer in diagram form:

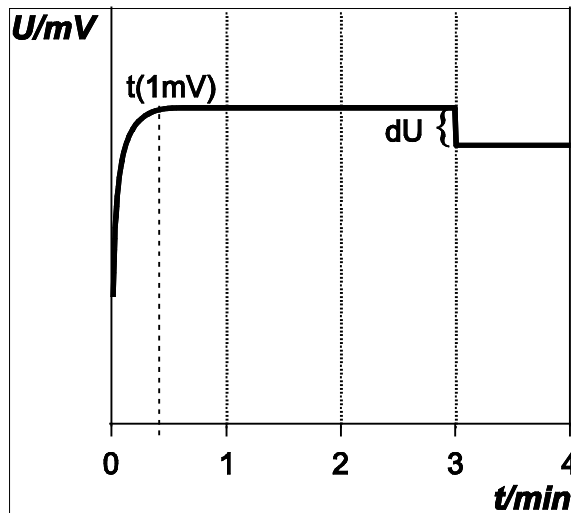


Fig. 14: Diagram showing changes in potential during an electrode test

The evaluation of the pH electrode is made according to the following criteria. These measured and calculated values are listed in the printed report:

Streaming potential dU (unstirred - stirred)

This is the absolute difference between the measured potentials in the stirred (after 3 min) and unstirred solution. It is determined at each pH, but is initially most significant for the pH 9 buffer.

Drift

The absolute drift in the stirred solution (after 3 min) is determined at each pH and used to calculate the total.

Slope

Just as in a calibration, for each pH combination (pH 4/7, 7/9 and 9/4) the electrode slope, $pH(0)$ and the offset potential U_{off} are determined in the stirred solution.

Response time $t(1mV)$

Time after which the measured potential is within 1 mV of the potential determined in the stirred solution after three minutes.

Offset potential U_{off}

The offset potential U_{off} , which is determined together with the slope and $pH(0)$, is tested once against a preset limit and is not included in the evaluation.

The following table lists the preset tolerances for the three types of electrode:

	excellent electrode	good electrode	passing electrode
Electrode type: standard			
Streaming potential dU [mV]	≤ 2.5	≤ 3.0	≤ 4.0
Total drift [mV]	≤ 2.0	≤ 2.5	≤ 3.0
Slope s [%]	$96.5 \leq s \leq 101$	$96 \leq s \leq 102$	$95 \leq s \leq 103$
Response time [s]	≤ 45	≤ 50	≤ 60
Offset potential U_{off} [mV]			$-15 \leq U_{\text{off}} \leq 15$
Electrode type: gel => all (reference-) electrodes filled with Idrolyte			
Streaming potential dU [mV]	≤ 3.0	≤ 3.5	≤ 4.5
Total drift [mV]	≤ 2.5	≤ 3.0	≤ 4.0
Slope s [%]	$96.5 \leq s \leq 101$	$96 \leq s \leq 102$	$95 \leq s \leq 103$
Response time [s]	≤ 60	≤ 75	≤ 90
Offset potential U_{off} [mV]			$-15 \leq U_{\text{off}} \leq 15$
Electr. type: non-aqueous => all (reference-) electrodes filled with TEABr or LiCl in ethanol			
Streaming potential dU [mV]	≤ 3	≤ 4.5	≤ 6
Total drift [mV]	≤ 5	≤ 7	≤ 9
Slope s [%]	$88 \leq s \leq 120$	$80 \leq s \leq 130$	$70 \leq s \leq 140$
Response time [s]	≤ 60	≤ 75	≤ 90
Offset potential U_{off} [mV]			$-10 \leq U_{\text{off}} \leq 70$

The tested pH electrode is given that evaluation for which it fulfills all the criteria. If one of the tolerances for a usable (passing) electrode is not observed then the electrode test will be concluded with the message '**electrode out of limits.**' in the report. If further test criteria are also not fulfilled then the electrode test evaluation will be '**electrode test not passed**'. In addition a more specific error message will be shown on the display and will also be included in the report (see following section).

TIP !

Instead of the stored tolerances for most Metrohm electrodes you can set your own values (see Section 6.2.7). This may be helpful for special applications if, for example, other quality requirements are placed on the pH electrode or work is carried out with a reference electrode which displaces the offset potential U_{off} beyond the required -15 to $+15$ mV (standard and gel electrodes).

8.6.4 Messages and measures


For the test results '**passing electrode**' and '**electrode out of limits**' the following recommendations for improving the quality of the electrode can be given:

Result	Measure
passing electrode	Clean diaphragm
electrode out of limits	Clean diaphragm and/or re-generate the glass membrane; check reference system

The following general information should be taken into consideration when evaluating the electrode test results:

- With separate measuring and reference electrodes the pH electrode is not always the cause of unexpectedly poor test results. This is why you should also check the condition of the **reference electrode** (see Section 8.6.5).
- If the tested pH electrode has been given a lower evaluation only because of its slope being inadequate then you should compare the individual slopes at pH 4/7 and pH 7/9. If these values are different then repeat the electrode test using a **fresh pH 9 buffer**. Only then can you conclude that there is an electrode problem.
- A correct **outflow of the inner electrolyte** causes only a minimum potential drop when the stirrer is turned of (see Fig. 14). A large drop indicates a too small outflow - the diaphragm is blocked. If you obtain a potential step-up, the outflow is too high and should be corrected.
- Under certain conditions, e.g. very low relative humidity, plastic floor coverings or clothing made from synthetic materials, the pH electrode can be affected by **electrostatic discharges**. The results are high drift values and correspondingly poor electrode test results. Such problems can be avoided by the user wearing e.g. an antistatic bracelet.

In addition to the evaluation of the electrode quality described above, the measured values are also checked to see if they have exceeded certain tolerances. In such cases the electrode test is concluded with the following message on the display:

 **electrode test not passed**

More specific error messages will also be shown and included in the report. The following table lists these tests, the resulting messages and recommended measures for remedying their possible causes. These measures are described in detail in the following Section.

The first two tests are carried out after the measurement in the pH 9 buffer and the electrode test then stopped if necessary.

Test criterion	Message	Measure
pH 9: absolute drift in stirred solution > 1 mV/min	problem	Clean diaphragm and/or regenerate the glass membrane.
pH 9: -10 mV < U(unstirred) < 10 mV AND sum of abs. drift values after 1, 2, 3 and 4 min < 12 mV/min	short circuit	Replace electrode (short circuit or crack in glass membrane).
2 slopes do not meet the conditions for a passing electrode	check buffer/ electrode	Repeat test using correct buffers.
Electrode poor as streaming potential dU is too high	bad diaphragm	Clean diaphragm.
All slopes meet conditions for passing electrode AND Uoff outside the preset limit	reference not matching	Repeat with suitable reference system; replace contaminated reference electrolyte. If necessary select electrode type 'own' and adapt the Uoff limits.
All slopes do not meet conditions for passing electrode	partial short circuit	Check temperature sensor or enter correct temperature. If this does not help then replace pH electrode.
A response time does not meet the criterion for passing electrode	glass membrane/ reference	Regenerate glass membrane and/or clean diaphragm.

8.6.5 Care and maintenance of pH glass electrodes

General

- A combined pH electrode must be filled with the correct reference electrolyte, e.g. with $c(\text{KCl}) = 3 \text{ mol/L}$.
- The reference electrolyte chamber should be completely filled with clean electrolyte.
- The reference electrolyte filling opening must remain open during the measurement and be closed during storage.
- There should be no air bubbles in the inner or reference electrolyte.
- All cable connections should be clean and dry.

Storage

- Combined glass electrodes with $c(\text{KCl}) = 3 \text{ mol/L}$ as reference electrolyte should be stored in the Storage solution 6.2323.000 (also contained in the maintenance kit for pH electrodes 6.2325.000). If the electrode is stored in water, then AgCl will precipitate out in the diaphragm! pH glass electrodes filled with another reference electrolyte should be stored in that reference electrolyte.
- Separate glass electrodes should be stored in distilled water.

Cleaning the diaphragm

- After measurements in solutions with low chloride concentration (precipitated AgCl in the diaphragm which is colored dark brown): place electrode overnight in a concentrated ammonia solution, rinse with water and replace the reference electrolyte.
- After measurements in protein-containing solutions: place electrode in a solution of 5% pepsin in $c(\text{HCl}) = 0.1 \text{ mol/L}$ for several hours; the best effects are obtained at a temperature of $38 \text{ }^\circ\text{C}$. Then rinse thoroughly with water and replace the reference electrolyte.
- After measurements in sulfide-containing solutions (Ag_2S in diaphragm, which has a dark color): immerse electrode in freshly prepared, slightly acidic 7% thiourea solution for several hours. Then rinse with water and replace the reference electrolyte.
- **Note:** Ultrasonic cleaning can destroy the electrode!

Care of the glass membrane

- When carrying out measurements in non-aqueous media the electrode should be hydrated between measurements.

