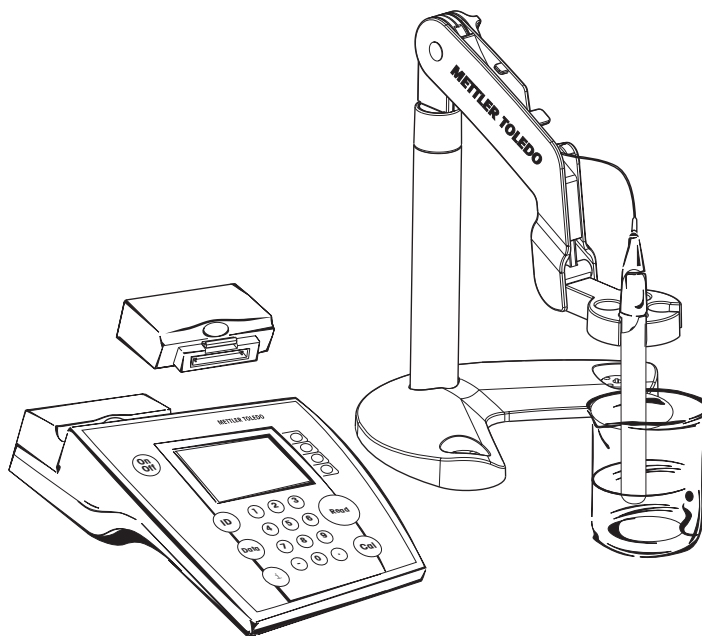


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## Operating Instructions

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# SevenMulti



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# 1. The new SevenMulti

## 1.1 Introduction

### SevenMulti – Modular expansion at any time

An ingenious instrument concept based on precise electrochemical measuring technique combined with latest options for your challenges in the laboratory.

- Extend the instrument's possibilities with durable plug-in expansion units at any time. With no effort, make it a dual channel instrument.
- Easily, control a sample changer or even check the instrument's status through your local network.

You will agree, an overall sophisticated concept for the challenges of today and tomorrow.

## 1.2 Safety precautions

### Measures for your protection



- Do not work in an explosion-hazardous environment! The housing of the instrument is not airtight. There is a risk of explosion from sparking and/or a risk of corrosion via penetrating gasses.



- When working with chemicals and solvents, observe the regulations set forth by the manufacturer and the general rules for safety in the laboratory!

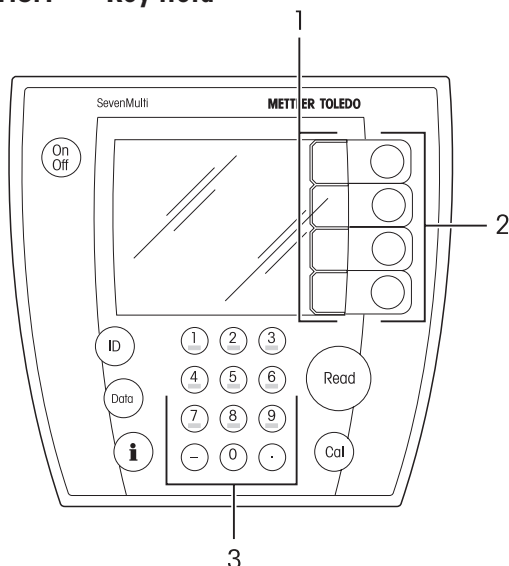
### Measures for operational safety



- Allow only METTLER TOLEDO Service to perform maintenance on the instrument!
- Dry off any liquids sprayed immediately! The instrument is not watertight.
- Protect the instrument from the following influences in its surroundings:
  - strong vibrations
  - direct sunlight
  - humidity above 80 %
  - corrosive gas atmosphere
  - temperatures below 5 °C and above 40 °C
  - strong electrical or magnetic fields

## 1.3 Description of the instrument

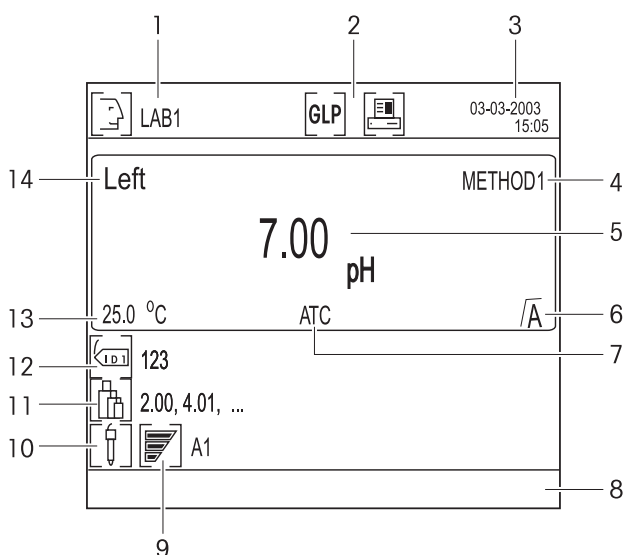
### 1.3.1 Key field



- Switches SevenMulti on/off
- Activates the input of sample or sensor IDs
- Stores data manually/displays stored data
- Calls up the help function
- Starts calibration
- Starts/ends reading
- 1** Softkey assignment (variable)
- 2** The current softkey assignment is shown to the left on the screen
- 3** Alphanumeric key field

### 1.3.2 Symbols in the measurement display

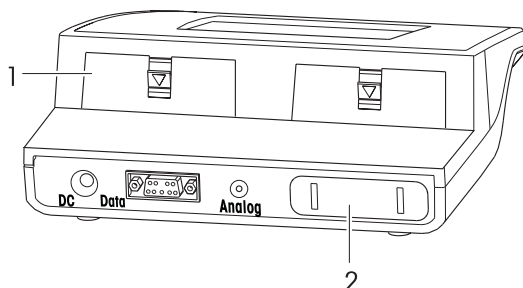
In addition to the measured value, additional symbols and messages appear on the screen, which allow you to check the measurement process for each expansion unit.



- 6** Endpoint  
 automatic, manual, timed
- 7** ATC or MTC – automatic or manual temperature compensation
- 8** Information line, e.g. for the calibration reminder
- 9** Condition of the attached electrode (pH)
  - Electrode in good condition  
 (slope conductance 95 to 105 %, offset –15 to +15 mV)
  - Electrode requires cleaning  
 (slope conductance 90 to 94 %, offset –15 to –35 mV and +15 to +35 mV)
  - Electrode is defective  
 (slope conductance 85 to 89 %, offset < –35 mV and offset > +35 mV)
- 10** Sensor ID
- 11** Calibration standards
- 12** Sample ID
- 13** Measured/specified temperature
- 14** Selected channel
- 1** User name
- 2** GLP mode active/  
data transfer to printer/PC active
- 3** Date and time
- 4** Selected method
- 5** Measured value with unit

### 1.3.3 Connections

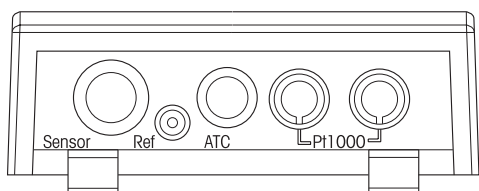
#### Connections on the SevenMulti



- DC** Mains connection socket
- Data** RS232 interface
- Analog** Analog output of electrode potential for pH/Ion expansion unit
- 1** 2 connections for expansion units
- 2** 1 connection for communication module

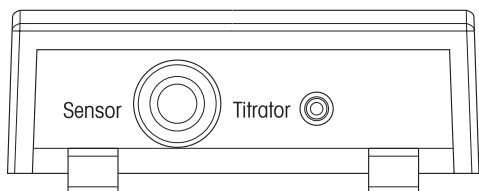
The expansion units can be combined together as you wish, with one **exception**: It is not possible to have 2 Conductivity expansion units.

#### Connections on the pH and Ion expansion unit



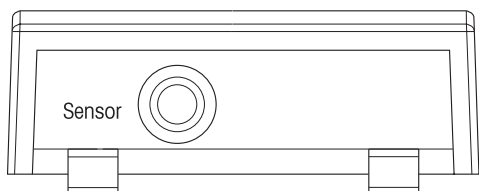
- Sensor** Electrode connection socket
- Ref** Reference-electrode connection socket
- ATC** Connection for temperature sensor NTC 30 k $\Omega$
- Pt1000** Connection for temperature sensor Pt1000

#### Connections on the Conductivity expansion unit



- Sensor** Electrode connection socket
- Titrator** Titration unit output (analog signal)

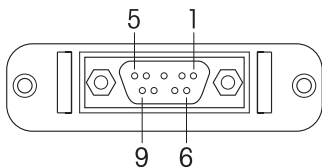
#### Connections on the ISFET expansion unit



- Sensor** Electrode connection socket

### 1.3.4 Pin assignments

#### RS232, TTL: Socket 9 Pin, D-Sub, female



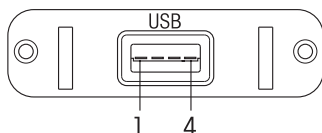
#### Pin assignment RS232

Pin 1	NC	Pin 6	NC
Pin 2	TxD (out)	Pin 7	NC
Pin 3	RxD (in)	Pin 8	NC
Pin 4	NC	Pin 9	NC
Pin 5	RSGND		

#### Pin assignment TTL

Pin 1	In 1	Pin 6	Out 4
Pin 2	In 2	Pin 7	Ground
Pin 3	Out 1	Pin 8	Ground
Pin 4	Out 2	Pin 9	NC
Pin 5	NC		

#### USB



#### Pin assignment USB

Pin 1	VCC
Pin 2	D-
Pin 3	D+
Pin 4	Ground

## 1.4 Cleaning




### 1.4.1 Cleaning the SevenMulti

#### Safety precaution

- The housing and power supply may not be opened!
- The housing is made of of ABS/PC, which could be damaged by certain organic solutions such as Toluol, Xylol and methyl ethyl ketone. Good laboratory conduct requires immediate wiping out of emptied liquids.

### 1.4.2 Cleaning the electrodes

The SevenMulti monitors the condition of the attached electrodes.

-  Electrode in good condition
-  Electrode must be cleaned
-  Electrode is defective

- When cleaning, always comply with the information contained in the operating instructions of the electrodes used.



## 2. Installation

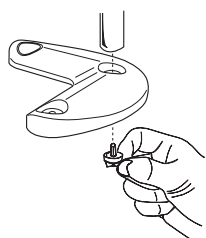
### 2.1 Unpacking/checking scope of delivery

- Unpack the instrument and check the scope of delivery with the accompanying shipping list.

### 2.2 Mounting electrode arm

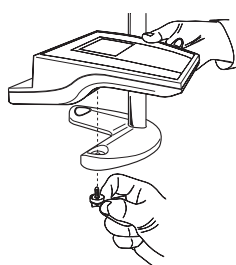
The electrode arm can be used standalone or mounted to the SevenMulti.

The base offers 3 different positions for mounting of the electrode arm.



#### Mounting electrode arm as standalone

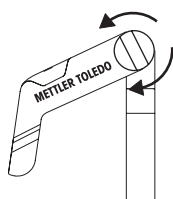
- Remove the cover from the central hole in the base.
- Place the electrode arm into the holder and secure the connection with the supplied mounting bolt.
- Save the cover in case you would like to mount the electrode arm in a different position at a later time.



#### Mounting electrode arm to SevenMulti

The electrode arm can be fastened to the SevenMulti on the left or right side.

- Remove the cover from two holes in the base.
- Mount the base to the instrument with the supplied mounting bolt so that the free end of the base points toward the rear.
- Place the electrode arm into the holder and secure the connection with the supplied mounting bolt.



#### Adjusting electrode arm

The position of the electrode arm can be adjusted with the rotary tensioning knob.

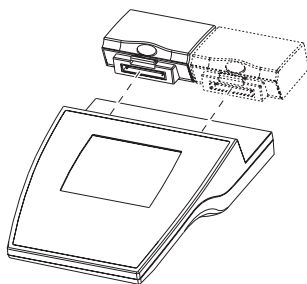
- To loosen the rotary tensioning knob: turn the knob anticlockwise.
- To tighten the rotary tensioning knob: turn the knob clockwise.

### 2.3 Installing/removing expansion units

The SevenMulti can be equipped with 2 expansion units. The expansion units can be combined together as you wish, with one **exception**: It is not possible to have 2 Conductivity expansion units.

#### Safety precaution

- Switch off the instrument and disconnect it from the mains network before installing or removing an expansion unit.



#### **Installing expansion unit**

- Remove the cover from the desired slot (left or right).
- Save the cover.
- Insert the expansion unit into the slot until it engages.

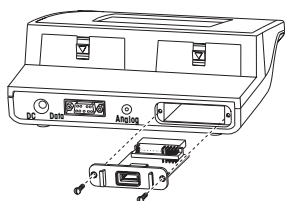
#### **Removing expansion unit**

- Press the coloured button on the expansion unit and remove it from the instrument.
- If you do not want to insert another expansion unit into this slot, replace the cover.

## **2.4 Installing/removing communication module**

#### **Safety precaution**

- Switch off the instrument and disconnect it from the mains network before installing or removing a communication module.



#### **Installing communication module**

- Remove the cover from the slot on the back of the instrument.
- Save the cover.
- Insert the communication module into the slot and fasten it with two screws.

#### **Removing communication module**

- Loosen both screws and pull out the communication module.
- If you do not wish to connect another communication module, replace the cover.

## **2.5 Connecting to the mains network**

#### **Safety precaution**

- Operate the SevenMulti with the supplied power supply only.
- Ensure that the power supply is designed for the mains voltage available where you are.  
If this is not the case, contact your METTLER TOLEDO representative.
- Insert the plug of the power supply into the mains connection socket (DC) on the back of the SevenMulti.
- Connect the power supply to an electrical outlet.

