848 Titrino plus

Manual

8.848.8008EN / 2019-11-27

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This documentation has been prepared with great care. However, errors can never be entirely ruled out. Please send comments regarding possible errors to the address above.

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1 Introduction

1.1 Instrument description

The 848 Titrino plus is a titrator for volumetric titrations for universal applications. Methods can be created and saved under a new name. The methods can be exported to a connected USB flash drive. This function allows you to copy methods quickly and easily from one device to another. The remote connector makes it possible to integrate the device into a Metrohm automation system.

1.1.1 Titration and measuring modes

The following titration and measuring modes are supported:

- **DET**
  Dynamic equivalence point titration. The reagent is added in variable volume steps.
  Measuring modes:
  - **pH** (pH measurement)
  - **U** (potentiometric voltage measurement)
  - **Ipol** (voltametric measurement with selectable polarization current)
  - **Upol** (amperometric measurement with selectable polarization voltage)
- **MET**
  Monotonic equivalence point titration. The reagent is added in constant volume steps.
  Measuring modes:
  - **pH** (pH measurement)
  - **U** (potentiometric voltage measurement)
  - **Ipol** (voltametric measurement with selectable polarization current)
  - **Upol** (amperometric measurement with selectable polarization voltage)
- **SET**
  Endpoint titration at one or two specified endpoints.
  Measuring modes:
  - **pH** (pH measurement)
  - **U** (potentiometric voltage measurement)
  - **Ipol** (voltametric measurement with selectable polarization current)
  - **Upol** (amperometric measurement with selectable polarization voltage)

- **CAL**
  Electrode calibration.
  Measuring mode:
  - **pH** (calibration of pH electrodes)

1.1.2 Connectors

The instrument is equipped with the following connectors:

- **MSB connector (Metrohm Serial Bus)**
  For connecting a stirrer.
- **USB (OTG) connector**
  The 6.2151.100 adapter can be used to connect, for example, a printer, a USB flash drive or a USB keyboard.
- **Sensor connectors**
  Four connectors for the following sensor types:
  - pH or redox electrodes
  - Reference electrodes
  - Polarizable electrodes
  - Temperature sensors (Pt1000 or NTC)
- **Remote connector**
  For connecting a Dosimat or sample changer. The Dosimat enables automatic addition of an auxiliary solution.

1.1.3 Intended use

The 848 Titrino plus is designed for usage as a titrator in analytical laboratories. Its main application field is volumetric titration.

This instrument is suitable for processing chemicals and flammable samples. Therefore, the use of the 848 Titrino plus requires the user to have basic knowledge and experience in handling toxic and caustic substances. Knowledge with respect to the application of the fire prevention measures prescribed for laboratories is also mandatory.

1.2 About the documentation

CAUTION

Please read through this documentation carefully before putting the instrument into operation. The documentation contains information and warnings which the user must follow in order to ensure safe operation of the instrument.

1.2.1 Symbols and conventions

The following symbols and formatting may appear in this documentation:

*(5-**12**)*	**Cross-reference to figure legend** The first number refers to the figure number, the second to the instrument part in the figure.
1	**Instruction step** Carry out these steps in the sequence shown.
Method	**Dialog text**, **parameter** in the software
File ▸ New	Menu or menu item
[Next]	**Button** or **key**
	**WARNING** This symbol draws attention to a possible life-threatening hazard or risk of injury.
	**WARNING** This symbol draws attention to a possible hazard due to electrical current.
	**WARNING** This symbol draws attention to a possible hazard due to heat or hot instrument parts.
	**WARNING** This symbol draws attention to a possible biological hazard.
	**CAUTION** This symbol draws attention to possible damage to instruments or instrument parts.
	**NOTE** This symbol highlights additional information and tips.

1.3 Safety instructions

1.3.1 General notes on safety

WARNING

Operate this instrument only according to the information contained in this documentation.

This instrument left the factory in a flawless state in terms of technical safety. To maintain this state and ensure non-hazardous operation of the instrument, the following instructions must be observed carefully.

1.3.2 Electrical safety

The electrical safety when working with the instrument is ensured as part of the international standard IEC 61010.