9 Annex

In this section you will find the most important technical data of the pH/Ion Meter, a description of evaluation principles, dialog structures, buffer tables, a description of the optional remote box, a list of standard accessories and optional accessories as well as warranty and declarations of conformity.

9.1 Technical data

Provided that nothing to the contrary is mentioned, the published values represent the typical data of the **780 pH Meter** and the **781 pH/Ion Meter**.

9.1.1 Measuring modes

<i>Measuring mode</i>	<i>Prim. measured quantity</i>	<i>Sec. measured quantity</i>
pH	pH	T
Temperature	T	
Potential	U	
Concentration (781 only)	Conc	T

9.1.2 Measuring inputs

Potentiometric

for pH (780/781), potential (780/781), concentration (781)

- 1 high-impedance measuring input for pH, redox and ISE electrodes
- 1 reference input for separate reference electrode

Input resistance > $1 * 10^{12}$ Ohm
Offset current < $1 * 10^{-12}$ A
 (under reference conditions)

Temperature

Also for automatic temperature compensation

- 1 measuring input for temperature sensors (Pt1000 or NTC)

NTC characteristics configurable

Default values $R(25^{\circ}\text{C}) = 30000 \text{ Ohm} / B_{25/50} = 4100$

Measuring interval

Measuring cycle 100 ms for all measuring modes

9.1.3 Measuring input specifications

	<i>Measuring range</i>	<i>Resolution</i>	<i>Measuring accuracy</i> ¹⁾
<i>pH</i>	-20.000...+20.000	0.001 pH	± 0.003 pH
<i>Temperature</i> <i>Pt1000</i> <i>NTC</i>	-150 °C...+250 °C -20 °C...+250 °C	0.1 °C 0.1 °C	± 0.2 °C (Pt1000: -20 °C... +150 °C)
<i>Potential</i>	-2200 mV...+2200 mV	0.1 mV	± 0.2 mV
<i>Concentration</i> <i>(781 only)</i>	$1.0 \cdot e^{-37} \dots 1.0 \cdot e^{37}$	0.2 % ²⁾	± 0.4 % ²⁾

¹⁾ ±1 digit, without sensor error, under reference conditions

²⁾ for single charged ions

9.1.4 Interfaces

RS232 connection

RS232 Hardware and software handshake for printer and remote control

MSB connections (MSB = Metrohm Serial Bus)

Stirrer Connection of max. 1 stirrer
Stirrer control: manual on/off, or automatic during measuring sequence
Rate selectable in 15 steps

Remote box Connection of max. 1 remote box
Activation and control of external devices, e.g. sample changer, Dosimat Plus (781: Conc mode)

Barcode / Keyboard connection

PC keyboard PS/2 PC keyboard

Barcode Barcode reader with PS/2 interface

9.1.5 Power supply

Power supply unit 12 V ±1%, 1A

Power consumption 5 W (without external loads)

The following current consumers are allowed:

Remote box with connection < 40 mA, 5 V

Stirrer at MSB connection < 200 mA, 12 V

Barcode / Keyboard < 250 mA, 5 V

9.1.6 Safety specifications

<i>Instrument 780/781</i>	Standards fulfilled: - EN/IEC 61010-1 - UL 61010-1 - CSA-C22.2 No. 61010-1 - protection class III
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9.1.7 Electromagnetic compatibility (EMC)

<i>Emission</i>	Standards fulfilled: - EN/IEC 61326-1 - EN/IEC 61000-6-3 - EN 55022 / CISPR 22
<i>Immunity</i>	Standards fulfilled: - EN/IEC 61326-1 - EN/IEC 61000-6-2 - EN/IEC 61000-4-2 - EN/IEC 61000-4-3 - EN/IEC 61000-4-4 - EN/IEC 61000-4-5 - EN/IEC 61000-4-6

9.1.8 Ambient temperature

<i>Nominal working range</i>	+5 °C...+45 °C (max. 85% rel. humidity)
<i>Storage</i>	-20 °C...+60 °C
<i>Transport</i>	-40 °C...+60 °C

9.1.9 Reference conditions

<i>Ambient temperature</i>	+25 °C (± 3 °C)
<i>Rel. humidity</i>	$\leq 60\%$
<i>Warmed-up condition</i>	Instrument in operation for at least 30 min
<i>Validity of data</i>	After adjustment

9.1.10 Dimensions

<i>Housing material</i>	Polybutylene terephthalate (PBT)
<i>Keyboard material</i>	Polyester
<i>Display cover material</i>	Glass
<i>Width</i>	305 mm
<i>Height (without stand)</i>	55 mm
<i>Height (with stand)</i>	410 mm
<i>Depth</i>	170 mm
<i>Weight (without stand)</i>	1378 g

9.2 Evaluation

9.2.1 pH calibration

pH calibration is used to assign the potentials measured at the pH electrode to the corresponding pH values. This relationship is known theoretically and is described by the Nernst equation. For pH measurement it can be simplified to:

$$U = U_{\text{pH}=0} - U_N \cdot \text{pH}$$

where $U_N = \ln(10) \cdot \frac{R \cdot T}{F}$

T: absolute temperature in K
R: ideal gas constant
F: Faraday constant

$U_{\text{pH}=0}$ is the ordinate intercept at $\text{pH} = 0$. Its value depends on the construction of the electrode. The theoretical Nernst constant U_N is temperature-dependent and is e.g. 59.16 mV at 25 °C.

This means that theoretically, i.e. with a standard pH glass electrode (inner electrolyte $c(\text{KCl}) = 3 \text{ mol/L}$; pH 7.0; Ag/AgCl reference system), at pH 7.0 a potential of 0 mV should be measured. This represents the so-called zero point of the electrode. The graphical plot of further U/pH pairs of values within the normal pH range then provides a linear relationship according to the above equation whose slope is $-U_N$.

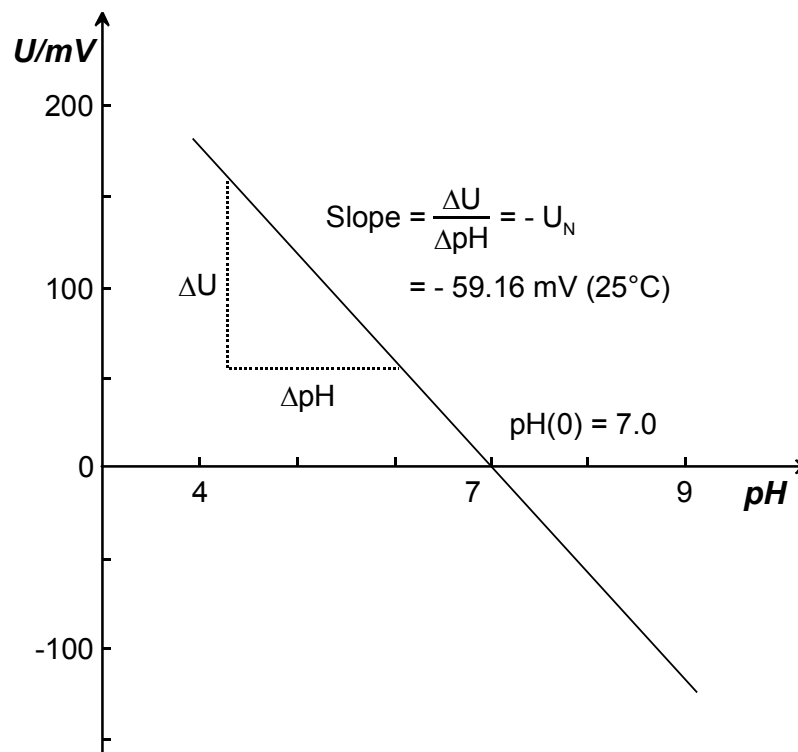


Fig. 15: Theoretical U/pH relationship

In fact this U/pH curve is usually different. The offset potential of the electrode ($U_{\text{off}} = U$ at $\text{pH} 7.0$) may not be zero as a result of the asymmetry potential at the glass membrane, a contaminated inner elec-

trolyte or an unsuitable reference system. The slope can also differ slightly from U_N .