## 3. How to operate the SevenMulti

### 3.1 Operation with softkeys

The SevenMulti has **4 softkeys**, whose functions are assigned differently depending on the application and the expansion unit used. The current assignment is shown on the screen to the left of the softkeys.

#### Working with 1 expansion unit ("left" or "right" selected)

The softkeys are assigned as follows in the basic configuration of the SevenMulti measurement display, with 1 expansion unit:

<b>Sys.</b>	Activate System menu
<b>Menu</b>	Activate menu of expansion unit
<b>Mode</b>	Select measurement method (e.g. pH or mV)
<b>Dual</b>	Switch to dual display, i.e. the measured value display for an expansion unit is limited to the left or right half of the screen

#### Working with 2 expansion units (simultaneously)

The softkeys are assigned as follows in the basic configuration of the SevenMulti measurement display, with 2 expansion units:

<b>Sys.</b>	Activate System menu
<b>Left</b>	Select left expansion unit, i.e. the display for the left expansion unit is expanded to fill the screen, and settings can be made for the left expansion unit
<b>Right</b>	Select right expansion unit, i.e. the display for the right expansion unit is expanded to fill the screen, and settings can be made for the right expansion unit

#### Softkeys in the expansion unit menus

The most important assignments of the softkeys in the menu are as follows:

↑, ↓	Select previous/next menu item
←, →	In tables: switch between columns
←	For input: delete the last character
→	For input: switch to the next character
<b>Enter</b>	Call up selected menu item
<b>Select</b>	Select selected menu parameter
<b>Save</b>	Accept selected parameter
<b>Exit</b>	Back to previous (higher level) menu
	To exit the menu, press the <b>Exit</b> key until the measurement display appears.

## 3.2 Entering IDs

The SevenMulti allows you to identify your readings via sample and sensor IDs.

An ID can consist of up to 8 alphanumeric characters. Capital letters can be used, but spaces and special characters can not.

All IDs can also be entered via a barcode reader (see Section 3.2.4).

### 3.2.1 Entering a sample ID

- If two expansion units are attached, first ensure that the desired expansion unit is selected.
- Press **ID** and confirm the menu item **1. Enter Sample ID** with **Enter**.
- Enter the sample ID with max. 8 characters using the alphanumeric keys.
- Save the sample ID with **Save** and exit the ID menu with **Exit**.

**Note:** If you enter an exclusively numerical sample ID (e.g. 123), it will be incremented by 1 for each reading.

### 3.2.2 Entering a sensor ID

**Attention:** Always enter a sensor ID so that the calibration data can be saved in the memory of the SevenMulti. Otherwise, the current calibration data are lost when another sensor is calibrated. The calibration data are also lost if the sensor ID is changed.

- If two expansion units are attached, first ensure that the desired expansion unit is selected.
- Press **ID**, select the menu item **2. Enter Sensor ID** and confirm with **Enter**.
- Enter the sensor ID with max. 8 characters using the alphanumeric keys.
- Save the sensor ID with **Save** and exit the ID menu with **Exit**.

### 3.2.3 Alphanumeric input

Keys 2 through 9 may be assigned with several values, including the letters shown, depending on the input window which was just called up.

- If only numerical values are allowed in an input field (e.g. time, PIN code), the keys are assigned the numbers shown.
- If both letters and numbers are allowed in an input field, first the letters and then the number value can be entered by pressing the keys repeatedly.
- If 2 letters found on the same key are next to each other in the word, press the → key to jump to the next space.
- With the ← key, input can be deleted character-by-character from right to left.

**Example:** Input UTA7 = 2 x **8** 1 x **8** 1 x **2** 5 x **7**

**Note:** Only capital letters and numbers can be entered. It is not possible to enter spaces or special characters.

### 3.2.4 Entering an ID via a barcode reader


A barcode reader can be attached to the RS232 interface to automate the input of IDs (e.g. sample ID, sensor ID).

**Note:** Up to 8 characters can be read in. If a longer ID is read in with the barcode reader, only the first 8 places are accepted.



### 3.3 Storing/displaying data

The SevenMulti can store up to 1,000 measurement data records and 10 calibration data records per sensor for up to 10 sensors per expansion unit.


Pressing  displays the last 25 readings and the current calibration data.

The current reading can be logged to memory with .

#### 3.3.1 Storing current reading

- If two expansion units are attached, first ensure that the desired expansion unit is selected.
- Press  when a reading is complete (measurement display does not change).
- Confirm **1. Store Current Reading in Memory** with **Enter**.  
The measurement data are stored.
- Note the message on the bottom line of the screen:
  - **Data are stored:** The measurement data are saved in memory.
  - **Memory is full:** The data memory is full. The measurement data were not stored.  
To clear the memory, see system menu **9.3 Delete Records in Memory**.
- Switch back to measurement display with **Exit** or .

#### 3.3.2 Displaying overview of last 25 readings

- Press , select **2. Overview of Last 25 Readings** and confirm with **Enter**.  
A table with the measured values of the last 25 readings appears.
- Display the last 25 measured values graphically with **Graph**. (measured value vs. running number).



**Note:** If data outside the measurement range are stored, they are represented with "---" in the table. If such data is found in the table, a graph cannot be displayed, and the warning **Display not possible: "---" data in table** appears.

#### 3.3.3 Displaying calibration data of the sensor

- Press , select **3. Show Current Sensor Calibration Data** and confirm with **Enter**.  
A table with the current calibration data of the sensor appears.

### 3.4 Help function

The SevenMulti features extensive context-sensitive help information.

- Press .  
A help text on the current step appears on the screen.
- Press .  
The entire help menu for the system and expansion unit is available.

## 3.5 Working with two expansion units

### 3.5.1 Reading with two expansion units

If two expansion units are installed, the screen is divided up into two areas while reading: **Left** for the expansion unit installed at the left insert, **Right** for the right expansion unit (dual display). The readings are performed at both expansion units simultaneously. It is not possible to make settings to the expansion units in the dual display.

### 3.5.2 Making settings with two expansion units

#### System settings

- Activate the input of system parameters with **Sys**.
- Make settings as described in Chapter 8.

After the system settings are made, they are immediately valid for both expansion units.

#### Settings for the expansion units

- Select the right or left expansion unit with **Left** or **Right**.
- Make menu and/or mode settings as described for the expansion units.

## 3.6 Analog output

For the pH and Ion expansion units the analog output of the SevenMulti supplies a voltage proportional to the displayed measured value (pH, mV, rel. mV and ion concentration). The polarity of the output corresponds to the polarity at the measurement electrode. The voltage at the analog output is not temperature-compensated.

- If only one pH or Ion expansion unit is installed, the pH or ion reading is always output at the analog output, regardless of whether other expansion units are installed.
- If a pH or Ion expansion unit is operated on both channels, the measurement signal of the expansion unit on the left channel is always output at the analog output.
- This analog output does not supply voltage for the Conductivity and ISFET expansion units.

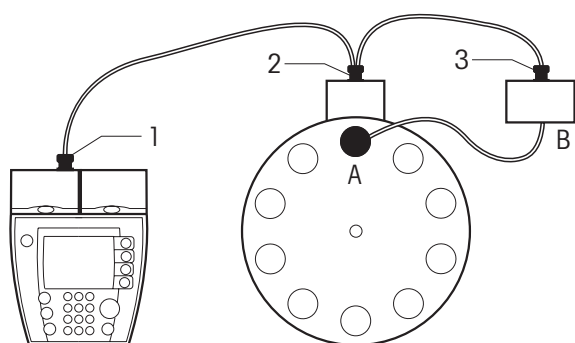
## 3.7 Connection of additional instruments to the TTL communication module

If the SevenMulti is outfitted with a TTL communication module, additional instruments such as the Rondolino sample changer can be attached.

The SevenMulti has a control protocol for communication with the Rondolino sample changer.

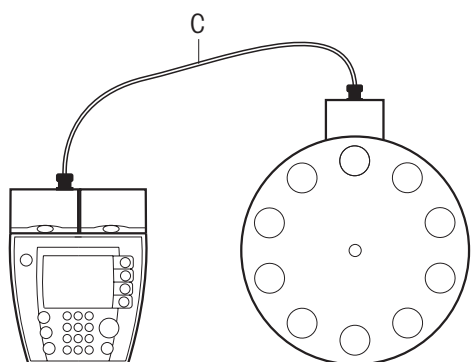
If operation with the sample changer is activated in the SevenMulti, readings can be performed automatically without any additional settings (see system menu **7. Activate Rondolino Sample Changer**).

### Rondolino sample changer setup with propeller stirrer



- A** Propeller stirrer incl. cable
- B** Seven/Rondolino Stirrer Driver incl y-shaped cable
- 1** male connector
- 2** female connector
- 3** female connector

### Rondolino sample changer setup without propeller stirrer



- C** Standard TTL cable (Order No. 51190589)


## 3.8 Connection of a computer via the USB communication module

The SevenMulti can be equipped with a USB communication module for data transfer to a computer. The USB communication module scope of supply includes a floppy disk with a driver which allows COM communication via the USB interface on the computer. This is offered for data recording programs which do not allow USB communication, e.g. MS Windows HyperTerminal. This allows, for example, IDs to be input with the barcode reader (RS232) and measured values to be transferred to the computer (USB) simultaneously.

## 4. Reading with the pH expansion unit

### 4.1 Reading a pH value

**Note:** To ensure precise pH-value readings, perform calibration before each series of readings (see Section 4.2).

- Attach a suitable pH electrode to the pH expansion unit.
- If the pH electrode does not have a temperature sensor, enter the sample temperature manually (see pH menu **4. Set MTC Temperature**).
- Submerge pH electrode into the sample and press . The pH value of the sample is shown on the screen.


#### Information in the display


The following symbols appear in the display, depending on the endpoint setting (see pH menu **3. Select Endpoint Formats**):

#### Automatic or timed endpoints

- A or  $\tau$  flashes during reading.
- When the measured value is stable or the reading time has expired, the measurement display stops and  $\sqrt{A}$  or  $\sqrt{\tau}$  appears on the screen as an indication that the reading is complete.

#### Manual endpoints

- M flashes until the endpoint is completed by pressing  again.
- The measurement display then stops moving and  $\sqrt{M}$  appears, indicating that the reading is complete.

**Note:** The SevenMulti also monitors the stabilisation of the measured value with timed and manual endpoints. When the measured value is stable, this is indicated by  $\sqrt{\phantom{x}}$ . M or  $\tau$  flashes below until  is pressed or the time expires. This also allows you to check whether the measurement time is selected correctly or when you can end reading manually.

### 4.2 Calibrating pH electrode

#### Preparing for calibration

- Have calibration buffers on hand.  
Max. 9 different calibration buffers are possible.
- Enter the parameters of the calibration buffers in the pH menu under **1.1 Set Calibration Buffer**.
- In the pH menu under **1.2. Select Calibration Mode**, select the calibration mode.



## Calibrating

- Submerge the electrode in the first calibration buffer and press **Cal** to start calibrating.  
CAL 1 on the screen indicates that the first calibration point is being measured.  
If a standard other than the selected one is to be used, it can still be changed via **Std**.  
When the measured value is stable, the first reading is automatically completed and the screen does not change.
- Rinse off electrode.
- Submerge the electrode in the second calibration buffer and press **Cal** to start calibrating again.  
CAL 2 on the screen indicates that the second calibration point is being measured.  
When the measured value is stable, the first reading is automatically completed and the screen does not change.
- Repeat the procedure for all calibration buffers.
- End calibration with **End** after reading of the last calibration buffer.  
A table with the calibration results appears in the display.

## Checking calibration

- To gauge the calibration, display the calibration curve (mV vs. pH) graphically with **Graph**.  
The calibration points are displayed as crosses.
  - With the segment method, the calibration points are connected by straight lines.
  - With the linear method, the calibration curve is calculated as a mean straight line.
- To use the calibration for additional readings: Press **Save**.
- To discard the calibration: Press **Cancel**.

## Notes for standard buffer groups

- The SevenMulti features automatic calibration-buffer recognition for the calibration buffers of buffer groups 1 to 5 permanently stored in the instrument (see Appendix).
- The pH electrode can only be calibrated in the temperature range in which the pH values of the selected buffer group are defined, e.g. between 5 °C and 50 °C for buffer groups 1, 2, 4 and 5. Otherwise the warning **Buffer temp. out of range** appears.
- If the read mV value for the first calibration point deviates by more than 60 mV (approx. +/- 1 pH) from the theoretical value of the next calibration buffer during an n-item calibration, the **Offset out of range** warning appears.
- If the read mV value for calibration points 2 through n deviates by more than 60 mV (approx. +/- 1 pH) from the theoretical value of the next calibration buffer during an n-item calibration, the **Slope out of range** warning appears.
- If the same calibration buffer is used twice or two calibration buffers whose mV values differ less than 60 mV are used for an n-point calibration, the **Wrong Buffer** warning appears.

## Notes for customized buffer groups

- Temperature-dependencies cannot be programmed for user-defined reference solutions. For this reason, a warning appears when the temperature deviates more than 0.5 °C from the specified value during calibration. The warning **Measured temp. differs from setting** appears.




- The pH values of the user-defined calibration buffers must differ by at least one pH unit. Otherwise, the following message appears: **Invalid value, please re-enter**.
- During calibration, the calibration buffers must be used in the same order as they were entered in the user-defined calibration-buffer group. If the mV value measured during calibration deviates from the theoretically determined mV value by more than 60 mV, the following warning appears: **pH differs from setting by more than 1 pH**.