WARNING

Only personnel qualified by Metrohm are authorized to carry out service work on electronic components.

WARNING

Never open the housing of the instrument. The instrument could be damaged by this. There is also a risk of serious injury if live components are touched.

There are no parts inside the housing which can be serviced or replaced by the user.

Supply voltage

WARNING

An incorrect supply voltage can damage the instrument.

Only operate this instrument with a supply voltage specified for it (see rear panel of the instrument).

Protection against electrostatic charges

WARNING

Electronic components are sensitive to electrostatic charges and can be destroyed by discharges.

Do not fail to pull the power cord out of the power socket before you set up or disconnect electrical plug connections at the rear of the instrument.

1.3.3 Tubing and capillary connections

CAUTION

Leaks in tubing and capillary connections are a safety risk. Tighten all connections well by hand. Avoid applying excessive force to tubing connections. Damaged tubing ends lead to leakage. Appropriate tools can be used to loosen connections.

Check the connections regularly for leakage. If the instrument is used mainly in unattended operation, then weekly inspections are mandatory.

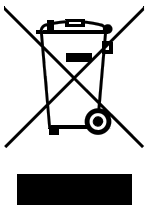
1.3.4 Flammable solvents and chemicals

WARNING

All relevant safety measures are to be observed when working with flammable solvents and chemicals.

- Set up the instrument in a well-ventilated location (e.g. fume cupboard).
- Keep all sources of flame far from the workplace.
- Clean up spilled liquids and solids immediately.
- Follow the safety instructions of the chemical manufacturer.

1.3.5 Recycling and disposal



This product is covered by European Directive 2012/19/EU, WEEE – Waste Electrical and Electronic Equipment.

The correct disposal of your old instrument will help to prevent negative effects on the environment and public health.

More details about the disposal of your old instrument can be obtained from your local authorities, from waste disposal companies or from your local dealer.

2 Overview of the instrument

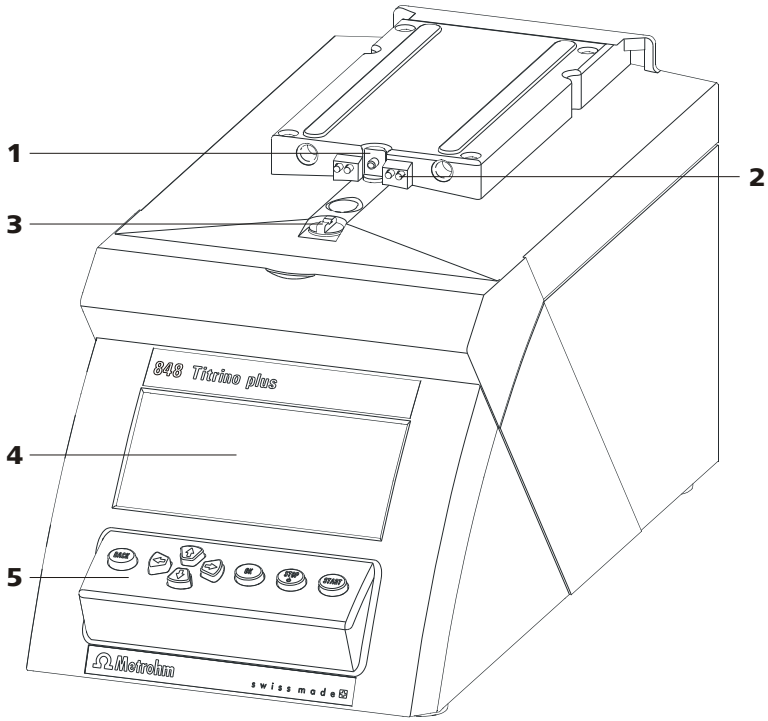


Figure 1 Front 848 Titrino plus

1 **Piston rod** Of the dosing drive.	**2** **Contact pins** For the data chip.
3 **Coupling** For switching the flat stopcock.	**4** **Display**
5 **Keypad**	