As these variations describe the condition of the pH electrode and are subject to variation with time this means that, depending on the accuracy required, a regular pH calibration is necessary. This calibration provides a new description of the relationship between the electrode potential and the measured pH value:

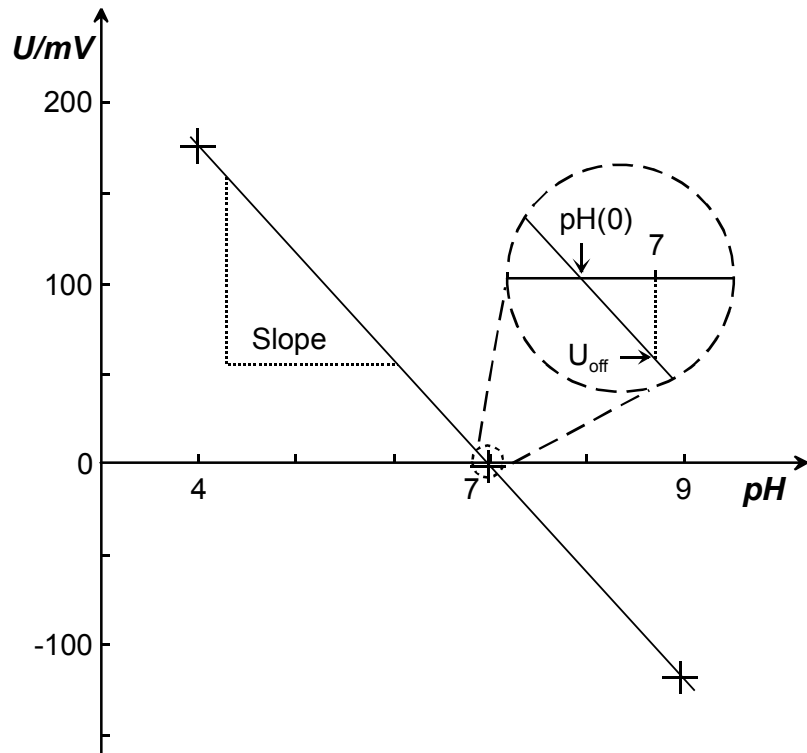


Fig. 16: 3-Point pH calibration

$pH(0)$ and slope are outputted by the pH/Ion Meter as calibration data. In this case the slope (e.g. 99.5%) is a relative quantity which refers to the temperature-specific value of the Nernst constant. It is given with a positive sign, which is why the following explanations are extended by including the negative sign.

Using this data the calibration curve can be described as follows:

$$U = -\text{Slope} \cdot U_N \cdot (pH - pH(0))$$

$$\text{resp. } pH = pH(0) - \frac{U}{\text{Slope} \cdot U_N}$$

The calculation of the calibration data depends on the number of pH buffers used:

1-Point calibration

Slope: The theoretical slope value of 100.0% is used.

$$\text{pH}(0) = \text{pH}_1 - \frac{U_1}{-\text{Slope} \cdot U_N}$$

2-Point calibration

$$\text{Slope} = \frac{(U_2 - U_1)}{(\text{pH}_2 - \text{pH}_1)} \cdot \frac{1}{-U_N}$$

$$\text{pH}(0) = \overline{\text{pH}} - \frac{\bar{U}}{-\text{Slope} \cdot U_N} \quad ; \overline{\text{pH}}, \bar{U} = \text{mean value}$$

3- and more point calibration

With at least 3 calibration buffers a compensation curve according to the principles of the smallest mean-square error (linear regression) will be calculated.

$$\text{Slope} = \frac{\sum_i (\text{pH}_i - \overline{\text{pH}}) \cdot (U_i - \bar{U})}{\sum_i (\text{pH}_i - \overline{\text{pH}})^2} \cdot \frac{1}{-U_N}$$

$$\text{pH}(0) = \overline{\text{pH}} - \frac{\bar{U}}{-\text{Slope} \cdot U_N}$$

$$\text{Variance} = \frac{\sum_i (U_i - U_{i,\text{calculated}})^2}{n - 2} \quad ; n = \text{no. of measuring points}$$

Notes

For a pH calibration at least two or more different buffers should be used; these should cover the intended measuring range (DIN 19268). For example, you can obtain **Metrohm buffer solutions** for pH 4, 7 and 9 as ready-to-use solutions or concentrates (see Optional Accessories, *Section 9.6*).

A pH electrode is an ion-selective electrode which responds to hydrogen ions (H^+) with great selectivity. This is the reason why the above linear relationship between the measured potential U and the pH value based on it can be assumed. A variation may be caused by the so-called **alkali error**. This describes the interference by high concentrations of alkali ions (e.g. 0.1 M Na^+) which can occur at high pH values ($> pH 12$).

The **temperature compensation** of the pH/Ion Meters during a pH measurement for the calculation of the pH value is based on a temperature-corrected slope (conversion via the definition of the Nernst constant UN , see *p. 138*). This method is based on the assumption that the intercept of all theoretical Nernst slopes lies at pH 7.0 and 0 mV (**isothermal intercept point**). However, this is not always the case. The measuring uncertainty increases with the temperature difference between calibration and measurement. Therefore, calibration and measurement should be performed at the same temperature wherever a high degree of accuracy is required. In this case DIN 19268 also stipulates that calibration and measurement are to be carried out at the same constant temperature.

The temperature compensation considers only the temperature dependence of the Nernst slope. In addition, the pH values of buffers and samples are also temperature dependent. The temperature dependence of the buffer is corrected by means of the stored buffer series (see *Section 9.4*). But no such information is usually given for the sample. Therefore, the pH should be measured at the 'original' sample temperature instead of adjusting the sample temperature to the buffer temperature. For high accuracies it is recommended that you calibrate at the samples temperature. During the calibration take care of a correct correlation of the temperature specific buffer pH values.

9.2.2 Calibration for ion measurements

Just as for pH measurement, ion measurement using an ion-selective electrode (ISE) also requires regular calibration. In contrast to pH measurement, a linear relationship between the measured potential U_i and the logarithm of the required ion concentration c_i cannot always be assumed. The influence of the interfering ions which is responsible for this can be described by the Nikolsky equation. This is an extended Nernst equation which takes the selectivity of the ISE into consideration. For the ISE calibration with the pH/Ion Meter it is used in the following form:

$$U_i = E(0) + \frac{U_N}{z} \cdot \log(c_i + c(\text{blank}))$$

The Nernst constant U_N represents, when divided by the charge z of the ion being measured, the theoretical slope of the calibration function. For anions it is given a negative sign, for cations a positive sign.

The influence of the interfering ions is given as the 'blank value concentration' $c(\text{blank})$. A significant blank value reduces the lower measuring range and therefore gives a poorer detection limit.

This means that during the calibration three unknown quantities, i.e. $E(0)$, *Slope* and $c(\text{blank})$ must be determined for the calibration function. In order to be able to calculate all the parameters properly this means that at least three standard measurements are required. A higher number of standards increases the reliability of the mathematical calculation of the calibration function.

As in a pH calibration, the pH/Ion Meter determines the calibration data for the measurement of the concentration according to the number of standard solutions used:

1-Point calibration

Slope: The existing value is retained, if available. Otherwise the theoretical slope U_N is used.

$$E(0) = U_1 + \text{Slope} \cdot \log(c_1)$$

$c(\text{blank})$: Is set to zero and not shown.

2-Point calibration

$$\text{Slope} = \frac{U_2 - U_1}{\log(c_2) - \log(c_1)}$$

$$E(0) = \bar{U} + \text{Slope} \cdot \overline{\log(c)} \quad ; \overline{\log(c)}, \bar{U} = \text{mean value}$$

$c(\text{blank})$: Is set to zero and not shown.

3- and more point calibration

With at least 3 calibration solutions the calibration function is determined according to the principle of the smallest mean-square error. The required calibration parameters *Slope*, *E(0)* and *c(blank)* are calculated iteratively. If *c(blank)* is sufficiently small to have no measurable influence, what means that *c(blank)* would be smaller than approx. 0.2 % of the smallest measured value, then it is set as zero and not shown. This limit represents the highest possible resolution of ISE measured values for a resolution of 0.05 mV for the measured potential. In such a case a linear relationship is obtained between *U_i* and *log(c_i)*.

Variance: This will always be calculated and outputted when at least 4 calibration standards are used. If *c(blank) = 0* then the variance will also be calculated for 3 standards:

$$= \frac{\sum_i (U_i - U_{i,calculated})^2}{n - F}$$

n: no. of meas. points
F: degree of freedom:
2 for *c(blank) = 0*
3 for *c(blank) ≠ 0*

9.2.3 Addition method

In addition measurements (standard or sample addition or subtraction) a linear relationship between *U* and *log(c)* is generally assumed. This means that *c(blank)* is not calculated but is set as zero and the compensation curve (linear regression) is determined according to the principle of the smallest mean-square error. The concentration of the ion to be determined in the sample solution is then calculated from the initially measured potential *U_A* and the regression data as follows:

$$c_A(\text{Ion}) = 10^{\frac{U_A - E(0)}{\text{Slope}}}$$

Please note that this result represents the primary result. The final result is calculated by taking into account the calculation parameters (*Sample size*, *V_{total}* and *Factor*; see also *Section 6.5.4*) and shown directly.

$$c(\text{Ion}) = c_A(\text{Ion}) \cdot \text{Factor} \cdot \frac{V_{\text{total}}}{\text{Smpl.size}}$$