### 4.3 Reading absolute potential (mV value)

#### Calling up mV mode

- Press **Mode** in the measurement display. Then press **mV** in the following menu.  
The measurement display is now in mV.

#### Performing reading

- Submerge pH electrode into the sample and press .
- Depending on the set endpoint, wait until the measurement display stops moving or press  to complete the reading.
- Press  again to start a new reading.

**Note:** Calibration is not possible in mV mode.

### 4.4 Reading relative potential (rel. mV value)

#### Calling up rel. mV mode

- Press **Mode** in the measurement display. Then press **Rel.mV** in the following menu.  
The measurement display is now in mV.  
The measured or entered offset is subtracted automatically.

#### Reading offset




- Call up the rel. mV menu with **Menu** and confirm **1. Offset Setting** with **Enter**.
- Select **2. Test a Reference Sample** and confirm with **Enter**.
- Submerge electrode into the reference sample.
- Start the reference reading with **Meas.** and wait until the measurement display stops moving after the automatic reading.
- To accept the offset: Press **Save**.
- To cancel the reading: Press **Exit**.

**Note:** Calibration is not possible in rel. mV mode.

### Entering offset manually

- Call up the rel. mV menu with **Mode** and confirm **1. Offset setting** with **Enter**.
- Confirm **1. Enter an Offset Value** with **Enter**.
- Enter offset in mV (–1999.9 – 1999.9 mV) in the input window.
- To accept the offset: Press **Save**.
- To cancel the input: Press **Exit**.

### Reading relative potential


- Submerge pH electrode into the sample and press .  
The relative potential at the electrode is displayed in mV in the display.  
Depending on the set endpoint, wait until the measurement display stops moving or press  to complete the reading.
- Press  again to start a new reading.

## 5. Reading with the Conductivity expansion unit

### 5.1 Reading conductivity


**Note:** To ensure precise conductivity readings, perform calibration before each series of readings (see Section 5.2).


If the conductivity sensor is changed, calibration **must** be performed again, as each sensor has a different cell constant.

- Attach a suitable conductivity sensor to the Conductivity expansion unit.
- If the conductivity sensor does not have a temperature sensor, enter the sample temperature manually (see Conductivity menu **4. Set MTC Temperature**).
- Submerge conductivity sensor into the sample and press . The conductivity of the sample is shown on the screen.

#### Information on the screen

The following symbols appear on the screen, depending on the endpoint setting (see Conductivity menu **3. Select Endpoint Formats**):

Automatic or timed endpoints	Manual endpoints
<ul style="list-style-type: none"> <li>• A or <math>\tau</math> flashes during reading.</li> <li>• When the measured value is stable or the reading time has expired, the measurement display stops and <math>\sqrt{A}</math> or <math>\sqrt{\tau}</math> appears on the screen as an indication that the reading is complete.</li> </ul>	<ul style="list-style-type: none"> <li>• M flashes until the endpoint is completed by pressing  again.</li> <li>• The measurement display then stops moving and <math>\sqrt{M}</math> appears, indicating that the reading is complete.</li> </ul>

**Note:** The SevenMulti also monitors the stabilisation of the measured value with timed and manual endpoints. When the measured value is stable, this is indicated by  $\sqrt{\phantom{x}}$ . M or  $\tau$  flashes below until  is pressed or the time expires. This also allows you to check whether the measurement time is selected correctly or when you can end reading manually.

### 5.2 Calibrating conductivity sensor

The conductivity sensor can be calibrated in 2 ways:

- Entry of the cell constants (see Conductivity menu item 2.2.5).
- Calibration with a conductivity standard (see next page).

### Preparing for calibration

- Have pre-fabricated or your own conductivity standard on hand.
- In the Conductivity menu under **2.1. Set Calibration Standard**, enter the conductivity of the conductivity standard.

**Note:** If you are using your own conductivity standard, enter its conductivity value for a temperature of 25 °C.

### Performing calibration

- Submerge sensor into the conductivity standard and press **Cal**, to start calibrating.  
CAL on the screen indicates that the calibration is being carried out.  
If a standard other than the selected one is to be used, it can still be changed via **Std**.  
When the measured value is stable, the reading is automatically completed and the screen does not change.
- End calibration with **End**. The value of the measured cell constant (unit: 1/cm) is shown on the screen.
- To accept the calibration for additional readings: Press **Save**.
- To discard the calibration: Press **Cancel**.

### Notes

- Calibration with the conductivity standard programmed in the instrument can only be performed at a temperature of 0 °C to 35 °C. Otherwise, the warning **Standard temp. out of range** appears.
- The second point required for the calibration line is permanently programmed in the SevenMulti and is 0 S/m for a specific resistivity tending toward infinity.
- Temperature dependencies cannot be programmed for the special standard (25 °C). For this reason, the warning **Measured temperature differs from setting** appears if the temperature deviates from the specified value by more than 0.5 °C.

## 5.3 Reading total dissolved solids (TDS)

A conductivity measured value can be converted to a total dissolved solids value.

- Press **Mode** in the conductivity display.
- Activate the conversion into the total dissolved solids (TDS) value with **TDS**.
- Press **Menu**, select **1. Set TDS Factor** and confirm with **Enter**.
- Enter TDS factor into the input window and save with **Save**.

Reading is carried out as described in Section 5.1.

Calibration is not possible in TDS mode.

## 5.4 Reading salinity

The salinity can be derived from the conductivity of a sample.

- Press **Mode** in the conductivity display.
- Activate conversion into salinity with **SAL**.
- Press **Menu** and select **1. Select Salinity Type**.
- Select salinity type and accept with **Select**.

Reading is carried out as described in Section 5.1., in the unit ppt (parts per thousand).

Calibration is not possible in SAL mode.

## 5.5 Reading resistivity

The resistivity is yielded from the reciprocal of the measured conductivity of the sample.

- Press **Mode** in the conductivity display.
- Activate conversion into resistivity [ $\Omega\cdot\text{cm}$ ] with **Res**.

Reading is carried out as described in Section 5.1.

Calibration is not possible in specific resistivity mode.


## 6. Reading with the Ion expansion unit

In addition to ion-concentration readings, the Ion expansion unit can be used for pH, potential and relative-potential readings. You can activate the various reading types with the **Mode** key.

The pH, potential and relative-potential readings are identical to those with the pH expansion unit and are described in Chapter 4.


### 6.1 Reading ion concentration


#### Notes

- To ensure precise ion-concentration readings, perform calibration before each series of readings (see Section 6.2).
  - Temperature dependencies cannot be programmed for the reference solutions. For this reason, the warning **Measured temperature differs from setting** appears if the temperature deviates from the specification by more than 0.5 °C during calibration.
  - Attach a suitable ion-sensitive electrode to the Ion expansion unit.
  - If the electrode does not have a temperature sensor, set the MTC temperature (see Ion menu **4. Set MTC Temperature**) or use a separate Pt1000 or NTC 30 kΩ temperature sensor.
  - Submerge electrode into the sample and press .
- The ion concentration of the sample is shown on the screen.  
The reading result is displayed in the unit set during the last calibration of the ion-sensitive electrode.

#### Information on the screen

The following symbols appear on the screen, depending on the endpoint setting (see Ion menu **3. Select Endpoint Formats**):

Automatic or timed endpoints	Manual endpoints
<ul style="list-style-type: none"> <li>• A or τ flashes during reading.</li> <li>• When the measured value is stable or the reading time has expired, the measurement display stops and <math>\sqrt{A}</math> or <math>\sqrt{\tau}</math> appears on the screen as an indication that the reading is complete.</li> </ul>	<ul style="list-style-type: none"> <li>• M flashes until the endpoint is completed by pressing  again.</li> <li>• The measurement display then stops moving and <math>\sqrt{M}</math> appears, indicating that the reading is complete.</li> </ul>

**Note:** The SevenMulti also monitors the stabilisation of the measured value with timed and manual endpoints. When the measured value is stable, this is indicated by  $\sqrt{\phantom{x}}$ . M or τ flashes below until  is pressed or the time expires. This also allows you to check whether the measurement time is selected correctly or when you can end reading manually.

## 6.2 Calibrating ion-sensitive electrode

### Preparing for calibration

- Have a set of calibration standards with known ion concentrations on hand.  
A maximum of 9 different calibration standards is possible.
- Select the electrode type in the Ion menu under **1.1 Define Electrode Type**.
- Enter parameters of the calibration standards in the Ion menu under **1.2. Calibration Setting**.

### Performing calibration

- Submerge electrode into the first calibration standard and press **Cal** to start calibrating.  
CAL 1 on the screen indicates that the first calibration point is being measured.  
If a standard other than the selected one is to be used, it can still be changed via **Std**.  
When the measured value is stable, the first reading is automatically completed and the screen does not change.
- Submerge electrode into the second calibration standard and press **Cal** to start calibrating again.  
CAL 2 on the screen indicates that the second calibration point is being measured.  
When the measured value is stable, the reading is automatically completed and the screen does not change.
- Repeat this procedure for all calibration standards.
- End the calibration with **End** after reading of the last calibration standard.  
A table with the calibration results appears on the screen.

### Checking calibration

- To gauge the calibration, display the calibration curve (mV vs. ion concentration) graphically with **Graph**.  
The calibration points are displayed as crosses, or, with the segment method, via straight lines.
- To accept the calibration for additional readings: Press **Save**.
- To discard the calibration: Press **Cancel**.

### Notes

- For a single-point calibration, the theoretical value of the ion to be determined is always used for the slope, e.g.  $-59.16 \text{ mV/pH}$  for  $\text{H}^+$  or  $59.16 \text{ mV/pH}$  for  $\text{F}^-$ .
- If two of the same ion solutions are used for an n-point calibration, the warning **Wrong standard** appears for the second one.
- If the temperature of the ion solution deviates by more than  $0.5 \text{ }^\circ\text{C}$  from the specified value, the warning **Measured temp. differs from setting** appears.
- Ensure that the calibration standards have the same temperature during calibration as the samples will later on during measurement.



## 6.3 Incremental measurement

Incremental readings are especially ideal when individual analyses are to be carried out, as only one solution and two potential measurements are necessary. Calibration need only be performed before the first reading with the sensor, as the slope conductance of the sensor generally remains the same for several months.


### Preparing for incremental measurement

- In the Ion menu, select **1.3. Incremental Measurement Parameters** and confirm with **Enter**.
- Select the desired incremental measurement method and confirm with **Enter**:
  - 1. Known Addition**
  - 2. Known Subtraction**
  - 3. Sample Addition**
  - 4. Sample Subtraction**
- Enter the volume of the sample(s) and calibration standard and the ion concentration of the calibration standard in the parameter table.

### Performing incremental measuring

- In the Ion menu, select **2. Use an Incremental Measurement Method** and confirm with **Enter**.
- Select the desired incremental measurement method and confirm with **Enter**:
  - 1. Known Addition**
  - 2. Known Subtraction**
  - 3. Sample Addition**
  - 4. Sample Subtraction**

The measurement method begins after it is selected. Follow the instructions on the screen.

**Note:** With the incremental measurement, the type of the endpoint cannot be selected. The measured value is always recorded automatically. The reading cannot be ended with  manually either.

### Example: Sample Addition

- Submerge electrode into the calibration standard and press **Meas**.

The first measurement starts automatically.

When the measurement is complete, you will be directed to submerge the electrode into the second solution.
- Add first sample addition to calibration standard and mix the solution.
- Submerge electrode into the solution and press **Meas**.

The measurement starts automatically.

When the measurement is complete, you will be directed to submerge the electrode into the third solution.
- Repeat this procedure for all samples, (max. 4).

When all samples are measured, the calculated concentration of the solution after each addition is displayed and can be printed or transferred to a computer.


## 7. Reading with the ISFET expansion unit

The ISFET expansion unit is used exclusively for pH readings with sensors based on **Ion-Sensitive Field Effect Transistors**.

### 7.1 Reading pH values


**Note:** To ensure precise pH-value readings, perform calibration before each series of readings (see Section 7.3) and adjust the offset regularly (see Section 7.2).


With a new ISFET electrode, the offset must be adjusted with a calibration buffer of pH 7.0 before the sample reading, as the offset can vary considerably.

- Attach a suitable ISFET electrode to the ISFET expansion unit.
  - Submerge ISFET electrode into the sample and press .
- The pH value of the sample is shown on the screen.

#### Information on the screen

The following symbols appear on the screen, depending on the endpoint setting (see ISFET menu **2. Select Endpoint Formats**):

Automatic or timed endpoints	Manual endpoints
<ul style="list-style-type: none"> <li>• A or <math>\tau</math> flashes during reading.</li> <li>• When the measured value is stable or the reading time has expired, the measurement display stops and <math>\sqrt{A}</math> or <math>\sqrt{\tau}</math> appears on the screen as an indication that the reading is complete.</li> </ul>	<ul style="list-style-type: none"> <li>• M flashes until the endpoint is completed by pressing  again.</li> <li>• The measurement display then stops moving and <math>\sqrt{M}</math> appears, indicating that the reading is complete.</li> </ul>

**Note:** The SevenMulti also monitors the stabilisation of the measured value with timed and manual endpoints. When the measured value is stable, this is indicated by  $\sqrt{\phantom{x}}$ . M or  $\tau$  flashes below until  is pressed or the time expires. This also allows you to check whether the measurement time is selected correctly or when you can end reading manually.

### 7.2 Reading offset of ISFET electrode

- Press **Offset**.  
You are directed to submerge the electrode into a calibration buffer of pH 7.0.
- Submerge the ISFET electrode into the calibration buffer of pH 7.0 and start the offset reading with **Meas**.  
The offset of the electrode is automatically measured and adjusted.  
The ISFET measurement display reappears when the procedure is complete.