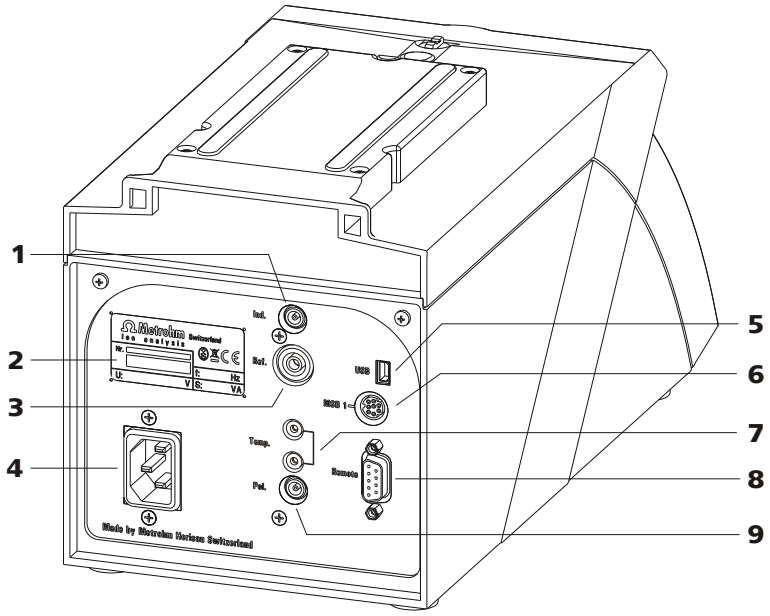


Figure 2 Rear 848 Titrino plus

1 Electrode connector (Ind.)
For connecting pH or redox electrodes with integrated or separate reference electrode. Socket F.

2 Type plate
Contains specifications concerning mains voltage and serial number.

3 Electrode connector (Ref.)
For connecting reference electrodes. Socket B, 4 mm.

4 Mains connection socket

5 USB (OTG) connector
For connecting printers, USB sticks, USB hubs, etc.

6 MSB connector
Metrohm Serial Bus.
For connecting a stirrer. Mini DIN, 9-pin.

7 Temperature sensor connector (Temp.)
For connecting temperature sensors of the Pt1000 or NTC types. Two B sockets, 2 mm.

8 Remote connector
For connecting instruments with a remote interface. D-Sub, 9-pin.

9 Electrode connector (Pol.)
For connecting polarizable electrodes, e.g. double Pt electrodes. Socket F.

3 Installation

3.1 Setting up the instrument

3.1.1 Packaging

The instrument is supplied in protective packaging together with the separately packed accessories. Keep this packaging, as only this ensures safe transportation of the instrument.

3.1.2 Checks

Immediately after receipt, check whether the shipment has arrived complete and without damage by comparing it with the delivery note.

3.1.3 Location

The instrument has been developed for operation indoors and may not be used in explosive environments.

Place the instrument in a location of the laboratory which is suitable for operation and free of vibrations and which provides protection against corrosive atmosphere and contamination by chemicals.

The instrument should be protected against excessive temperature fluctuations and direct sunlight.

3.2 Connecting a sensor

Connecting pH or redox electrodes

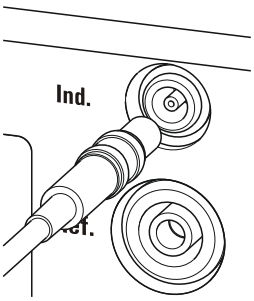


Figure 3 Connecting pH or redox electrodes

NOTICE

The electrode cable is protected against accidental disconnection of the cable by means of a pull-out protection feature. If you wish to remove the plug, then you must first retract the outer plug sleeve.

Connecting a reference electrode

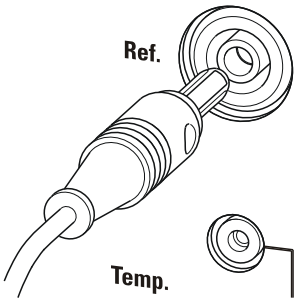


Figure 4 Connecting a reference electrode

Connecting a temperature sensor or an electrode with integrated temperature sensor

Temperature sensors of the Pt1000 or NTC type can be connected to the **Temp.** connector.