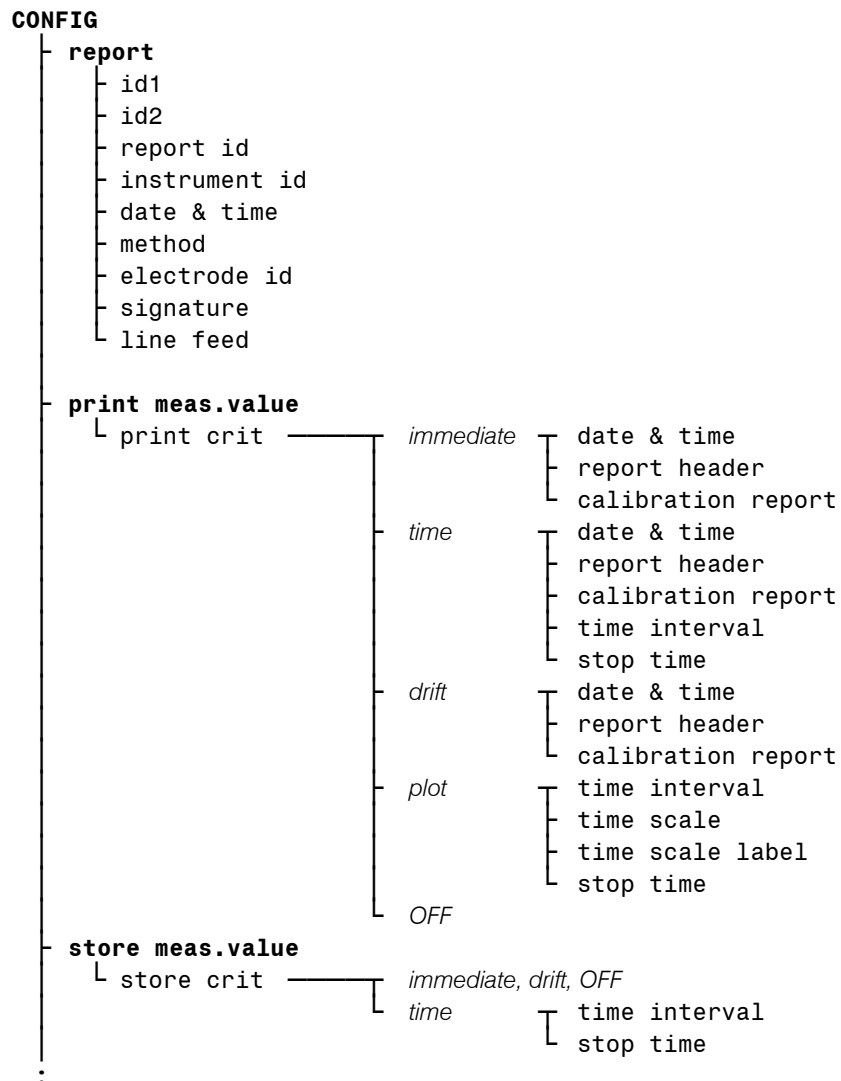
If the parameter *Smpl.size* is set to '**OFF**' then *c_A(Ion)* will simply be multiplied by *Factor*.

9.3 Menu structures

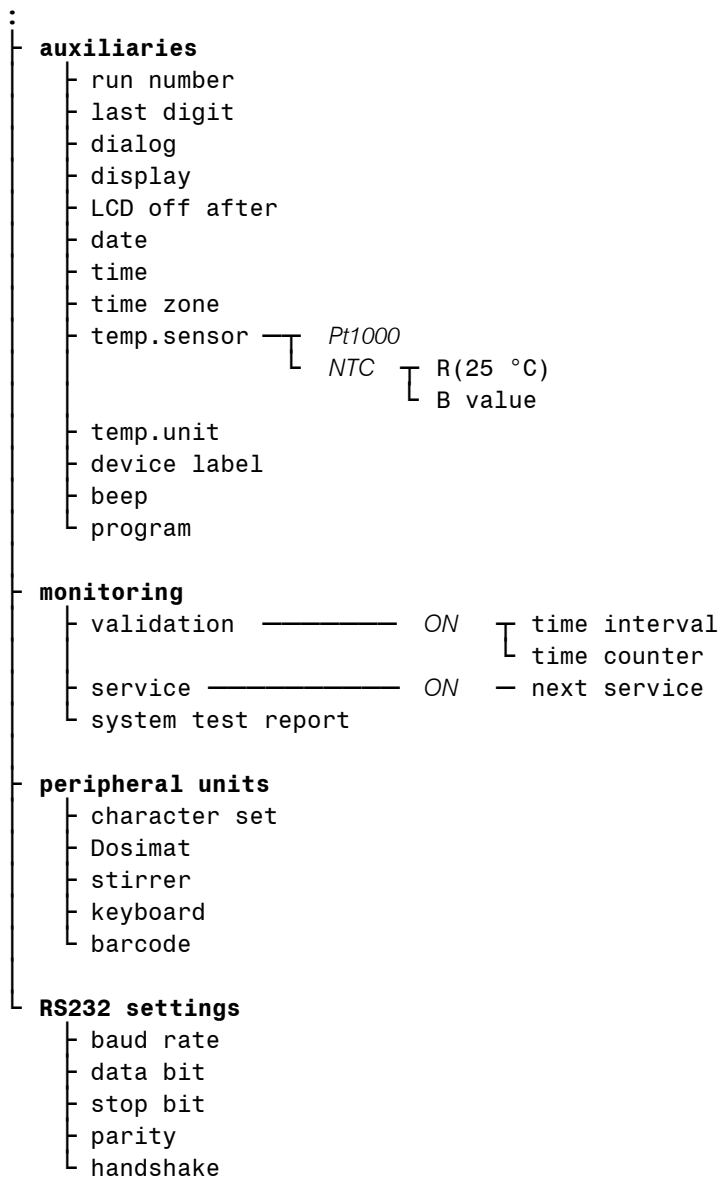
The menu structures of the instrument configuration and the method parameters of all operating modes are shown on the following pages.

This so-called instrument tree can also be used to control the pH/Ion Meter via the serial interface. It is described in a separate document together with the exact syntax used (780/781 pH/Ion Meter Operation via RS232, No. 8.781.1113). The document is available from your local Metrohm agency.