## 7.3 Calibrating ISFET electrode

### Preparing for calibration

- Have a set of calibration buffers on hand.  
At least 2 calibration buffers with different pH values are required, and max. 9 different calibration buffers are possible.
- Enter the parameters of the calibration buffer in the ISFET menu under **1.1. Select a Standard Buffer Group**.

### Performing calibration

- Submerge the electrode in the first calibration buffer and press **Cal** to start calibrating.  
CAL 1 on the screen indicates that the first calibration point is being measured.  
If a standard other than the selected one is to be used, it can still be changed via **Tab**.  
When the measured value is stable, the first reading is automatically completed and the screen does not change.
- Submerge electrode into the second buffer and press **Cal** to start calibrating again.  
CAL 2 in the display indicates that the second calibration point is being measured.  
When the measured value is stable, the reading is automatically completed and the screen does not change.
- Repeat this procedure for all calibration buffers.
- End calibration with **End** after reading of the last calibration buffer.  
table with the calibration results appears on the screen.

### Checking calibration

- To gauge the calibration, display the calibration curve (mV vs. pH) graphically with **Graph**.  
The calibration points are displayed as crosses.  
With the segment method, the calibration points are connected by straight lines.
- To accept the calibration for additional readings: Press **Save**.
- To discard the calibration: Press **Cancel**.

## 8. System menu

### 8.1 System-menu structure

<b>1. Select Language ..... Page 27</b>	<b>6. Baud Rate Setting ..... Page 29</b>
<ul style="list-style-type: none"> <li>1. English</li> <li>2. Deutsch</li> <li>3. Français</li> <li>4. Español</li> <li>5. Italiano</li> </ul>	<ul style="list-style-type: none"> <li>1. 1200</li> <li>2. 2400</li> <li>3. 4800</li> <li>4. 9600</li> </ul>
<b>2. Set Time and Date ..... Page 27</b>	<b>7. Activate Rondolino Sample Changer ..... Page 29</b>
<ul style="list-style-type: none"> <li>1. Set Time <ul style="list-style-type: none"> <li>1. 24 Hour Format</li> <li>2. 12 Hour Format</li> </ul> </li> <li>2. Set Date <ul style="list-style-type: none"> <li>1. Set Date: mm-dd-yy</li> <li>2. Set Date: dd-mm-yy</li> </ul> </li> </ul>	<b>8. Start Instrument Self-test ..... Page 30</b>
<b>3. Screen Setting ..... Page 27</b>	<b>9. Lab Manager's Menu ..... Page 30</b>
<ul style="list-style-type: none"> <li>1. Screen Contrast</li> <li>2. Screen Saver</li> </ul>	<ul style="list-style-type: none"> <li>1. Set Instrument ID</li> <li>2. Set Expansion Unit ID</li> <li>3. Delete Records in Memory <ul style="list-style-type: none"> <li>1. Empty Memory</li> <li>2. Delete Measurement Data <ul style="list-style-type: none"> <li>1. Delete all</li> <li>2. Delete by Date</li> <li>3. Delete by User Name</li> <li>4. Delete by Sample ID</li> </ul> </li> <li>3. Delete Calibration Data <ul style="list-style-type: none"> <li>1. pH</li> <li>2. Ion</li> <li>3. ISFET</li> <li>4. Conductivity</li> </ul> </li> <li>4. Delete Stored Methods <ul style="list-style-type: none"> <li>1. pH</li> <li>2. Ion</li> <li>3. Conductivity</li> </ul> </li> </ul> </li> <li>4. Set Instrument Login Password <ul style="list-style-type: none"> <li>1. Password Protection Off</li> <li>2. Password Protection On</li> </ul> </li> <li>5. Change PIN Code</li> </ul>
<b>4. Register User Name ..... Page 27</b>	
<b>5. Access Memory Functions ..... Page 28</b>	
<ul style="list-style-type: none"> <li>1. Review/Transfer Measurement Data <ul style="list-style-type: none"> <li>1. Display all</li> <li>2. Search by Date</li> <li>3. Search by User</li> <li>4. Search by Sample ID</li> </ul> </li> <li>2. Review/Transfer Calibration Data <ul style="list-style-type: none"> <li>1. pH</li> <li>2. Ion</li> <li>3. ISFET</li> <li>4. Conductivity</li> </ul> </li> <li>3. Review/Transfer Method Data <ul style="list-style-type: none"> <li>1. pH</li> <li>2. Ion</li> <li>3. Conductivity</li> </ul> </li> <li>4. Review/Transfer Current Instrument Setting</li> </ul>	

## 8.2 Description of the system menu

- To call up the system menu, press **Sys.** in the measurement display.

### 1. Select Language

The following languages are available for the system: German, English, French, Spanish and Italian.

- Select the desired language and confirm with **Select**.

### 2. Set Time and Date

#### 2.1. Set Time

You can select between two display formats:

24 Hour Format                      Ex.: 18:56

12 Hour Format                      Ex.: 06:56 PM

For 12 Hour Format, select the time of day with **AM/PM**: AM = morning; PM = after 12 noon

#### 2.2. Set Date

You can select between two display formats:

mm-dd-yy (month - day - year): Ex.: 09-27-03

dd-mm-yy (day - month - year): Ex.: 27-09-03

### 3. Screen Setting

#### 3.1. Screen Contrast

You can set the contrast of the screen to one of 32 levels with the ↑ ↓ keys.

#### 3.2. Screen Saver

In this menu, you set the amount of time which passes until the screen saver is activated:

5 – 99 minutes


If the SevenMulti is not operated during this time, the screen saver is activated. The screen is reactivated by pressing any key.

### 4. Register User Name

If you would like to assign readings to a certain user, enter a user name.

When entering, note:

- A user name can be up to 8 characters long.
- Only capital letters may be entered, i.e. spaces may not be entered.  
To make a correction, use the ← key to delete your input.
- If you do not wish to enter a user name, delete the input field with the ← key.

**Note:** The user name is retained when the SevenMulti is switched off with . Ensure that the right user name is assigned after switching on.

## 5. Access Memory Functions

In this menu, you can display overviews of:

- Measurement data
- Calibration data
- Method Data
- Instrument settings

You can transmit the displayed data to an attached computer or printer. The entire data record is transferred in this case.

### 5.1. Review/Transfer Measurement Data

It is possible to create overviews of the stored measurement data:

- All measurement data
- Measurement data recorded as of a specific date
- Measurement data recorded by a specific user
- Measurement data recorded with a specific sample ID

The last saved data record of the selection appears on the screen.

The number and total amount of selected readings are displayed on the bottom line.

- Pressing the  $\uparrow \downarrow$  keys brings you to the data record of the previous/next reading.
- Pressing **Trans** transmits the displayed data record to an attached computer or printer.

### 5.2. Review/Transfer Calibration Data

You can display the calibration data saved under a sensor ID for the following sensor types:

- pH sensor
- ion sensor
- ISFET sensor
- conductivity sensor

When a sensor ID is selected, the stored calibration data are displayed.

- Pressing the  $\uparrow \downarrow$  keys brings you to the previous/next calibration.
- Pressing **Trans** transmits the displayed data record to an attached computer or printer.

**Note:** A calibration without a sensor ID can only be displayed via . This screen is only possible for the last performed calibration.

### 5.3. Review/Transfer Method Data

You can display the stored method data for the following sensor types:

- pH sensor
- ion sensor
- conductivity sensor

Methods cannot be defined or stored for ISFET.

When a sensor type is selected, a list of the accompanying stored methods appears.

When the desired method is selected, the corresponding method parameters are displayed.

- Pressing **Trans** transmits the displayed data record to an attached computer or printer and ends the procedure.

#### 5.4. Review/Transfer Current Instrument Setting

The current instrument settings are displayed.

- Pressing the **Trans** key transmits the displayed data record to an attached computer or printer.

### 6. Baud Rate Setting

The RS232 interface is configured with the following standard values:

- Baud rate 1200 (adjustable)
- Data bits 8 (fixed)
- Stop bit 1 (fixed)
- Parity none (fixed)
- Handshake none (fixed)

A baud rate of 1200, 2400, 4800 or 9600 can be set, depending on the requirements of the attached instrument (e.g. barcode reader).

### 7. Activate Rondolino Sample Changer

**Requirement:** The Rondolino sample changer is connected via a TTL cable and a channel (left or right) is selected.

The current Rondolino settings are displayed.

#### Changing sample changer settings

If you would like to change the sample changer settings:

- Press **Edit**.  
The input window for the sample ID of the first Rondolino position appears.
- Enter sample ID with the keypad or barcode scanner.
- Confirm entry with **Next** and change to the input window of the next Rondolino position. Up to 9 Rondolino positions can be assigned.
- Confirm the last entry with **End** and exit.  
The sample changer settings are displayed.

#### Starting reading with the Rondolino sample changer


If you would like to start the reading with the sample changer using the current settings:

- Press **Start**.  
Reading with the sample changer starts.

When the readings have been performed with all samples, a list of the measurement results appears.

- To transfer the measurement results to a printer or a computer: Press **Print**.
- To repeat reading with the sample changer: Press **Redo**.

#### Notes

- When working with the Rondolino sample changer, the endpoint cannot be chosen and the measured value is always recorded automatically. The reading cannot be ended with  manually either.
- A METTLER TOLEDO titration stirrer can be connected using the Seven/Rondolino Stirrer Driver accessories. This allows fully-automatic measurement with a high rate of repeatability.

## 8. Start Instrument Self-test

This menu item starts the self-test routine. The self-test result is displayed after a few seconds. If errors are reported: Contact METTLER TOLEDO Service.

## 9. Lab Manager's Menu

In Lab Manager's Menu, you can enter ID numbers of the instrument and the expansion units, delete data records from memory, set and change passwords.

**Note:** This menu is protected by a lab manager's PIN code. Upon delivery, the PIN code is set to **000000**. Please change the lab manager's PIN code to prevent unauthorised access.

### 9.1. Set Instrument ID

The current instrument ID is displayed in the input field of the input window.

- Enter an alphanumeric instrument ID (max. 6 places).

The entered instrument ID remains intact when the instrument is switched off.

**Note:** When the SevenMulti is delivered, no instrument ID is set.

### 9.2. Set Expansion Unit ID

In this menu, you can allocate an expansion unit ID to the expansion units in the left and right slots.

- Select **right** or **left** slot with **Select**.

The input window for the ID of the expansion unit appears.

The current ID is displayed via the input field.

- Enter an alphanumeric ID (max. 6 places).

The menu for selection of the expansion unit in the left or right slot reappears.

- Repeat steps for the second expansion unit or end procedure with **Exit**.

### 9.3. Delete Records in Memory

With this menu, you can delete stored measurement data, calibration data and methods based on specific criteria:

#### 1. Empty Memory

removes all measurement data, all calibration data and methods from memory.



## 2. Delete Measurement Data

deletes measurement data from memory based on the following criteria:

- **All** measurement data
- Measurement data recorded on a specific **date**
- Measurement data recorded by a specific **user**
- Measurement data recorded with a specific **sample ID**

## 3. Delete Calibration Data

removes calibration data for various sensor types from memory.

- Select measurement parameter (pH, ion, ISFET, conductivity) with **Select**.
- Select sensor ID with ↑ or ↓ and press **Delete** to delete the data record.
- Confirm or correct the message **This will delete all your selected data** with **Yes** or **Exit** accordingly.

## 4. Delete Stored Methods

removes method data for pH, ion or conductivity measurement.

- Select measurement parameter (pH, ion, conductivity) with **Select**.
- Select the method to be deleted with ↑ or ↓ and press **Delete** to delete the method.
- Confirm or correct the message **This will delete all your selected data** with **Yes** or **Exit** accordingly.

**Note:** Only methods not currently in use are offered for deletion in the list. An active method cannot be deleted.

## 9.4. Set Instrument Login Password

Setting a login password can protect the SevenMulti from unauthorised use. When the instrument is switched on, the user must enter the login password in order to be able to use the instrument. When the SevenMulti is delivered, no login password is set.

- Enter a numeric login password (max. 6 places).  
The input window for verification of the login password appears.
- Reenter password.

**Note:** If entry was not successful, the password must be reentered and verification must be performed again.

After password entry, the **Set Instrument Switch-on Mode** menu appears.

- Activate/deactivate login password protection with **Password protection On / Off**.

## 9.5. Change PIN Code

- Enter a numeric PIN code (max. 6 places).  
The input window for verification of the PIN code appears.
- Reenter PIN code.

**Note:** If entry was not successful, the PIN code must be reentered and verification must be performed again.

## 9. Menus of the pH expansion unit

The pH expansion unit allows reading of pH values, potentials and relative potentials. The menus for these reading types are described in the following.