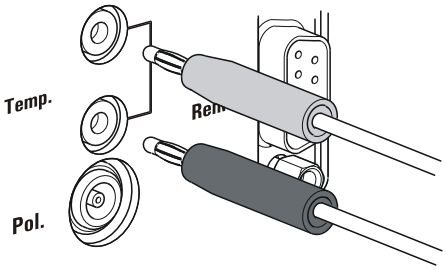


Figure 5 Connecting a temperature sensor

NOTICE

The red plug must always be plugged into the red socket at the temperature sensor for the purpose of shielding against disruptions.

If you use an electrode with an integrated NTC probe, then you must plug the red plug into the red socket.

Connecting a polarizable electrode

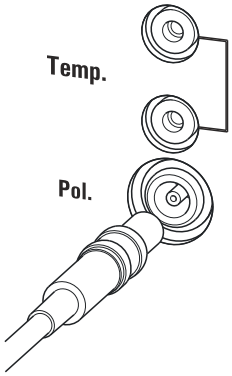


Figure 6 Connecting a polarizable electrode

NOTICE

The electrode cable is protected against accidental disconnection of the cable by means of a pull-out protection feature. If you wish to remove the plug, then you must first retract the outer plug sleeve.

3.3 Connecting a stirrer

You can connect the following stirrers:

- 801 Stirrer
- 803 Ti Stand
- 804 Ti Stand (requires rod stirrer)

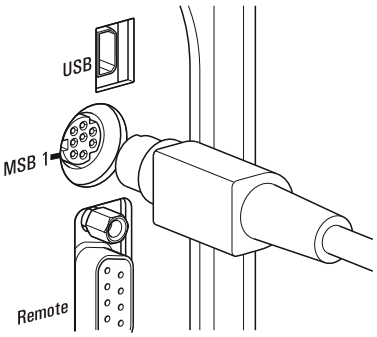


Figure 7 Connecting a stirrer

CAUTION

Make sure that the flat side of the plug matches the marking on the socket.

3.4 Connecting a balance

Balances are equipped with a serial RS-232 interface as a rule. To connect a balance, you require a 6.2148.030 RS-232/USB Box.

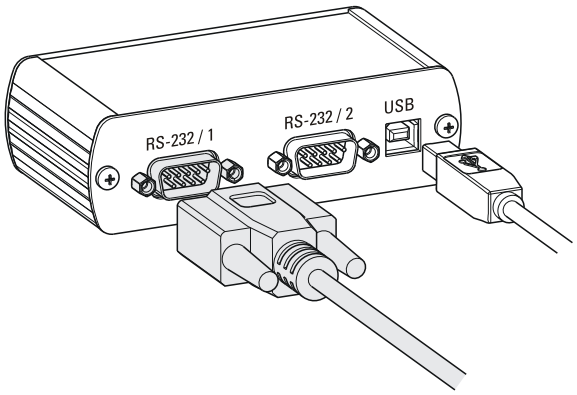


Figure 8 Connecting a balance

When a 6.2151.020 USB cable is used, then the 6.2148.030 RS-232/USB Box can be connected to the 848 Titrino plus by means of a USB hub or a 6.2151.100 adapter *(see chapter 3.5, page 12)*.

Connect the 9-pin plug of the respective balance connecting cable to the **RS 232/1** connector. Consult the user manual of the balance in order to select the correct connecting cable.

The parameters for the RS-232 interface on the instrument must match those on the balance *(see "Editing the COM1 settings", page 65)*. Additionally consult the user manual of the balance.

3.5 Connecting a keyboard, printer and other USB devices

The 848 Titrino plus has a USB (OTG) connector. Use the provided 6.2151.100 adapter USB MINI (OTG) - USB A for connecting USB devices as e.g. printers, keyboards or USB sticks, see the following figure.