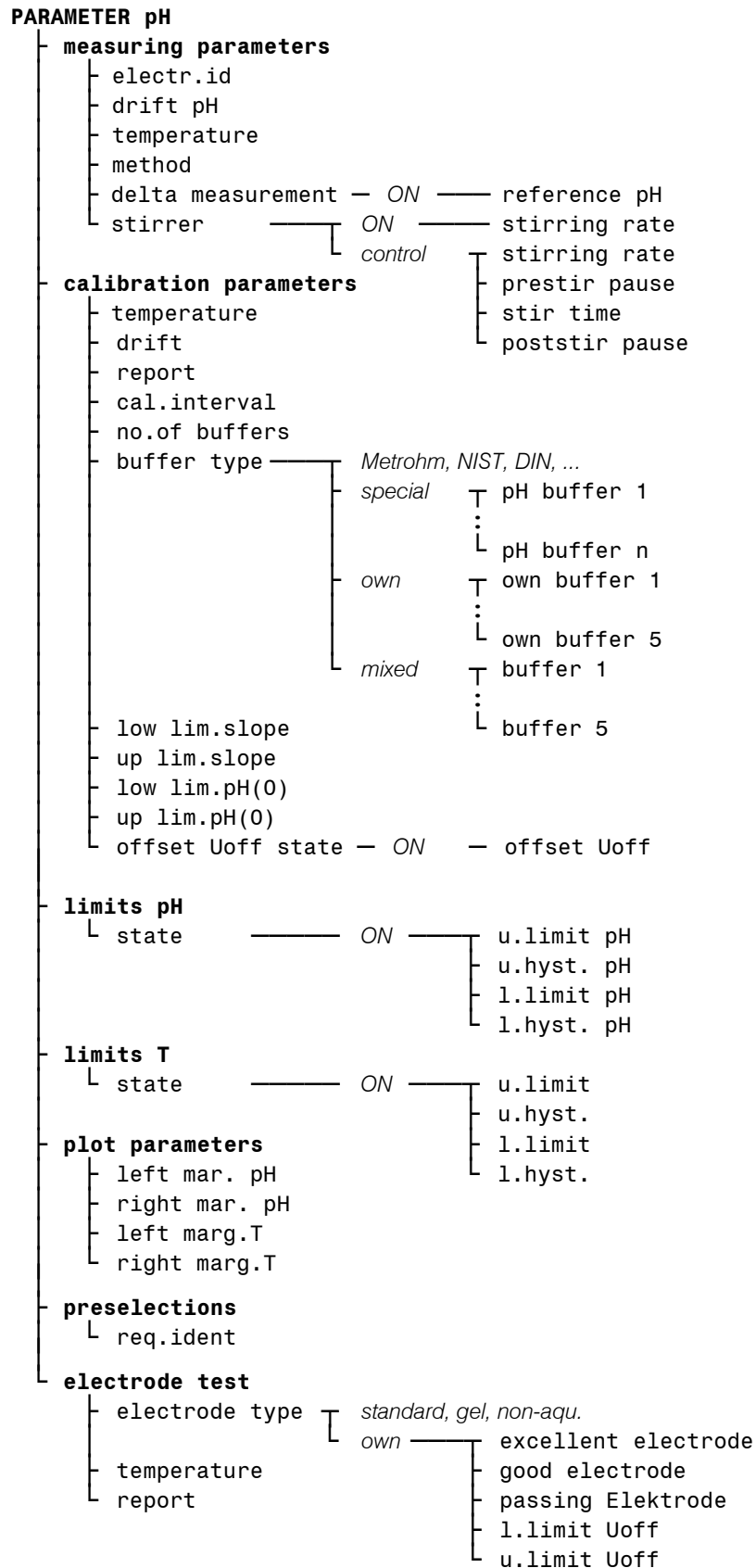
9.3.1 Instrument configuration



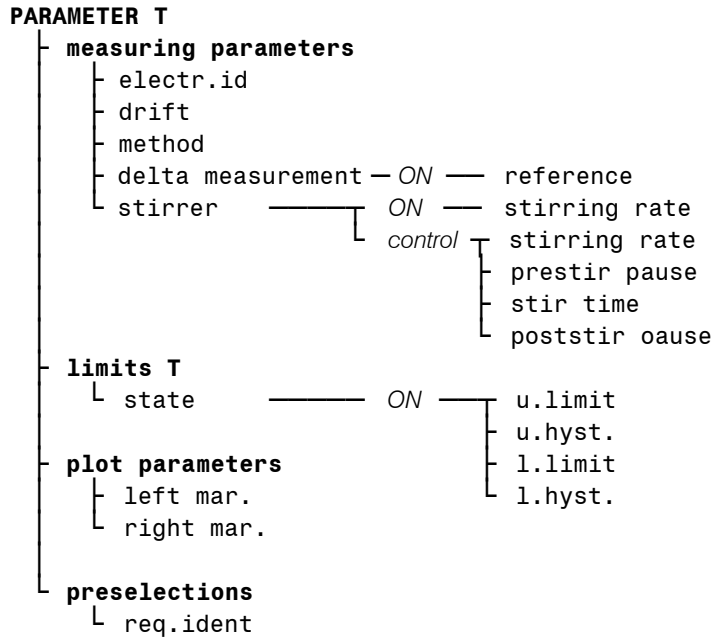
CONFIG



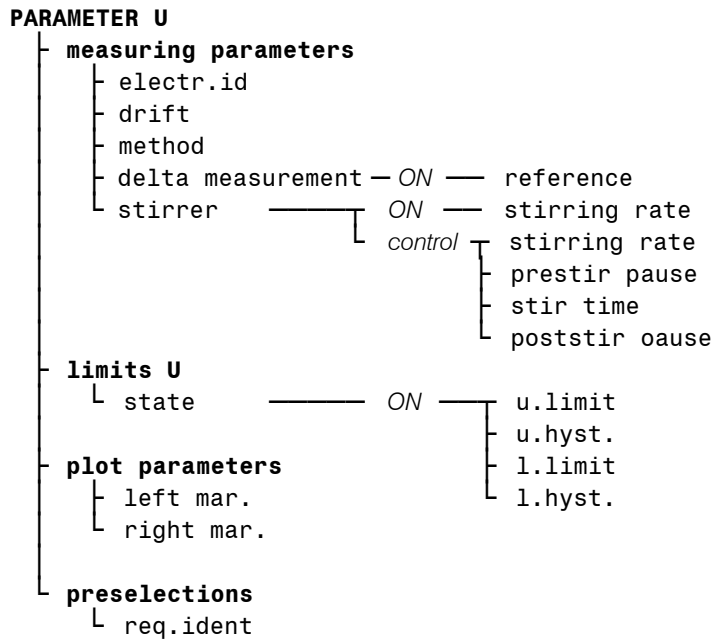
9.3.2 Method parameters in the pH mode



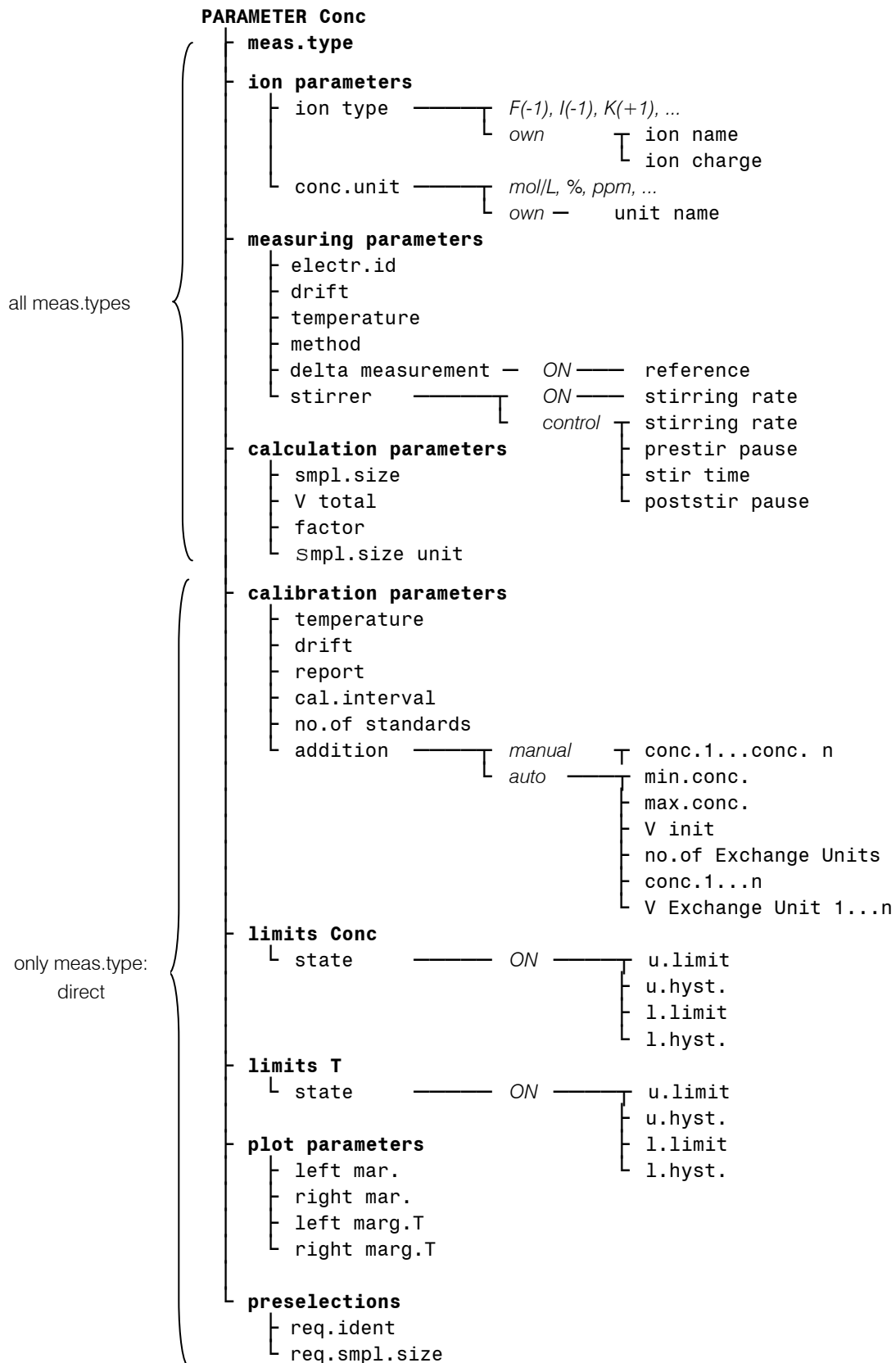
9.3.3 Method parameters in the T mode

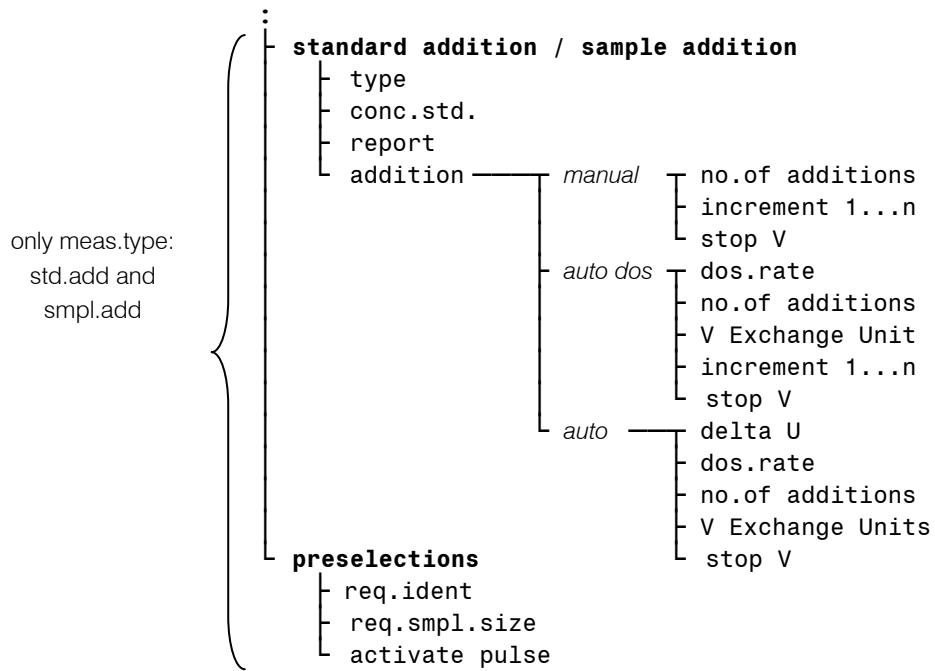


9.3.4 Method parameters in the U mode



9.3.5 Method parameter in the Conc mode





9.4 Stored buffer series

For automatic buffer recognition during pH calibration the temperature-dependent pH values of several common pH buffers are stored in the 780/781 pH/Ion Meter. Apart from the Metrohm buffer solutions other reference and technical buffers are also included in the tables.