### 9.1 pH menu structure

<b>1. Calibration Setting ..... Page 33</b>	<b>6. Timed Interval Readings ..... Page 35</b>
<ul style="list-style-type: none"> <li>1. Set Calibration Buffer <ul style="list-style-type: none"> <li>1. Select a Standard Buffer Group</li> <li>2. Set a Customized Buffer Group</li> </ul> </li> <li>2. Select Calibration Mode <ul style="list-style-type: none"> <li>1. Segment Method</li> <li>2. Linear Method</li> </ul> </li> <li>3. Select Calibration Reminder <ul style="list-style-type: none"> <li>1. Off</li> <li>2. Remind by Interval Time</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>1. Off</li> <li>2. On <ul style="list-style-type: none"> <li>1. Log to Memory</li> <li>2. Log to Interface</li> <li>3. Log to Memory and Interface</li> </ul> </li> </ul>
<b>2. Select Display Resolution ..... Page 34</b>	<b>7. GLP Operating Mode ..... Page 36</b>
<ul style="list-style-type: none"> <li>1. X.X</li> <li>2. X.XX</li> <li>3. X.XXX</li> </ul>	<ul style="list-style-type: none"> <li>1. Off</li> <li>2. On</li> </ul>
<b>3. Select Endpoint Formats ..... Page 34</b>	<b>8. Select Data Transfer Mode ..... Page 36</b>
<ul style="list-style-type: none"> <li>1. Auto</li> <li>2. Manual</li> <li>3. Timed</li> </ul>	<ul style="list-style-type: none"> <li>1. Automatic Data Transfer <ul style="list-style-type: none"> <li>1. Log to Memory</li> <li>2. Log to Interface</li> <li>3. Log to Memory and Interface</li> </ul> </li> <li>2. Manual Data Transfer to Memory</li> </ul>
<b>4. Set MTC Temperature ..... Page 35</b>	<b>9. pH Methods in Memory ..... Page 36</b>
<b>5. Set Alarm Limits ..... Page 35</b>	<ul style="list-style-type: none"> <li>1. Save Current Settings as a Method</li> <li>2. Load a Stored pH Method from Memory</li> </ul>
<ul style="list-style-type: none"> <li>1. pH Max. Limit</li> <li>2. pH Min. Limit</li> <li>3. Temperature Max. Limit</li> <li>4. Temperature Min. Limit</li> <li>5. Calibration Offset Max. Limit</li> <li>6. Calibration Offset Min. Limit</li> <li>7. Calibration Slope Max. Limit</li> <li>8. Calibration Slope Min. Limit</li> </ul>	

## 9.2 Description of the pH menu

- To call up the pH menu, first select the individual measurement display for the pH reading.
- Press **Mode** and select the pH mode in the menu which appears with **pH**.
- Call up the pH menu with **Menu**.

### 1. Calibration Setting

#### 1.1. Set Calibration Buffer

##### 1. Select a Standard Buffer Group

- Select predefined parameters for standard calibration buffers.  
The following buffer groups are predefined.

No.	Buffer 1	Buffer 2	Buffer 3	Buffer 4	Buffer 5	Temp.	Designation
1.	1.68	4.00	7.00	10.01	–	25 °C	METTLER TOLEDO US
2.	2.00	4.01	7.00	9.21	11.00	25 °C	METTLER TOLEDO Europa
3.	2.00	4.00	7.00	9.00	12.00	20 °C	Merck
4.	1.680	4.008	6.865	9.184	12.454	25 °C	DIN
5.	1.09	4.65	6.79	9.23	12.75	25 °C	

##### 2. Set a Customized Buffer Group

In this menu, you can define your own set of calibration buffers for the calibration of the SevenMulti. A table with the parameters of the current set of calibration buffers appears.

- To use the current parameters for the calibration, press the **Save** key.
- To change the parameters of the current set or to create a new parameter set, press the **Edit** key. An input window appears, into which you enter the temperature within the range –5 °C to 130 °C.
- Pressing **Next** brings you to the input window for the parameters of the first calibration buffer.
- Enter pH value with the number keys.
- Pressing **Next** confirms the entry and brings you to the input window for the second calibration buffer.
- Repeat this step for all calibration buffers of the set. The individual buffers must differ by at least 1 pH unit.
- When the last pH value has been entered, confirm the entire set with **End**. A table with the parameters of the current set of calibration buffers appears.
- If you would like to use these parameters, confirm with **Save**.
- If you would like to change parameters, pressing **Edit** will bring you to the first input window again.
- Press **Next** repeatedly until you reach the input window of the parameter to be changed.

**Important:** When a value has been changed, press **Next** repeatedly until the input window for the last parameter of the set appears and only then confirm with **End**. If the procedure was previously completed with **End**, the parameters of the following calibration buffers are deleted.

## 1.2. Select Calibration Mode

### 1. Segment Method

The segment method is the most modern method for precise pH readings. The calibration curve consists of lines connecting the individual calibration points. This takes a non-linear behaviour of the measurement head over large ranges into account. A reading is then calibrated with each subsequent curve segment. The segment method is preferred for high-precision readings.

### 2. Linear Method

With this method, the calibration data are approximated via a linear regression line. The linear method is preferred for greatly varying samples whose pH values are to be compared.

## 1.3. Set Calibration Reminder

### 1. Off – no calibration reminder

### 2. Remind by Interval Time

If the calibration reminder is active, you are reminded to perform a new calibration after a specified amount of time has passed. The reminder comes in the form of a message on the bottom line of the measurement display.

Activating this item leads to an input window, into which you enter the time interval (1 to 1,000 h).

## 2. Select Display Resolution

In this menu, you select the resolution to which the measurement display is to be shown:

- 2.1. X.X**            one decimal place
- 2.2. X.XX**          two decimal places
- 2.3. X.XXX**        three decimal places

## 3. Select Endpoint Formats

### 3.1. Auto

With the automatic endpoint, special algorithms determine the end of an individual reading, depending on the behaviour of the sensor used. This ensures an easy, quick and precise reading.

- Start reading with .

The reading ends automatically when the measured value is stable.

#### Stability criterion for a resolution of 0.1 pH units

The signal of the sensor input may not change by more than 0.6 mV within 4 seconds.

#### Stability criterion for a resolution of 0.01 pH units

The signal of the sensor input may not change by more than 0.1 mV within 6 seconds.

#### Stability criterion for a resolution of 0.001 pH units

The signal of the sensor input may not change by more than 0.03 mV within 6 seconds.

### 3.2. Manual

- Start reading with .
- End the reading by pressing  again.

### 3.3. Timed

With the timed endpoint, reading is started with . The reading is ended automatically when the set time period expires.

You set this time period (3 s to 3,600 s) in the following input window.

## 4. Set MTC Temperature (manual temperature compensation)

If you are working without a temperature sensor during the pH reading, enter the temperature of the sample in this menu (–5 °C to 130 °C). The SevenMulti calculates the temperature-adjusted electrode slope conductance with this temperature and shows the temperature-compensated pH value in the measurement display.

## 5. Set Alarm Limits

In this menu, you can define the upper and lower limits for measurement or calibration data. If a limit is exceeded or undershot, a warning is output to the screen.

Parameter	Minimum	Maximum	Unit
pH value	–2.000	20.000	pH
Temperature	–5.0	130.0	°C
Calibration offset	–60.0	60.0	mV
Calibration slope	85.0	110.0	%

When a limit has been entered, you can activate or deactivate the alarm for this limit.

## 6. Timed Interval Readings

In this menu, you activate and deactivate series readings and set the time interval between two successive readings.

### 6.1. Off – no series reading

### 6.2. On

The input window for the time interval (3 s to 2,400 s) appears.

When the time interval is entered, a menu appears for selection of the mode of measured data recording:

#### 1. Log to Memory

The measured data are saved in the SevenMulti memory.

#### 2. Log to Interface

The measured data are transferred to an attached computer or printer via the interface.

#### 3. Log to Memory and Interface

The measurement data are saved in the SevenMulti and transferred to an attached computer or printer via the interface.

## 7. GLP Operating Mode

If the GLP operating mode is activated, the SevenMulti monitors work with the instrument according to general laboratory rules (**G**ood **L**aboratory **P**ractice).

You must, for example, enter the sample ID, sensor ID and the time interval for the calibration reminder function, before beginning a reading. When the GLP operating mode is activated, [GLP] appears on the top line of the screen.

Follow the instructions on the screen and enter all information which is requested.

## 8. Select Data Transfer Mode

### 8.1. Automatic Data Transfer

#### 1. Log to Memory

The measured data are saved in the SevenMulti memory.


#### 2. Log to Interface

The measured data are transferred to an attached computer or printer via the interface.

#### 3. Log to Memory and Interface

The measurement data are saved in the SevenMulti and transferred to an attached computer or printer via the interface.

### 8.2. Manual Data Transfer to Memory

Automatic measurement-data transfer is deactivated. If you would like to store the measured values after a reading, press  (see Section 3.3.1).

## 9. pH Methods in Memory

Up to 10 methods can be saved for the pH expansion unit.

### 9.1. Save Current Settings as a Method

The current settings for the reading are displayed.

– Press the **Save** key.

The input window for entry of the name of the measurement method appears.

– When the name has been entered, press **Save** again to store the measurement method.

### 9.2. Load a Stored pH Method from Memory

A list of the names of stored measurement methods appears on the screen.

– Select method with the arrow keys.

– Display the parameters of the selected method with **Select**.

– Press **Load** to load the parameters for the following readings.

## 9.3 Description of the mV menu

- To call up the mV menu, first select the individual measurement display for the pH reading.
- Press **Mode** and select the mV mode in the menu which appears with **mV**.
- Call up the mV menu with **Menu**.

### 1. Select Display Resolution

In this menu, you select the resolution to which the measurement display is to be shown:

- 1.1. X**          no decimal place
- 1.2. X.X**      one decimal place

### 2. Set mV Alarm Limits

In this menu, you can define the upper and lower limits for measurement data. If a limit defined in this way is exceeded or undershot, a warning is output to the screen.

Parameter	Minimum	Maximum	Unit
mV value	–1999.9	1999.9	mV

When a limit has been entered, you can activate or deactivate the alarm for this limit.

**Additional parameters**, e.g. the endpoint setting, are accepted from the pH mode.

## 9.4 Description of the Rel. mV menu

- To call up the Rel. mV menu, first select the individual measurement display for the pH reading.
- Press **Mode** and select the Rel. mV mode in the menu which appears with **Rel.mV**.
- Call up the Rel. mV menu with **Menu**.

### 1. Set Offset

#### 1.1. Enter Offset


The input window for the offset appears.

- Enter offset in mV and save with **Save**.

#### 1.2. Test a Reference Sample

You are directed to submerge the pH electrode into the test sample.

- When the pH electrode submerges in the test sample, start reading with **Meas**.
- When the measurement display no longer changes, save reading with **Save**.

**Note:** In Rel. mV mode, the endpoint cannot be chosen and the measured value is always recorded automatically. The reading cannot be ended with  manually either.

**Additional parameters**, e.g. the endpoint setting, are accepted from the pH mode.

## 10. Menus of the Conductivity expansion unit

In addition to conductivity reading, the conductivity expansion unit allows reading of TDS, salinity and resistivity. The menus for these reading types are described in the following.

### 10.1 Conductivity menu structure

<b>1. Set Conductivity Measurement Parameters ..... Page 39</b>	<b>6. Timed Interval Readings ..... Page 41</b>
<ul style="list-style-type: none"> <li>1. Select Reference Temperature</li> <li>2. Select Temp. Correction Method/USP                             <ul style="list-style-type: none"> <li>1. Linear Correction</li> <li>2. Non-Linear Correction: Natural Water</li> <li>3. USP Mode</li> </ul> </li> <li>3. Select Measurement Units                             <ul style="list-style-type: none"> <li>1. Auto <math>\mu\text{S}/\text{cm}</math>, <math>\text{mS}/\text{cm}</math></li> <li>2. X.XXE-X S/m</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>1. Off</li> <li>2. On                             <ul style="list-style-type: none"> <li>1. Log to Memory</li> <li>2. Log to Interface</li> <li>3. Log to Memory and Interface</li> </ul> </li> </ul>
<b>2. Calibration Setting ..... Page 40</b>	<b>7. GLP Operating Mode ..... Page 41</b>
<ul style="list-style-type: none"> <li>1. Set Calibration Standard                             <ul style="list-style-type: none"> <li>1. 84 <math>\mu\text{S}/\text{cm}</math></li> <li>2. 1413 <math>\mu\text{S}/\text{cm}</math></li> <li>3. 12.88 <math>\text{mS}/\text{cm}</math></li> <li>4. Saturated NaCl</li> <li>5. Enter Cell Constant</li> <li>6. Enter Your Special Standard (25 °C)</li> </ul> </li> <li>2. Set Calibration Reminder                             <ul style="list-style-type: none"> <li>1. Off</li> <li>2. Remind by Interval Time</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>1. Off</li> <li>2. On</li> </ul>
<b>3. Select Endpoint Formats ..... Page 41</b>	<b>8. Select Data Transfer Mode ..... Page 41</b>
<ul style="list-style-type: none"> <li>1. Auto</li> <li>2. Manual</li> <li>3. Timed</li> </ul>	<ul style="list-style-type: none"> <li>1. Automatic Data Transfer                             <ul style="list-style-type: none"> <li>1. Log to Memory</li> <li>2. Log to Interface</li> <li>3. Log to Memory and Interface</li> </ul> </li> <li>2. Manual Data Transfer to Memory</li> </ul>
<b>4. Set MTC Temperature ..... Page 41</b>	<b>9. Analog Output Setting ..... Page 41</b>
<b>5. Set Alarm Limits ..... Page 41</b>	<ul style="list-style-type: none"> <li>1. 20 <math>\mu\text{S}/\text{cm}</math> (middle point)</li> <li>2. 200 <math>\mu\text{S}/\text{cm}</math> (middle point)</li> <li>3. 2 <math>\text{mS}/\text{cm}</math> (middle point)</li> <li>4. 20 <math>\text{mS}/\text{cm}</math> (middle point)</li> <li>5. 200 <math>\text{mS}/\text{cm}</math> (middle point)</li> <li>6. Whole Range</li> </ul>
<ul style="list-style-type: none"> <li>1. Conductivity Max. Limit</li> <li>2. Conductivity Min. Limit</li> <li>3. Temperature Max. Limit</li> <li>4. Temperature Min. Limit</li> </ul>	<b>10. Conductivity Methods in Memory ..... Page 42</b>
	<ul style="list-style-type: none"> <li>1. Save Current Settings as a Method</li> <li>2. Load a Stored Method from Memory</li> </ul>



## 10.2 Description of the Conductivity menu

- To call up the Conductivity menu, first select the individual measurement display for the conductivity reading.
- Press **Mode** and select the conductivity mode in the menu which appears with **Cond.**
- Call up the Conductivity menu with **Menu**.