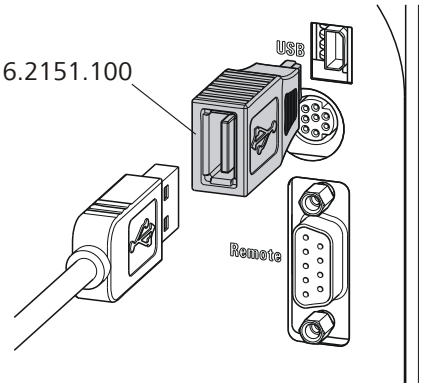


Figure 9 Connecting USB devices

CAUTION

Switch the instrument off before connecting or disconnecting a USB device or a USB stick.

The 848 Titrino plus can only recognize the device immediately after switching on.

The following devices can be operated **directly on the USB connector with the 6.2151.100 adapter**:

- USB sticks (for the backup or storing of methods)
- 6.2147.000 numerical USB keypad
- 6.2148.030 RS-232/USB Box (for connecting balances or for the RS-232 remote control)
- USB hub (with or without an own power supply)

The **6.2147.000 numerical USB keypad** serves for comfortable numerical input and for navigating in the dialog. In addition, it provides two USB connectors. Connect additional USB devices to the keypad.

NOTICE

Most of the USB devices need a so-called hub in order to work correctly.

A USB hub is a distributor to which several USB devices can be connected. USB hubs are available in specialty stores in a number of different models.

The USB (OTG) connector of the 848 Titrino plus has no such hub. The 6.2147.000 numerical USB keypad has a USB hub and two USB connectors.

The following devices can **only be connected to a 6.2147.000 numerical keypad or to a USB hub**:

- Printer (with USB connector, use the 6.2151.020 connecting cable)
- Barcode reader (with USB cable)
- Mouse (PC mouse with USB cable, for navigating in the dialog)

The following devices can **only be connected to a USB hub**:

- PC keyboard (with USB cable, for the comfortable input of letters and numbers)
- Keypad with numerical keypad (with USB cable)

If you wish to connect **several different instruments without own power supply**, then you must possibly use a USB hub with own power supply (*self powered*). The USB (OTG) connector of the 848 Titrino plus is not designed for supplying power to several devices with elevated electricity requirements.

Also observe the instructions in *chapter 9.4, page 119*.

Examples:

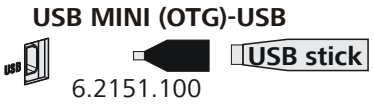


Figure 10 Connecting the USB stick

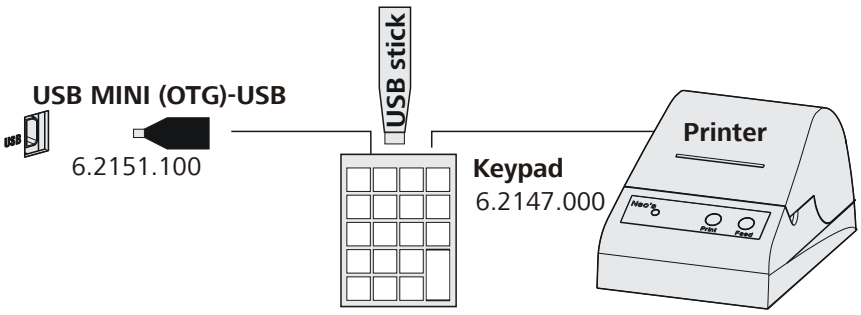


Figure 11 Connecting the 6.2147.000 USB keyboard with USB stick and printer

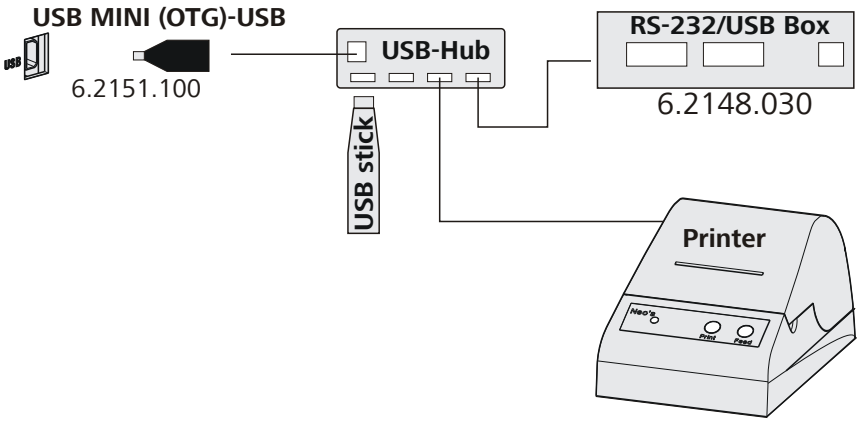


Figure 12 Connecting the USB hub with USB stick, printer and the 6.2148.030 RS-232/USB Box (for connecting balances).

3.6 Connecting instruments to the remote connector

The 848 Titrino plus can be integrated in an automation system with the aid of a remote cable.

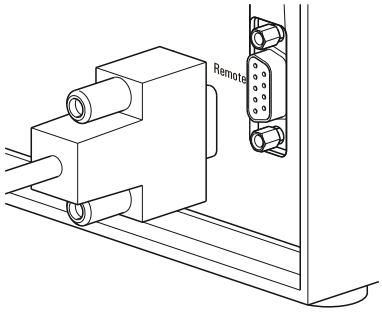


Figure 13 Connecting a remote cable

A variety of different connecting cables are available for connecting Metrohm instruments (e.g. sample changers) *(see Optional Accessories chapter)*.

3.7 Attaching the exchange unit

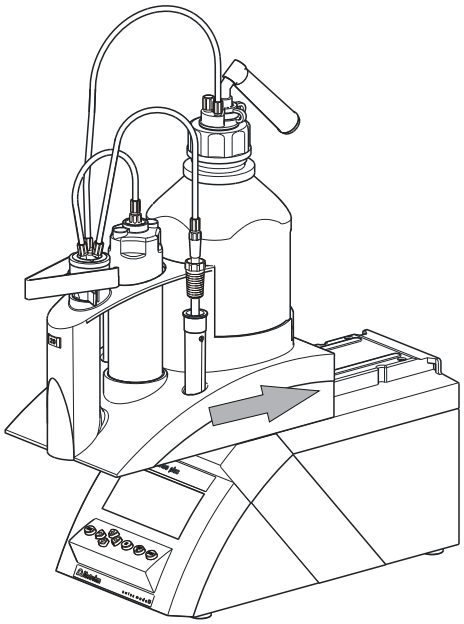


Figure 14 Attaching the exchange unit

To attach the exchange unit, proceed as follows:

1 Slide the exchange unit from the front onto the 848 Titrino plus and push all the way to the rear.

It must snap in audibly.

3.8 Connecting the instrument to the power grid

WARNING

Electric shock from electrical potential

Risk of injury by touching live components or through moisture on live parts.

- Never open the housing of the instrument while the power cord is still connected.
- Protect live parts (e.g. power supply unit, power cord, connection sockets) against moisture.
- Unplug the power plug immediately if you suspect that moisture has gotten inside the instrument.
- Only personnel who have been issued Metrohm qualifications may perform service and repair work on electrical and electronic parts.

Connecting the power cord

Accessories

Power cord with the following specifications:

- Length: max. 2 m
- Number of cores: 3, with protective conductor
- Instrument plug: IEC 60320 type C13
- Conductor cross-section 3x min. 0.75 mm^2 / 18 AWG
- Power plug:
  - according to customer requirement (6.2122.XX0)
  - min. 10 A

NOTICE

Do not use a not permitted power cord!

1 Plugging in the power cord

- Plug the power cord into the instrument's power socket.
- Connect the power cord to the power grid.

4 Titrations

4.1 Dynamic equivalence point titration (DET)

Dynamic equivalence point titration is a titration mode for all standard titrations with an s-shaped curve progression. The reagent is added in variable volume steps. The volume steps vary as a function of the slope of the curve. An attempt is made to reach constant measured value changes with each dosing. The optimal volume for dosing is determined from the measured value changes of the previous dosings. Measured value acceptance is measured value drift-controlled (equilibrium titration) or after a waiting time. Equivalence points are evaluated automatically.