The following tables provide an overview of the stored pH(T) series. Buffers marked with an * are not taken into account during automatic buffer recognition if one of the complete sets of buffers is selected as the buffer type. However, all the buffers listed can be selected to give a new combination under

PARAMETER pH/calibration parameters/buffer type:
mixed

(see Section 6.2.2).

The pH values printed in bold are the values at the reference temperature of the particular buffer set.

The pH values marked with ¹⁾ are interpolated or extrapolated values, all the others correspond to the manufacturer's specifications.

Temp. (°C)	Metrohm			NIST (according to DIN standard 19266, 2000)				
	Met4 pH 4.00	Met7 pH 7.00	Met9 pH 9.00	NIST1 pH 1	NIST4 pH 4	NIST7 pH 7	NIST9 pH 9	NIST13 pH 13
0	3.99	7.11	9.27	-	4.010	6.984	9.464	13.423
5	3.99	7.08	9.18	1.668	4.004	6.950	9.392	13.207
10	3.99	7.06	9.13	1.670	4.001	6.922	9.331	13.003
15	3.99	7.04	9.08	1.672	4.001	6.900	9.277	12.810
20	3.99	7.02	9.04	1.676	4.003	6.880	9.228	12.627
25	4.00	7.00	9.00	1.680	4.008	6.865	9.184	12.454
30	4.00	6.99	8.96	1.685	4.015	6.853	9.144	12.289
35	4.01	6.98	8.93	1.691	4.025	6.843	9.107	12.133
40	4.02	6.98	8.90	1.697	4.036	6.837	9.076	11.984
45	4.03	6.97	8.87	1.704	4.049	6.834	9.046	11.841
50	4.04	6.97	8.84	1.712	4.064	6.833	9.018	11.705
55	4.06	6.97	8.81	1.715	4.075	6.834	8.985	11.574
60	4.07	6.97	8.79	1.723	4.091	6.836	8.962	11.449
65	4.09	6.98	8.76	1.732 ¹⁾	4.108 ¹⁾	6.840 ¹⁾	8.941 ¹⁾	-
70	4.11	6.98	8.74	1.743	4.126	6.845	8.921	-
75	4.13	6.99	8.73	1.754 ¹⁾	4.145 ¹⁾	6.852 ¹⁾	8.902 ¹⁾	-
80	4.15	7.00	8.71	1.766	4.164	6.859	8.885	-
85	4.18	7.00	8.70	1.778 ¹⁾	4.185 ¹⁾	6.867 ¹⁾	8.867 ¹⁾	-
90	4.20	7.01	8.68	1.792	4.205	6.877	8.850	-
95	4.23	7.02	8.67	1.806	4.227	6.886	8.833	-

Temp. (°C)	DIN (according to DIN standard 19267, 1978)					
	DIN1 pH 1	DIN3 pH 3	DIN4 pH 4	DIN7 pH 7	DIN9 pH 9	DIN12 pH 12
0	1.08	-	4.67	6.89	9.48	-
5	1.08 ¹⁾	-	4.66 ¹⁾	6.86 ¹⁾	9.43 ¹⁾	-
10	1.09	3.10	4.66	6.84	9.37	13.37
15	1.09 ¹⁾	3.08 ¹⁾	4.65 ¹⁾	6.82 ¹⁾	9.32 ¹⁾	13.15 ¹⁾
20	1.09	3.07	4.65	6.80	9.27	12.96
25	1.09	3.06	4.65	6.79	9.23	12.75
30	1.10	3.05	4.65	6.78	9.18	12.61
35	1.10 ¹⁾	3.05 ¹⁾	4.66 ¹⁾	6.77 ¹⁾	9.13 ¹⁾	12.44 ¹⁾
40	1.10	3.04	4.66	6.76	9.09	12.29
45	1.10 ¹⁾	3.04 ¹⁾	4.67 ¹⁾	6.76 ¹⁾	9.04 ¹⁾	12.13 ¹⁾
50	1.11	3.04	4.68	6.76	9.00	11.98
55	1.11 ¹⁾	3.04 ¹⁾	4.69 ¹⁾	6.76 ¹⁾	8.97 ¹⁾	11.84 ¹⁾
60	1.11	3.04	4.70	6.76	8.92	11.69
65	1.11 ¹⁾	3.04 ¹⁾	4.71 ¹⁾	6.76 ¹⁾	8.90 ¹⁾	11.56 ¹⁾
70	1.11	3.04	4.72	6.76	8.88	11.43
75	1.12 ¹⁾	3.04 ¹⁾	4.74 ¹⁾	6.77 ¹⁾	8.86 ¹⁾	11.30 ¹⁾
80	1.12	3.05	4.75	6.78	8.85	11.19
85	1.12 ¹⁾	3.06 ¹⁾	4.77 ¹⁾	6.79 ¹⁾	8.83 ¹⁾	11.08 ¹⁾
90	1.13	3.07	4.79	6.80	8.82	10.99
95	-	-	-	-	-	-

Temp. (°C)	Fisher				Fluka Basel		
	Fis2 pH 2	Fis4 pH 4	Fis7 pH 7	Fis10 pH 10	FBS4 pH 4	FBS7 pH 7	FBS9 pH 9
0	-	4.01	7.13	10.34	4.01	7.11	9.20
5	1.98	3.99	7.10	10.26	4.00	7.08	9.15
10	1.98	4.00	7.07	10.19	4.00	7.05	9.10
15	2.02	3.99	7.05	10.12	4.00	7.02	9.05
20	2.00	4.00	7.02	10.06	4.00	7.00	9.00
25	2.00	4.00	7.00	10.00	4.01	6.98	8.96
30	2.00	4.01	6.99	9.94	4.01	6.97	8.91
35	2.02	4.02	6.98	9.90	4.02	6.96	8.88
40	2.01	4.03	6.97	9.85	4.03	6.95	8.84
45	2.01	4.04 ¹⁾	6.97 ¹⁾	9.81 ¹⁾	4.04	6.94	8.80
50	2.01	4.06	6.97	9.78	4.06	6.94	8.77
55	-	4.07 ¹⁾	6.97 ¹⁾	9.74 ¹⁾	4.07	6.93	8.74
60	-	4.09	6.98	9.70	4.09	6.93	8.71
65	-	4.11 ¹⁾	6.99 ¹⁾	9.68 ¹⁾	4.11 ¹⁾	6.93 ¹⁾	8.69 ¹⁾
70	-	4.13 ¹⁾	7.00 ¹⁾	9.65 ¹⁾	4.13	6.94	8.67
75	-	4.14 ¹⁾	7.02 ¹⁾	9.63 ¹⁾	4.14 ¹⁾	6.94 ¹⁾	8.65 ¹⁾
80	-	4.16 ¹⁾	7.03 ¹⁾	9.62 ¹⁾	4.16	6.95	8.63
85	-	4.18 ¹⁾	7.06 ¹⁾	9.61 ¹⁾	4.18 ¹⁾	6.96 ¹⁾	8.61 ¹⁾
90	-	4.21 ¹⁾	7.08 ¹⁾	9.60 ¹⁾	4.21	6.97	8.60
95	-	4.23 ¹⁾	7.11 ¹⁾	9.60 ¹⁾	4.23 ¹⁾	6.98 ¹⁾	8.59 ¹⁾