### 1. Set Conductivity Measurement Parameters

#### 1.1. Select Reference Temperature

You can select between the reference temperatures 20 °C and 25 °C. The conductivity of the sample is referenced to the selected temperature during reading.

#### 1.2. Select Temp. Correction Method/USP

##### 1. Linear Correction

The conductivity of a solution increases when the temperature increases. With most solutions, a linear interrelationship between conductivity and temperature is given. In such cases, select the linear correction method.

The input window for the temperature-correction coefficient (0 – 10 % / °C) appears.

The measured conductivity is corrected and displayed using the following formula:

$$G_{T_{Ref}} = G_T / (1 + (\alpha(T - T_{Ref}))/100 \%)$$

whereas

$G_T$  = conductivity measured at temperature T (mS/cm)

$G_{T_{Ref}}$  = conductivity (mS/cm) displayed by the instrument, calculated back to the reference temperature  $T_{Ref}$

$\alpha$  = linear temperature correction coefficient (%/°C);  $\alpha = 0$ : no temperature correction

$T$  = measured temperature (°C)

$T_{Ref}$  = Reference temperature (20 °C or 25 °C)

##### 2. Non-Linear Correction: Natural Water

The conductivity of natural water shows strong non-linear temperature behaviour. For this reason, use the non-linear correction for natural water.

The measured conductivity is multiplied by the factor  $f_{25}$  of the measured temperature (see table in appendix) and thus referenced from the reference temperature of 25 °C:

$$G_{T25} = G_T \cdot f_{25}$$

If another reference temperature is to be referenced, e.g. 20 °C, the conductivity referenced from 25 °C is divided by 1.116 (see  $f_{25}$  for 20.0 °C)

$$G_{T20} = (G_T \cdot f_{25}) / 1.116$$

**Note:** Conductivity measurements of natural water can only be performed at temperatures ranging from 0 °C to 36 °C. Otherwise, the warning **Temp. out of nLF correction range** appears.

##### 3. USP Mode

In USP mode, the SevenMulti tests whether the measured conductivity of the water is not greater than the permissible value for "purified water" or "water for injection" at the relevant temperature according to the USP (**U**nited **S**tates **P**harmacopoeia) (see table in appendix). This is the first step of the USP test.

If the value is lower, the water fulfills the USP requirements. If the value is greater, the warning **Conductivity exceeds USP limit** appears. Then you must proceed in accordance with the second step of the USP test.

If you have more stringent requirements for "purified water" than the USP, you can use the USP factor to take these into account.

**Example:** At 15 °C, the water may not exceed a conductivity of 1 µS/cm, in order to fulfill the USP requirements in the first step. A warning appears with a USP factor of 100 % if the measured conductivity is greater than 1 µS/cm. With a USP factor of 80 %, this message appears when the measured conductivity is 0.8 µS/cm.

– Enter USP factor (10 % to 100 %).

### 1.3. Select Measurement Units

#### 1. Auto Range µS/cm or mS/cm

The screen automatically sets itself to the best measurement range. The measurement unit is adjusted depending on the measured conductivity value.

#### 2. X.XX E-X S/m

The measured value display is given in scientific notation.

## 2. Calibration Setting

### 2.1. Set Calibration Standard

#### 1. 84 µS/cm

#### 2. 1413 µS/cm

#### 3. 12.88 mS/cm

#### 4. Saturated NaCl

#### 5. Enter Cell Constant

If you know the cell constant of the conductivity sensor being used.

– Press **(Cal)**. The direction to enter the cell constant then appears.

#### 6. Enter Your Special Standard (25°C)

If you are using your own conductivity standard for calibration of the conductivity sensor, you can enter the conductivity of the calibration standard in mS/cm at 25 °C in this window.

Lowest possible special standard: 0.00005 mS/cm. This corresponds to the conductivity of natural water at 25 °C, exclusively caused by the autoprotolysis of water.

Temperature dependencies cannot be programmed for the special standard (25 °C). For this reason, the warning **Measured temp. differs from setting** occurs if the temperature deviates by more than 0.5 °C from 25 °C during calibration.

### 2.2. Set Calibration Reminder

The calibration reminder setting is made as in the pH menu, Item 1.3

### 3. Select Endpoint Formats

The endpoint setting is made as in the pH menu, Item 3.

#### Stability criterion for conductivity measurements

The measured conductivity of the sample may not deviate by more than 0.4% from the measured average conductivity of the probe of over 6 seconds.

### 4. Set MTC Temperature (manual temperature compensation)

If you are working without a temperature sensor during the conductivity measurement, enter the temperature of the sample in this menu (–5 °C to 130 °C). The SevenMulti uses this temperature to calculate the conductivity value based on the selected reference temperature.

### 5. Set Alarm Limits

In this menu, you can define the upper and lower limits for measurement data. If a limit is exceeded or undershot, a warning is output to the screen.

Parameter	Minimum	Maximum	Unit
Conductivity	0.000	1 100.000	mS/cm
Temperature	–5.0	130.0	°C

When a limit has been entered, you can activate or deactivate the alarm for this limit.

### 6. Timed Interval Readings

The timed interval readings setting is made exactly as in the pH menu, Item 6.

### 7. GLP Operating Mode

The GLP mode setting is made exactly as in the pH menu, Item 7.

### 8. Select Data Transfer Mode

The data transfer mode setting is made exactly as in the pH menu, Item 8.

### 9. Analog Output Setting

The conductivity expansion unit has a separate analog output, where the conductivity measurement is converted into a voltage. In contrast to a common analog output on the SevenMulti, the analog signal at the conductivity expansion unit is temperature compensated.

With this menu, you can set the sensitivity of the analog output of the conductivity expansion unit for a titration unit. The output voltage depends on the measurement range.

The following values are available for the mean output voltage at the analog output:

No.	Mean value	Meas. range 18 – 180 mV	Meas. range 180 – 1800 mV
9.1.	20 µS/cm	2 – 20 µS/cm	20 – 200 µS/cm
9.2.	200 µS/cm	20 – 200 µS/cm	0.2 – 2 mS/cm
9.3.	2 mS/cm	0.2 – 2 mS/cm	2 – 20 mS/cm
9.4.	20 mS/cm	2 – 20 mS/cm	20 – 200 mS/cm
9.5.	200 mS/cm	20 – 200 mS/cm	200 – 2000 mS/cm

### 9.6. Whole Range

The following voltages are provided at the analog output in this setting:

#### Measurement rangeVoltage range

1 µS/cm – 10 µS/cm	0 – 300 mV
10 µS/cm – 100 µS/cm	300 – 600 mV
100 µS/cm – 1 mS/cm	600 – 900 mV
1 mS/cm – 10 mS/cm	900 – 1200 mV
10 mS/cm – 100 mS/cm	1200 – 1500 mV
100 mS/cm – 1S/cm	1500 – 1800 mV

## 10. Conductivity Methods in Memory

Up to 10 methods can be saved for the Conductivity expansion unit.

Conductivity methods in memory are dealt with as in the pH menu, Item 9.

### 10.3 Description of the TDS menu

TDS is the concentration of dissolved solids which pass a filter with a pore size of 0.45 micrometers. These are typically the following components: carbonate, bicarbonate, chloride, sulfate, phosphate, nitrate, calcium, magnesium, sodium, organic ions and other ions.

TDS is often viewed as the directional quantity for life in water, as a certain ion concentration is essential for organisms. If the value is too high or too low, life is impossible. TDS can also be used for the determination of drinking water quality.

TDS behaves in a linear manner and is directly proportional to the conductivity of a sample.

TDS (mg/l) is calculated by multiplying the conductivity value (mS/cm) by the TDS factor.

- To call up the TDS menu, first select the individual measurement display for the conductivity reading.
- Press **Mode** and select the TDS mode in the menu which appears with **TDS**.
- Call up the TDS menu with **Menu**.

## 1. Enter TDS Factor

The input window for the TDS factor appears.

- Enter factor (between 0.4 and 1.0) and save with **Save**.

**Additional parameters**, e.g. the endpoint setting, are accepted from conductivity mode.

## 10.4 Description of the Salinity menu

- To call up the Salinity menu, first select the individual measurement display for the conductivity reading.
- Press **Mode** and select the salinity mode in the menu which appears with **SAL**.
- Call up the Salinity menu with **Menu**.

For practical reasons, the salinity of a solution is derived from the salinity of seawater. Two methods of calculating the salinity from the conductivity are supported.

### 1. Select Calculation Method for Salinity

#### 1.1. Practical Salinity Scale (UNESCO 1978)

In the official definition, the salinity  $S_{\text{psu}}$  of a sample in psu (**p**actical **s**alinity **u**nit) is calculated using the following formula for a temperature of  $T = 15\text{ °C}$  and at standard atmospheric pressure:

$$S_{\text{psu}} = 0.008 - 0.1692 K^{1/2} + 25.3851 K + 14.0941 K^{3/2} - 7.0261 K^2 + 2.7081 K^{5/2}$$

whereas

$$K = C_{\text{sample}} / C_{\text{KCl}}$$

$C_{\text{sample}}$  = conductivity of sample

$C_{\text{KCl}}$  = 42.914 mS/cm conductivity of reference KCl solution (32.4356 g KCl per 1000 g of solution)

If the conductivity is not measured at  $15\text{ °C}$ , the following applies for  $10\text{ °C} < T < 31\text{ °C}$ :

$$R_T = C_{\text{sample}}(T) / C(T)$$

$$K = R_T + 10^{-5} R_T (R_T - 1)(T - 15) [96.7 - 72.0 R_T + 37.3 R_T^2 - (0.63 + 0.21 R_T^2)(1 - 15)]$$

#### 1.2. Natural Sea Water Scale (UNESCO 1966b)

According to the older definition, the salinity  $S_{\text{ppt}}$  of a sample in ppt is calculated using the following formula for a temperature of  $T = 15\text{ °C}$  and at standard atmospheric pressure:

$$S_{\text{ppt}} = -0.08996 + 28.2929729 R + 12.80832 R^2 - 10.67869 R^3 + 5.98624 R^4 - 1.32311 R^5$$

whereas

$$R = C_{\text{sample}} / C \text{ with } T = 15\text{ °C}$$

$C_{\text{sample}}$  = conductivity of sample

$C$  = 42.914 mS/cm Conductivity of Copenhagen Seawater Standard

If the conductivity is not measured at  $15\text{ °C}$ , the following applies for  $10\text{ °C} < T < 31\text{ °C}$ :

$$R_T = C_{\text{sample}}(T) / C(T)$$

$$R = R_T + 10^{-5} R_T (R_T - 1)(T - 15) [96.7 - 72.0 R_T + 37.3 R_T^2 - (0.63 + 0.21 R_T^2)(1 - 15)]$$

**Additional parameters**, e.g. the endpoint setting, are accepted from conductivity mode.

## 11. Menus of the Ion expansion unit

In addition to the ion mode, the Ion expansion unit also allows you to measure pH, mV and rel. mV. Descriptions of the pH, mV and rel. mV menus are found in Sections 9.2, 9.3 and 9.4.

### 11.1 Ion menu structure

<b>1. Set Ion Measurement Parameters ..... Page 45</b>	<b>5. Set Alarm Limits ..... Page 48</b>
<ul style="list-style-type: none"> <li>1. Define Electrode Type</li> <li>2. Calibration Setting <ul style="list-style-type: none"> <li>1. Set Calibration Standard <ul style="list-style-type: none"> <li>1. mmol / l</li> <li>2. mol / l</li> <li>3. ppm</li> <li>4. mg / l</li> <li>5. %</li> </ul> </li> <li>2. Set Calibration Reminder</li> </ul> </li> <li>3. Set Incremental Measurement Parameters <ul style="list-style-type: none"> <li>1. Known Addition</li> <li>2. Known Subtraction</li> <li>3. Sample Addition</li> <li>4. Sample Subtraction</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>1. Temperature Max. Limit</li> <li>2. Temperature Min. Limit</li> <li>3. Calibration Slope Max. Limit</li> <li>4. Calibration Slope Min. Limit</li> </ul>
<b>2. Use an Incremental Measurement Method ..... Page 48</b>	<b>6. Timed Interval Readings ..... Page 49</b>
<ul style="list-style-type: none"> <li>1. Known Addition</li> <li>2. Known Subtraction</li> <li>3. Sample Addition</li> <li>4. Sample Subtraction</li> </ul>	<ul style="list-style-type: none"> <li>1. Off</li> <li>2. On <ul style="list-style-type: none"> <li>1. Log to Memory</li> <li>2. Log to Interface</li> <li>3. Log to Memory and Interface</li> </ul> </li> </ul>
<b>3. Select Endpoint Formats ..... Page 48</b>	<b>7. GLP Operating Mode ..... Page 49</b>
<ul style="list-style-type: none"> <li>1. Auto</li> <li>2. Manual</li> <li>3. Timed</li> </ul>	<ul style="list-style-type: none"> <li>1. Off</li> <li>2. On</li> </ul>
<b>4. Set MTC Temperature ..... Page 48</b>	<b>8. Select Data Transfer Mode ..... Page 49</b>
	<ul style="list-style-type: none"> <li>1. Automatic Data Transfer <ul style="list-style-type: none"> <li>1. Log to Memory</li> <li>2. Log to Interface</li> <li>3. Log to Memory and Interface</li> </ul> </li> <li>2. Manual Data Transfer to Memory</li> </ul>
	<b>9. Ion Methods in Memory ..... Page 49</b>
	<ul style="list-style-type: none"> <li>1. Save Current Settings as a Method</li> <li>2. Load a Stored Ion Method from Memory</li> </ul>

### 11.2 Description of the Ion menu

- To call up the Ion menu, first select the individual measurement display for the Ion reading.
- Press **Mode** and select the ion mode in the menu which appears with **Ion**.
- Call up the Ion menu with **Menu**.