Temp. (°C)	Mettler Toledo					Beckmann		
	MT2 pH 2	MT4 pH 4	MT7 pH 7	MT9 pH 9	MT11 pH 11	Bec4 pH 4	Bec7 pH 7	Bec10 pH 10
0	2.03 ¹⁾	4.01 ¹⁾	7.12 ¹⁾	9.52 ¹⁾	11.90 ¹⁾	4.00	7.12	10.32
5	2.02	4.01	7.09	9.45	11.72	4.00	7.09	10.25
10	2.01	4.00	7.06	9.38	11.54	4.00	7.06	10.18
15	2.00	4.00	7.04	9.32	11.36	4.00	7.04	10.12
20	2.00	4.00	7.02	9.26	11.18	4.00	7.02	10.06
25	2.00	4.01	7.00	9.21	11.00	4.00	7.00	10.01
30	1.99	4.01	6.99	9.16	10.82	4.01	6.99	9.97
35	1.99	4.02	6.98	9.11	10.64	4.02	6.99	9.93
40	1.98	4.03	6.97	9.06	10.46	4.03	6.98	9.89
45	1.98	4.04	6.97	9.03	10.28	4.05	6.98	9.86
50	1.98	4.06	6.97	8.99	10.10	4.06	6.97	9.83
55	1.98 ¹⁾	4.08 ¹⁾	6.98 ¹⁾	8.96 ¹⁾	-	4.08	6.98	-
60	1.98 ¹⁾	4.10 ¹⁾	6.98 ¹⁾	8.93 ¹⁾	-	4.09	6.98	-
65	1.98 ¹⁾	4.13 ¹⁾	6.99 ¹⁾	8.90 ¹⁾	-	4.11	6.99	-
70	1.99 ¹⁾	4.16 ¹⁾	7.00 ¹⁾	8.88 ¹⁾	-	4.12	6.99	-
75	1.99 ¹⁾	4.19 ¹⁾	7.02 ¹⁾	8.85 ¹⁾	-	4.14	7.00	-
80	2.00 ¹⁾	4.22 ¹⁾	7.04 ¹⁾	8.83 ¹⁾	-	4.16	7.00	-
85	2.00 ¹⁾	4.26 ¹⁾	7.06 ¹⁾	8.81 ¹⁾	-	4.18	7.01	-
90	2.00 ¹⁾	4.30 ¹⁾	7.09 ¹⁾	8.79 ¹⁾	-	4.19	7.02	-
95	-	4.35 ¹⁾	7.12 ¹⁾	8.77 ¹⁾	-	4.21	7.03	-

Temp. (°C)	Radiometer							
	Rad1.09* pH 1.09	Rad1.68* pH 1.68	Rad4.01 pH 4.01	Rad6.84* pH 6.84	Rad7.00 pH 7	Rad7.38* pH 7.38	Rad9.18 pH 9.18	Rad10.01* pH 10.01
0	1.082	1.666	4.000	6.984	7.118	7.534	9.464	10.317
5	1.085	1.668	3.998	6.951	7.087	7.500	9.395	10.245
10	1.087	1.670	3.997	6.923	7.059	7.472	9.332	10.179
15	1.089	1.672	3.998	6.900	7.036	7.448	9.276	10.118
20	1.091	1.675	4.001	6.881	7.016	7.429	9.225	10.062
25	1.094	1.679	4.005	6.865	7.000	7.413	9.180	10.012
30	1.096	1.683	4.011	6.853	6.987	7.400	9.139	9.966
35	1.098	1.688	4.018	6.844	6.977	7.389	9.102	9.925
40	1.101	1.694	4.027	6.838	6.970	7.380	9.068	9.889
45	1.103	1.700	4.038	6.834	6.965	7.373	9.038	9.856
50	1.106	1.707	4.050	6.833	6.964	7.367	9.011	9.828
55	1.108	1.715	4.064	6.834	6.965	7.361	8.985	9.813
60	1.111	1.723	4.080	6.836	6.968	-	8.962	9.782
65	1.113	1.732	4.097	6.840	6.974	-	8.941	9.765
70	1.116	1.743	4.116	6.845	6.982	-	8.921	9.751
75	1.119	1.754	4.137	6.852	6.992	-	8.900	9.739
80	1.121	1.765	4.159	6.859	7.004	-	8.885	9.731
85	1.124	1.778	4.183	6.867	7.018	-	8.867	9.726
90	1.127	1.792	4.210	6.877	7.034	-	8.850	9.724
95	-	-	4.240	6.886	-	-	-	-

Temp. (°C)	Baker			
	Bak4 pH 4.00	Bak7 pH 7.00	Bak9 pH 9.00	Bak10 pH 10.00
0	4.00	7.13	9.23	10.30
5	4.00 ¹⁾	7.09 ¹⁾	9.17 ¹⁾	10.24 ¹⁾
10	4.00	7.05	9.10	10.17
15	4.00 ¹⁾	7.03 ¹⁾	9.05 ¹⁾	10.11 ¹⁾
20	4.00	7.00	9.00	10.05
25	4.00 ¹⁾	6.98 ¹⁾	8.96 ¹⁾	10.00
30	4.01	6.98	8.91	9.96
35	4.02 ¹⁾	6.98 ¹⁾	8.88 ¹⁾	9.93 ¹⁾
40	4.03	6.97	8.84	9.89
45	4.04 ¹⁾	6.97 ¹⁾	8.81 ¹⁾	9.86 ¹⁾
50	4.05	6.96	8.78	9.82
55	4.07 ¹⁾	6.96 ¹⁾	8.76 ¹⁾	9.79 ¹⁾
60	4.08	6.96	8.73	9.76
65	4.10 ¹⁾	6.97 ¹⁾	8.71 ¹⁾	9.74 ¹⁾
70	4.12	6.97	8.69	9.72
75	4.14 ¹⁾	6.98 ¹⁾	8.68 ¹⁾	9.70 ¹⁾
80	4.16	6.98	8.66	9.68
85	4.19 ¹⁾	6.99 ¹⁾	8.64 ¹⁾	9.66 ¹⁾
90	4.21	7.00	8.62	9.64
95	-	-	-	-

Temp. (°C)	Hamilton DURACAL				Precisa		
	Ham4.01 pH 4.01	Ham7.00 pH 7.00	Ham9.21 pH 9.21	Ham10.01 pH10.01	Pre4 pH 4.00	Pre7 pH 7.00	Pre9 pH 9.00
0	-	-	-	-	3.99	7.11	9.27
5	4.01	7.09	9.45	10.19	3.99	7.08	9.18
10	4.00	7.06	9.38	10.15	3.99	7.06	9.13
15	4.00	7.04	9.32	10.11	3.99	7.04	9.08
20	4.00	7.02	9.26	10.06	3.99	7.02	9.04
25	4.01	7.00	9.21	10.01	4.00	7.00	9.00
30	4.01	6.99	9.16	9.97	4.00	6.99	8.96
35	4.02	6.98	9.11	9.92	4.01	6.98	8.93
40	4.03	6.97	9.06	9.86	4.02	6.98	8.90
45	4.04	6.97	9.03	9.83	4.03	6.97	8.87
50	4.06	6.97	8.99	9.79	4.04	6.97	8.84
55	-	-	-	-	4.06	6.97	8.81
60	-	-	-	-	4.07	6.97	8.79
65	-	-	-	-	4.09	6.98	8.76
70	-	-	-	-	4.11	6.98	8.74
75	-	-	-	-	4.13	6.99	8.73
80	-	-	-	-	4.15	7.00	8.71
85	-	-	-	-	4.18	7.00	8.70
90	-	-	-	-	4.20	7.01	8.68
95	-	-	-	-	4.23	7.02	8.67

Temp. (°C)	Merck Titrisol							
	Mer1* pH 1	Mer2 pH 2	Mer3* pH 3	Mer4 pH 4	Mer4.66* pH 4.66	Mer5* pH 5	Mer6* pH 6	Mer6.88* pH 6.88
0	0.960	2.01	3.050	4.05	4.680	5.060	6.040	6.980
5	0.990	2.01	3.050	4.04	4.680	5.050	6.020	6.950
10	0.990	2.01	3.030	4.02	4.670	5.020	6.010	6.920
15	0.990	2.00	3.010	4.01	4.670	5.010	6.000	6.900
20	1.000	2.00	3.000	4.00	4.660	5.000	6.000	6.880
25	1.010	2.00	3.000	4.01	4.660	5.000	6.020	6.860
30	1.010	2.00	3.000	4.01	4.660	5.000	6.030	6.860
35	1.010	2.00	3.000	4.01	4.660	5.000	6.030	6.850
40	1.010	2.00	2.980	4.01	4.670	5.000	6.040	6.840
45	1.010 ¹⁾	2.00 ¹⁾	2.975 ¹⁾	4.00 ¹⁾	4.675 ¹⁾	5.005 ¹⁾	6.050 ¹⁾	6.840 ¹⁾
50	1.010	2.00	2.970	4.00	4.680	5.010	6.060	6.840
55	1.015 ¹⁾	2.00 ¹⁾	2.970 ¹⁾	4.00 ¹⁾	-	5.025 ¹⁾	6.080 ¹⁾	6.840 ¹⁾
60	1.020	2.00	2.970	4.00	-	5.040	6.100	6.840
65	1.020 ¹⁾	2.00 ¹⁾	2.970 ¹⁾	4.00 ¹⁾	-	5.045 ¹⁾	6.110 ¹⁾	6.840 ¹⁾
70	1.020	2.01	2.970	4.00	-	5.050	6.120	6.840
75	1.020 ¹⁾	2.01 ¹⁾	2.970 ¹⁾	4.00 ¹⁾	-	5.075 ¹⁾	6.145 ¹⁾	6.850 ¹⁾
80	1.020	2.01	2.970	4.00	-	5.100	6.170	6.860
85	1.020 ¹⁾	2.01 ¹⁾	2.965 ¹⁾	4.00 ¹⁾	-	5.120 ¹⁾	6.205 ¹⁾	6.870 ¹⁾
90	1.020	2.01	2.960	4.00	-	5.140	6.240	6.880
95	-	-	-	4.00 ¹⁾	-	-	-	-