## 1. Set Ion Measurement Parameters

### 1.1. Define Electrode Type

A table with possible electrode types appears:

blank	CN <sup>-</sup>	Na <sup>+</sup>	SCN <sup>-</sup>
Ag <sup>+</sup>	CO <sub>2</sub>	NH <sub>3</sub>	WH <sup>2+</sup>
BF <sub>4</sub> <sup>-</sup>	CO <sub>3</sub> <sup>2-</sup>	NH <sub>4</sub> <sup>+</sup>	Ion <sup>+</sup>
Br <sup>-</sup>	Cu <sup>2+</sup>	NO <sub>2</sub> <sup>-</sup>	Ion <sup>2+</sup>
Ca <sup>2+</sup>	F <sup>-</sup>	NO <sub>3</sub> <sup>-</sup>	Ion <sup>-</sup>
Cd <sup>2+</sup>	H <sup>+</sup>	NO <sub>x</sub>	Ion <sup>2-</sup>
Cl <sup>-</sup>	I <sup>-</sup>	Pb <sup>2+</sup>	—
ClO <sub>4</sub> <sup>-</sup>	K <sup>+</sup>	S <sup>2-</sup>	—

- To select the corresponding electrode type, move the cursor with the **←** and **→** keys column by column through the table.

When you select a new electrode type, the previous calibration data are replaced by the theoretical values for this electrode type.

### 1.2. Calibration Setting

#### 1. Set Calibration Standard

- Select a unit in which you specify the concentrations of the calibration standard:  
A table with the parameters of the programmed set of calibration standards appears.
- To use the programmed parameters for the calibration, press the **Save** key.
- If you want to change the parameters of the current set or create a new parameter set, press the **Edit** key.  
An input window appears, into which you enter the temperature.
- Pressing **Next** brings you to the input window for the parameters of the first calibration standard.
- Enter concentration with the number keys.
- Pressing **Next** confirms the entry and brings you to the input window for the second calibration standard.
- Repeat this step for all calibration standards of the set.
- When the last concentration has been entered, confirm with **End**.  
A table with the parameters of the current set of calibration standards appears.
- If you would like to use these parameters, confirm with **Save**.
- If you would like to change parameters, pressing **Edit** will bring you to the first input window again.
- Press **Next** repeatedly until you reach the input window of the parameter to be changed.

**Important:** When a value has been changed, press **Next** repeatedly until the input window for the last parameter of the set appears and only then confirm with **End**. If the procedure was previously completed with **End**, the parameters of the following buffer solutions are deleted.

**Note:** In the ion mode, calibration is always performed with the segment method. See pH menu, item 1.2.1.

## 2. Set Calibration Reminder

The calibration reminder setting is made as in the pH menu, Item 1.3.

### 1.3 Set Incremental Measurement Parameters

Incremental readings are especially ideal when individual analyses are to be carried out, as only one solution and two potential measurements are necessary. Calibration need only be performed before the first reading with the sensor, as the slope conductance of the sensor generally remains the same for several months.

#### 1. Known Addition

For the known addition, the potential of a sample with a known volume is measured. After a small, known volume (increment) of a standard with a known concentration is added, the potential is measured again and the concentration of the sample is calculated using the following formula:

$$C_S = (C_{STD} \cdot V_{STD}) / ((V_S + V_{STD}) \cdot 10^{\Delta E/S} - V_S)$$

whereas

$C_S$  = desired concentration of sample in the selected unit U, e.g. ppm

$C_{STD}$  = known concentration of the standard (U)

$V_{STD}$  = known volume of the standard (ml)

$V_S$  = known volume of the sample (ml)

$\Delta E$  = change of the mV signal after addition of the standard increment (mV)

$S$  = slope conductance of the sensor being used (mV/pX), saved in the instrument

A table with the current values for the following parameters appears:

<b>V (sample)</b>	volume of the sample in ml
<b>V (stand)</b>	volume of calibration standard in ml
<b>C (stand)</b>	concentration of the ion to be determined in the calibration standard (unit selected as usual)

- If you would like to use the current parameters for the reading, confirm with the **Save** key.
- If you would like to change the parameters, press **Edit**.

An input window appears, into which you enter the volume of the sample.

Pressing **Next** brings you to the input window for the volume of the calibration standard.

Pressing **Next** confirms the entry and brings you to the input window for the concentration of the calibration standard.

- When the concentration has been entered, confirm with **Next**. A table with the new parameters appears.
- If you would like to use these parameters, confirm with **Save**.
- If you would like to change parameters, pressing **Edit** will bring you to the first input window again.
- Press **Next** repeatedly until you reach the input window of the parameter to be changed.

**Important:** Press **Next** repeatedly after changing the value until the parameter table reappears and then confirm with **Save**.



## 2. Known Subtraction

For the known subtraction, the potential of a sample with a known volume is measured. A small, known volume (increment) of a standard solution of a substance different from the measured ion, and which forms a precipitate with low solubility with the measured ion, is then added. This leads to a measurable decrease in the measured ion concentration. The potential is measured again and the concentration of the sample calculated using the following formula:

$$C_S = (C_{STD} \cdot V_{STD}) / (V_S - ((V_S + V_{STD}) \cdot 10^{\Delta E/S}))$$

Legends and setting options as with 1. Known Addition (see above).

## 3. Sample Addition

With the sample addition, the potential of a highly-thinned solution with a known volume and concentration is measured. A small, known volume (increment) of a sample is added, and the potential is measured again. The concentration of the sample is calculated using the following formula:

$$C_{S1} = C_{STD1} \cdot (((V_{S1} + V_{STD1})/V_{S1}) \cdot 10^{\Delta E1/S}) - (V_{STD1}/V_{S1})$$

whereas

$C_{S1}$  = desired concentration of the sample, determined via sample addition

$C_{STD1}$  = known concentration of the solution before addition of the first sample increment

$V_{STD1}$  = known volume of the solution before addition of the first sample increment

$V_{S1}$  = known volume of the sample before addition of the first sample increment

$\Delta E1$  = change of the mV signal after addition of the first sample increment

Up to 4 sample increments of the same volume can be added for one reading. This yields 4 results, which should theoretically be the same. When calculating the desired concentration of the sample after the second sample addition, the same formula as above is used, but with the following solution concentration and volume:

$$C_{STD2} = (C_{STD1} \cdot V_{STD1} + C_{S1} \cdot V_{S1}) / (V_{STD1} + V_{S1})$$

$$V_{STD2} = V_{STD1} + V_{S1}$$

$\Delta E2$  = change of the mV signal after addition of the second sample increment.

The third and fourth sample additions are performed accordingly.

A table with the current values for the following parameters appears:

**C (stand)** concentration of the ion to be determined in the calibration standard (unit selected as usual)

**V (stand)** volume of calibration standard in ml

**Vs1** volume of the first sample increment or the first thinning in ml

**Vs2** volume of the second sample increment or the second thinning in ml

**Vs3** volume of the third sample increment or the third thinning in ml

**Vs4** volume of the fourth sample increment or the fourth thinning in ml

Parameter entry occurs as described under 2.1.

#### 4. Sample Subtraction

With the sample subtraction, the potential of a highly-thinned solution with a known volume and concentration is measured. A small, known volume (increment) of a standard solution of a substance different from the measured ion, and which forms a precipitate with low solubility with the measured ion, is then added. The electrode responds to the standard, but not to the sample to be determined. The potential is measured again and the concentration of the sample calculated using the following formula:


$$C_{S1} = C_{STD1} \cdot (V_{STD1}/V_{S1} - ((V_{S1} + V_{STD1})/V_{S1}) \cdot 10^{\Delta E1/S})$$

Legend and setting options the same as with 3. Sample Addition, see above.

## 2. Use an Incremental Measurement Method

In this menu, you select an incremental measurement method and start the measurement procedure. Instructions on the screen guide you through the measurement procedure.

- When the measurement method is selected, you are directed to submerge the electrode into the first solution. Start the reading with **Meas.** The measurement display appears until the first reading is complete.
- You are then directed to submerge the electrode into the second solution and to start reading again with **Meas.** This procedure is repeated until all of the solutions designated by the measurement method have been read.
- The measurement results are displayed at the end of the procedure and can be printed or transferred to a computer.
- You can restart the measurement procedure with **Next.**

**Note:** With the incremental measurement method, the format of the endpoint cannot be selected. The measured value is always recorded automatically. The reading cannot be ended with  manually either.

## 3. Select Endpoint Formats

The endpoint setting is made as in the pH menu, Item 3.

### Stability criterion for ion measurement

The signal of the sensor input may not change by more than 0.03 mV within 6 seconds.

## 4. Set MTC Temperature (manual temperature compensation)

The MTC temperature setting is made as in the pH menu, Item 4.

## 5. Set Alarm Limits

In this menu, you can define the upper and lower limits for measurement or calibration data. If a limit is exceeded or undershot, a warning is output to the screen.

Parameter	Minimum	Maximum	Unit
Temperature	–5.0	130.0	°C
Calibration slope	–100.0	100.0	%

When a limit has been entered, you can activate or deactivate the alarm for this limit.

## **6. Timed Interval Readings**

The timed interval readings setting is made as in the pH menu, Item 6.

## **7. GLP Operating Mode**

The GLP mode setting is made as in the pH menu, Item 7.

## **8. Select Data Transfer Mode**

The data transfer mode setting is made as in the pH menu, Item 8.

## **9. Ion Methods in Memory**

Up to 10 methods can be saved in the Ion expansion unit.

Ion methods in memory are dealt with as in the pH menu, Item 9.

## 12. Menu of the ISFET expansion unit

### 12.1 ISFET menu structure

<b>1. Calibration Setting ..... Page 50</b>	<b>4. Timed Interval Readings ..... Page 51</b>
1. Select a Standard Buffer Group	1. Off
2. Set Calibration Reminder	2. On
<b>2. Select Endpoint Formats ..... Page 51</b>	1. Log to Memory
1. Auto	2. Log to Interface
2. Manual	3. Log to Memory and Interface
3. Timed	<b>5. GLP Operating Mode ..... Page 51</b>
<b>3. Set Alarm Limits ..... Page 51</b>	1. Off
1. pH Max. Limit	2. On
2. pH Min. Limit	<b>6. Select Data Transfer Mode ..... Page 51</b>
3. Temperature Max. Limit	1. Automatic Data Transfer
4. Temperature Min. Limit	1. Log to Memory
	2. Log to Interface
	3. Log to Memory and Interface
	2. Manual Data Transfer to Memory

### 12.2 Description of the ISFET menu

– To call up the ISFET menu, first select the individual measurement display for the ISFET reading and press **Menu**.

#### 1. Calibration Setting

##### 1.1. Select a Standard Buffer Group

– Select predefined parameters for standard calibration buffers.

No.	Buffer 1	Buffer 2	Buffer 3	Buffer 4	Buffer 5	Temp.	Designation
1.	1.68	4.00	7.00	10.01		25 °C	METTLER TOLEDO US
2.	2.00	4.01	7.00	9.21	11.00	25 °C	METTLER TOLEDO Europa
3.	2.00	4.00	7.00	9.00	12.00	20 °C	Merck
4.	1.680	4.008	6.865	9.184	12.454	25 °C	DIN
5.	1.09	4.65	6.79	9.23	12.75	25 °C	

**Note:** In the ISFET mode, calibration is always performed with the segment method. See pH menu, item 1.2.1.

## 1.2. Set Calibration Reminder

The calibration reminder setting is made as in the pH menu, Item 1.3.

## 2. Select Endpoint Formats

The endpoint setting is made as in the pH menu, Item 3.

### Stability criterion for ISFET measurement

The signal of the sensor input may not change by more than 0.1 mV within 6 seconds.

## 3. Set Alarm Limits

In this menu, you can define the upper and lower limits for measurement data. If a limit is exceeded or undershot, a warning is output to the screen.

Parameter	Minimum	Maximum	Unit
pH value	0.00	14.00	pH
Temperature	-30.0	130.0	°C

When a limit has been entered, you can activate or deactivate the alarm for this limit.

## 4. Timed Interval Readings

The timed interval readings setting is made as in the pH menu, Item 6.

## 5. GLP Operating Mode

The GLP mode setting is made as in the pH menu, Item 7.

## 6. Select Data Transfer Mode

The data transfer mode setting is made as in the pH menu, Item 8.