Temp. (°C)	Merck Titrisol							
	Mer7 pH 7	Mer8* pH 8	Mer9 pH 9	Mer9.22* pH 9.22	Mer10* pH 10	Mer11* pH 11	Mer12 pH 12	Mer13* pH 13
0	7.13	8.150	9.24	9.460	10.260	11.450	12.58	13.800
5	7.07	8.100	9.16	9.400	10.170	11.320	12.41	13.590
10	7.05	8.070	9.11	9.330	10.110	11.200	12.26	13.370
15	7.02	8.040	9.05	9.280	10.050	11.100	12.10	13.180
20	7.00	8.000	9.00	9.220	10.000	11.000	12.00	13.000
25	6.98	7.960	8.95	9.180	9.940	10.900	11.88	12.830
30	6.98	7.940	8.91	9.140	9.890	10.810	11.72	12.670
35	6.96	7.920	8.88	9.100	9.840	10.720	11.67	12.590
40	6.95	7.900	8.85	9.070	9.820	10.640	11.54	12.410
45	6.95 ¹⁾	7.875 ¹⁾	8.82 ¹⁾	9.040 ¹⁾	9.780 ¹⁾	10.560 ¹⁾	11.44 ¹⁾	12.280 ¹⁾
50	6.95	7.850	8.79	9.010	9.740	10.480	11.33	12.150
55	6.95 ¹⁾	7.840 ¹⁾	8.76 ¹⁾	8.985 ¹⁾	9.705 ¹⁾	10.465 ¹⁾	11.19 ¹⁾	11.950 ¹⁾
60	6.96	7.830	8.73	8.960	9.670	10.450	11.04	11.750
65	6.96 ¹⁾	7.815 ¹⁾	8.715 ¹⁾	8.945 ¹⁾	9.645 ¹⁾	10.320 ¹⁾	10.97 ¹⁾	11.680 ¹⁾
70	6.96	7.800	8.70	8.930	9.620	10.190	10.90	11.610
75	6.96 ¹⁾	7.790 ¹⁾	8.68 ¹⁾	8.910 ¹⁾	9.585 ¹⁾	10.125 ¹⁾	10.80 ¹⁾	11.500 ¹⁾
80	6.97	7.780	8.66	8.890	9.550	10.060	10.70	11.390
85	6.98 ¹⁾	7.765 ¹⁾	8.65 ¹⁾	8.870 ¹⁾	9.520 ¹⁾	9.995 ¹⁾	10.59 ¹⁾	11.270 ¹⁾
90	7.00	7.750	8.64	8.850	9.490	9.930	10.48	11.150
95	7.02 ¹⁾	-	-	-	-	-	-	-

Temp. (°C)	Merck CertiPUR (25 °C)			
	MerC4.01 pH 4.01	MerC7.00 pH 7.00	MerC9.00 pH 9.00	MerC10.00 pH 10.00
0	-	-	-	-
5	4.00	7.09	9.22	10.22
10	4.00	7.06	9.16	10.16
15	4.00	7.04	9.10	10.10
20	4.00	7.02	9.05	10.05
25	4.01	7.00	9.00	10.00
30	4.01	6.98	8.96	9.94
35	4.03	6.98	8.93	9.90
40	4.03	6.97	8.89	9.86
45	4.05	6.97	8.87	9.80
50	4.06	6.97	8.84	9.73
55	-	-	-	-
60	-	-	-	-
65	-	-	-	-
70	-	-	-	-
75	-	-	-	-
80	-	-	-	-
85	-	-	-	-
90	-	-	-	-
95	-	-	-	-

When using Merck CertiPUR (20 °C) buffers, you have to select the buffer type "Merck Titrisol".

9.5 Remote box

The 6.2148.010 Remote box allows the control of Metrohm instruments which cannot be connected directly to the MSB interface of the pH/Ion Meter. This applies, for example, to Dosimat Plus devices, series 7xx stirrers and sample changers. The remote box therefore provides a connection between the MSB interface and the remote connection of the instrument to be controlled.

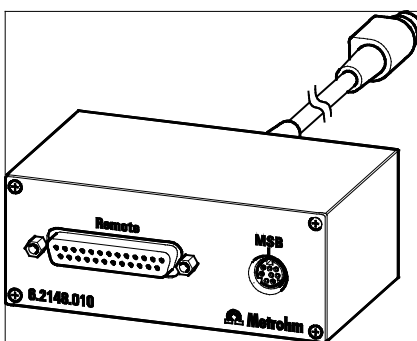


Fig. 17: Connections of the optional 6.2148.010 Remote box

The connection of the Remote box to the instruments is described in Section 2.3.3 and 2.3.4.

If the Remote box is used then other Metrohm instruments with an MSB connection can also be used. This means that, for example, an 801 Stirrer and an 804 Ti-Stand can be connected to the free MSB connection of the Remote box. However, it is not possible to connect a second Remote box.

9.5.1 Pin occupancy of the remote connection of the Remote box

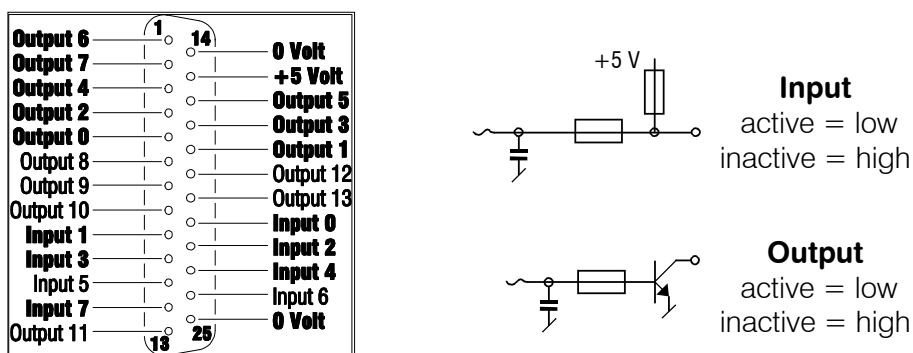


Fig. 18: Pin occupancy at remote interface

All the lines used by the 780/781 pH/Ion Meter are shown in bold type.

The following applies for all outputs: $V_{CE0} = 40\text{ V}$
 $I_C = 20\text{ mA}$
 $t_{\text{Pulse}} > 100\text{ ms}$


9.5.2 Functions of the individual remote lines

Name	Pin	Function									
Input 0	21	Print/Start Outputs a measuring points or results report with stepping impulse (Output 3) $t_{Puls} > 100$ ms									
		Inactive	Mode pH	Mode T	Mode U	pH Cal	El. Test	Mode Conc	Conc Cal	<ENTER>	
Input 1	9		●		●	●			●	●	● = active (low) $t_{Puls} > 100$ ms
Input 2	22			●	●		●			●	
Input 3	10					●	●			●	
Input 4	23							●	●	●	
Input 7	12	Ready "Ready" signal from 865 or 876 Dosimat Plus (Conc mode: automatic calibration or standard / sample addition)									
Output 0	5	Ready Instrument is in measuring mode and all runs are finished									
Output 1	18	Prim. meas. value: if above upper limit : active (low)									
Output 2	4	Prim. meas. value: if below lower limit : active (low)									
Output 3	17	Stepping impulse after successful measurement, $t_{Puls} > 80$ ms									
Output 4	3	Stirrer control									
Output 5	16	Error (see Section 8.2)									
Output 6	1	Sec. meas. value: if above upper limit : active (low) (781: with autom. addition: FILL for 865/876, $t_{Puls} > 10$ ms)									
Output 7	2	Sec. meas. value: if below lower limit : active (low) (781: with autom. addition: impulse for Dosimat Plus, $t_{Puls} = 1.25$ ms)									
+5 V	15	$I \leq 40$ mA, $R_i \approx 12 \Omega$									
0 V	14/25	0 V: active (low), 5 V: inactive									

9.6 Displaying accessories

Up-to-date information on the scope of delivery and on optional accessories can be found on the Metrohm website.

1 Searching for a product on the website

- Go to <https://www.metrohm.com>.
- Click on .
- Enter the article number of the product (e.g. 2.1001.0010) into the search field and press **[Enter]**.

The search result is displayed.

2 Displaying product information

- To display the products matching the search term, click on **Product models**.
- Click on the desired product.

Detailed information regarding the product is displayed.

3 Displaying accessories and downloading the accessories list

- To display the accessories, scroll down to **Accessories and more**.
 - The **scope of delivery** is displayed.
 - Click on **[Optional parts]** for the optional accessories.
- To download the accessories list, click on **[Download accessories PDF]** under **Accessories and more**.



Metrohm recommends keeping the accessories list for reference purposes.

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