## 13. Appendix

### 13.1 Technical data

#### 13.1.1 Technical data of the SevenMulti

<b>Screen</b>	LCD
<b>Outputs</b>	<ul style="list-style-type: none"> <li>• RS232 serial Adjustable baud rate (1200, 2400, 4800, 9600 baud), 8 data bits, 1 stop bit, no parity</li> <li>• Analog output (with pH and Ion expansion unit only) Output impedance <math>\leq 10\text{ k}\Omega</math></li> </ul>
<b>Ambient conditions</b>	Room temperature 5 °C to 40 °C Relative humidity 80 % at 31 °C, decreasing linearly to 50 % at 40 °C Height above sea level max. 2000m Overvoltage category II Degree of contamination 2
<b>Dimensions</b>	190 x 240 x 65 mm
<b>Weight</b>	Basic device 850 g 1 expansion unit 135 g
<b>Power supply</b>	The SevenMulti is equipped with a power supply adapter suitable for your area: USA 120 V / 60 Hz, 10 VA, 9 V DC Europe 230 V / 50 Hz, 10 VA, 9 V DC UK 240 V / 50 Hz, 10 VA, 9 V DC Japan 110 V / 50 Hz, 10 VA, 9 V DC Australia 240 V / 50 Hz, 10 VA, 9 V DC China 220 V / 50 Hz, 10 VA, 9 V DC
<b>Materials</b>	Housing ABS, reinforced with PC Expansion units ABS, reinforced with PC Electrode arm ABS, reinforced with PC Keypad foil Polyester

#### 13.1.2 Technical data of pH expansion unit

	<b>pH</b>	<b>mV</b>	<b>Temperature</b>
<b>Measurement range</b>	–2.000 to 20.000	–1999.9 to 1999.9	– 5 °C to 130 °C
<b>Resolution</b>	0.001/0.01/(0.1)	0.1	0.1
<b>Precision</b>	+/-0.001	+/- 0.1	+/- 0.1
<b>Relative mV</b>	–	yes	–
<b>Temperature compensation</b>	ATC: –5 °C to 130 °C MTC: –30 °C to 130 °C		
<b>Sensor input</b>	Input impedance $\geq 3 \times 10^{12}\ \Omega$ Input offset current $\leq 1 \times 10^{-12}\text{ A}$		

### 13.1.3 Technical data of Conductivity expansion unit

<b>Measurement range</b>	<b>Conductivity</b>	0.01 $\mu\text{S}/\text{cm}$ to 1000 $\text{mS}/\text{cm}$ 1.00E-6 to 1.00E+2 $\text{S}/\text{m}$
	<b>TDS</b>	0.1 $\text{mg}/\text{L}$ to 1000 $\text{g}/\text{L}$ Factor: 0.40 to 1.00
	<b>Salinity</b>	0.00 to 80.00 ppt
	<b>Resistivity</b>	0.00 to 20.00 $\text{M}\Omega\cdot\text{cm}$
	<b>Temperature</b>	-5 $^{\circ}\text{C}$ to 130 $^{\circ}\text{C}$
<b>Temperature compensation</b> ATC: -5 $^{\circ}\text{C}$ to 130 $^{\circ}\text{C}$ MTC: -30 $^{\circ}\text{C}$ to 130 $^{\circ}\text{C}$		
<b>Resolution</b>	Auto range	
<b>Relative precision</b>	+/- 0.5 %	
<b>Analog output</b>	Output impedance $\leq 20 \text{ k}\Omega$	

### 13.1.4 Technical data of Ion expansion unit

<b>Ion mode</b>	
<b>Measurement range</b>	1.00E-9 to 9.99E+9 $\text{mmol}/\text{l}$ , $\text{mol}/\text{l}$ , $\text{mg}/\text{l}$
	0.001 to 9999 ppm
	0.001 % to 999.9 %
<b>Resolution</b>	+/- 1 of the least relevant place
<b>Relative precision</b>	+/- 0.5 %
<b>Temperature compensation</b> ATC: -5 $^{\circ}\text{C}$ to 130 $^{\circ}\text{C}$ MTC: -30 $^{\circ}\text{C}$ to 130 $^{\circ}\text{C}$	
<b>Sensor input</b>	Input impedance $\geq 3 \times 10^{12} \Omega$
	Input offset current $\leq 1 \times 10^{-12} \text{ A}$

<b>Other modes</b>	<b>pH</b>	<b>mV</b>	<b>Temperature</b>
<b>Measurement range</b>	-2.000 to 20.000	-1999.9 to 1999.9	-30 $^{\circ}\text{C}$ to 130 $^{\circ}\text{C}$
<b>Resolution</b>	0.001/0.01/0.1	0.1	0.1
<b>Precision</b>	+/- 0.001	+/- 0.1	+/- 0.1
<b>Relative mV</b>	—	yes	—

### 13.1.5 Technical data of ISFET expansion unit

<b>Measurement range pH</b>	0.00 to 14.00
<b>Meas. range temperature</b>	-5 $^{\circ}\text{C}$ to 105 $^{\circ}\text{C}$
<b>Resolution</b>	0.01
<b>Precision</b>	+/-0.01

## 13.2 Accessories

	Order No.
pH expansion unit	51302821
Conductivity expansion unit	51302822
Ion expansion unit	51302823
ISFET expansion unit	51302824
TTL communication module	51302825
USB communication module	51302826
Power supply EU	51302870
Power supply US	51302871
Power supply UK	51302872
SevenMulti protective cover	51302819
Electrode arm, complete	51302820
Rondolino sample changer, complete	51108500
Bar stirrer, incl. 2 propeller stirrers	51107019
Seven/Rondolino Stirrer Driver	51302827
Disposable cups for Rondolino (1400 pieces)	00001974
Guide to pH measurement	51300047
Guide to conductivity and dissolved oxygen	51724716
Guide to ion selective measurement	51300075
pH 4.01 buffer, 30 packets at 20 mL each	51302069
pH 4.01 buffer, 6 bottles at 250 mL each	51340058
pH 7.00 buffer, 30 packets at 20 mL each	51302047
pH 7.00 buffer, 6 bottles at 250 mL each	51340060
pH 9.21 buffer, 30 packets at 20 mL each	51302070
pH 9.21 buffer, 6 bottles at 250 mL each	51300194
pH 10.01 buffer, 30 packets at 20 mL each	51302079
pH 10.01 buffer, 6 bottles at 250 mL each	51340231
InLab®410, pH electrode; temperature sensor; refillable	52000118
InLab®412, laboratory pH electrode; glass; refillable	52000112
InLab®413, robust pH electrode; PEEK shaft; ATC	52000100
InLab®420, pH electrode with PTFE polished diaphragm	52000113
InLab®730, laboratory conductivity electrode	51302119
InLab®490, laboratory ISFET electrode	51302305
HCl/pepsin solution (removes protein contamination)	51340068
Thiourea solution (removes silver sulfide contamination)	51340070
Reactivation solution for pH electrodes	51340073



### 13.3 Buffer groups

#### Buffer group 1 (ref. 25 °C)

5	1.67	4.00	7.09	10.25
10	1.67	4.00	7.06	10.18
15	1.67	4.00	7.04	10.12
20	1.68	4.00	7.02	10.06
<b>25</b>	<b>1.68</b>	<b>4.00</b>	<b>7.00</b>	<b>10.01</b>
30	1.68	4.01	6.99	9.97
35	1.69	4.02	6.98	9.93
40	1.69	4.03	6.97	9.89
45	1.70	4.04	6.97	9.86
50	1.71	4.06	6.97	9.83

#### Buffer group 4 (ref. 20 °C)

5	2.01	4.04	7.07	9.16	12.41
10	2.01	4.02	7.05	9.11	12.26
15	2.00	4.01	7.02	9.05	12.10
<b>20</b>	<b>2.00</b>	<b>4.00</b>	<b>7.00</b>	<b>9.00</b>	<b>12.00</b>
25	2.00	4.01	6.98	8.95	11.88
30	2.00	4.01	6.98	8.91	11.72
35	2.00	4.01	6.96	8.88	11.67
40	2.00	4.01	6.95	8.85	11.54
45	2.00	4.01	6.95	8.82	11.44
50	2.00	4.00	6.95	8.79	11.33

#### Buffer group 2 (ref. 25 °C)

5	2.02	4.01	7.09	9.45	11.72
10	2.01	4.00	7.06	9.38	11.54
15	2.00	4.00	7.04	9.32	11.35
20	2.00	4.00	7.02	9.26	11.18
<b>25</b>	<b>2.00</b>	<b>4.01</b>	<b>7.00</b>	<b>9.21</b>	<b>11.00</b>
30	1.99	4.01	6.99	9.16	10.82
35	1.99	4.02	6.98	9.11	10.64
40	1.98	4.03	6.97	9.06	10.46
45	1.98	4.04	6.97	9.03	10.28
50	1.98	4.06	6.97	8.99	10.10

#### Buffer group 5 (ref. 25 °C)

5	1.08	4.67	6.87	9.43	13.63
10	1.09	4.66	6.84	9.37	13.37
15	1.09	4.66	6.82	9.32	13.16
20	1.09	4.65	6.80	9.27	12.96
<b>25</b>	<b>1.09</b>	<b>4.65</b>	<b>6.79</b>	<b>9.23</b>	<b>12.75</b>
30	1.10	4.65	6.78	9.18	12.61
35	1.10	4.65	6.77	9.13	12.45
40	1.10	4.66	6.76	9.09	12.29
45	1.10	4.67	6.76	9.04	12.09
50	1.11	4.68	6.76	9.00	11.98

#### Buffer group 3 (ref. 25 °C)

5	1.668	4.004	6.950	0.392	13.207
10	1.670	4.001	6.922	9.331	13.003
15	1.672	4.001	6.900	9.277	12.810
20	1.676	4.003	6.880	9.228	12.627
<b>25</b>	<b>1.680</b>	<b>4.008</b>	<b>6.865</b>	<b>9.183</b>	<b>12.454</b>
30	1.685	4.015	6.853	9.144	12.289
35	1.691	4.026	6.845	9.110	12.133

### 13.4 Conductivity standards

T (°C)	84 µS/cm	1413 µS/cm	12.88 mS/cm	Saturated NaCl mS/cm
0	0.046	0.776	7.15	134.5
5	0.053	0.896	8.22	155.5
10	0.060	1.020	9.33	177.9
15	0.068	1.147	10.48	201.5
20	0.076	1.278	11.67	226.0
<b>25</b>	<b>0.084</b>	<b>1.413</b>	<b>12.88</b>	<b>251.3</b>
30	0.093	1.552	14.12	277.4
35	0.102	1.696	15.39	304.1

### 13.5 Temperature-correction factors $f_{25}$

°C	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
0	1.918	1.912	1.906	1.899	1.893	1.887	1.881	1.875	1.869	1.863
1	1.857	1.851	1.845	1.840	1.834	1.829	1.822	1.817	1.811	1.805
2	1.800	1.794	1.788	1.783	1.777	1.772	1.766	1.761	1.756	1.750
3	1.745	1.740	1.734	1.729	1.724	1.719	1.713	1.708	1.703	1.698
4	1.693	1.688	1.683	1.678	1.673	1.668	1.663	1.658	1.653	1.648
5	1.643	1.638	1.634	1.629	1.624	1.619	1.615	1.610	1.605	1.601
6	1.596	1.591	1.587	1.582	1.578	1.573	1.569	1.564	1.560	1.555
7	1.551	1.547	1.542	1.538	1.534	1.529	1.525	1.521	1.516	1.512
8	1.508	1.504	1.500	1.496	1.491	1.487	1.483	1.479	1.475	1.471
9	1.467	1.463	1.459	1.455	1.451	1.447	1.443	1.439	1.436	1.432
10	1.428	1.424	1.420	1.416	1.413	1.409	1.405	1.401	1.398	1.384
11	1.390	1.387	1.383	1.379	1.376	1.372	1.369	1.365	1.362	1.358
12	1.354	1.351	1.347	1.344	1.341	1.337	1.334	1.330	1.327	1.323
13	1.320	1.317	1.313	1.310	1.307	1.303	1.300	1.297	1.294	1.290
14	1.287	1.284	1.281	1.278	1.274	1.271	1.268	1.265	1.262	1.259
15	1.256	1.253	1.249	1.246	1.243	1.240	1.237	1.234	1.231	1.228
16	1.225	1.222	1.219	1.216	1.214	1.211	1.208	1.205	1.202	1.199
17	1.196	1.193	1.191	1.188	1.185	1.182	1.179	1.177	1.174	1.171
18	1.168	1.166	1.163	1.160	1.157	1.155	1.152	1.149	1.147	1.144
19	1.141	1.139	1.136	1.134	1.131	1.128	1.126	1.123	1.121	1.118
20	1.116	1.113	1.111	1.108	1.105	1.103	1.101	1.098	1.096	1.093
21	1.091	1.088	1.086	1.083	1.081	1.079	1.076	1.074	1.071	1.069
22	1.067	1.064	1.062	1.060	1.057	1.055	1.053	1.051	1.048	1.046
23	1.044	1.041	1.039	1.037	1.035	1.032	1.030	1.028	1.026	1.024
24	1.021	1.019	1.017	1.015	1.013	1.011	1.008	1.006	1.004	1.002
25	1.000	0.998	0.996	0.994	0.992	0.990	0.987	0.985	0.983	0.981
26	0.979	0.977	0.975	0.973	0.971	0.969	0.967	0.965	0.963	0.961
27	0.959	0.957	0.955	0.953	0.952	0.950	0.948	0.946	0.944	0.942
28	0.940	0.938	0.936	0.934	0.933	0.931	0.929	0.927	0.925	0.923
29	0.921	0.920	0.918	0.916	0.914	0.912	0.911	0.909	0.907	0.905
30	0.903	0.902	0.900	0.898	0.896	0.895	0.893	0.891	0.889	0.888
31	0.886	0.884	0.883	0.881	0.879	0.877	0.876	0.874	0.872	0.871
32	0.869	0.867	0.866	0.864	0.863	0.861	0.859	0.858	0.856	0.854
33	0.853	0.851	0.850	0.848	0.846	0.845	0.843	0.842	0.840	0.839
34	0.837	0.835	0.834	0.832	0.831	0.829	0.828	0.826	0.825	0.823
35	0.822	0.820	0.819	0.817	0.816	0.814	0.813	0.811	0.810	0.808

### 13.6 USP table

Temp (°C)	Conductivity requirement (μS/cm)	Temp (°C)	Conductivity requirement (μS/cm)
0	0.6	55	2.1
5	0.8	60	2.2
10	0.9	65	2.4
15	1.0	70	2.5
20	1.1	75	2.7
25	1.3	80	2.7
30	1.4	85	2.7
35	1.5	90	2.7
40	1.7	95	2.9
45	1.8	100	3.1
50	1.9		

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