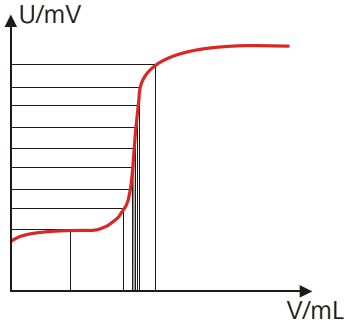


Figure 15 Reagent dosing for DET

4.2 Monotonic equivalence point titration (MET)

Monotonic equivalence point titration is a robust titration mode for titrations with any curve shape and for slow titrations or slow-response electrodes. The reagent is added in constant volume steps. Measured value acceptance is measured value drift-controlled (equilibrium titration) or after a waiting time. Equivalence points are evaluated automatically.

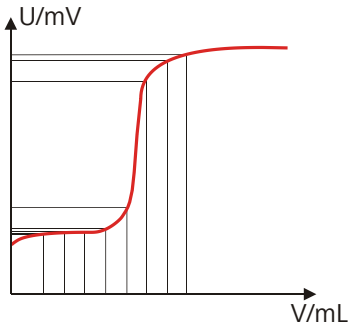


Figure 16 Reagent dosing for MET

4.3 Endpoint titration (SET)

Endpoint titration is a titration mode for rapid routine determinations to a preset endpoint (e.g. titrations in accordance with special standards) and titrations for which reagent overflow must be avoided. The titration termination at the endpoint takes place either volume drift-controlled or after a waiting time. The volume dosed until the endpoint can be used for further calculations (e.g. the content of the sample).

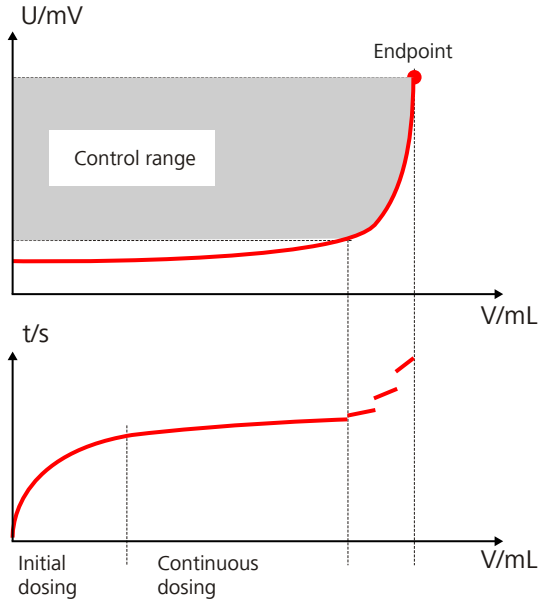


Figure 17 Reagent dosing for SET

5 Operation

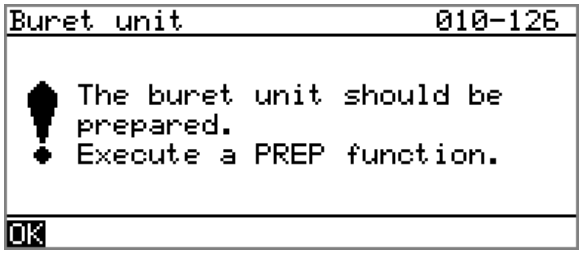
5.1 Switching the instrument on and off

Switching on the instrument

Proceed as follows:

1 ▪ Press the red **[STOP]** key.
The instrument is initialized and a system test performed. This process takes some time.

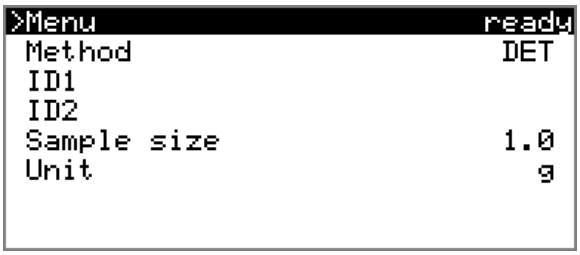
▪ If a buret unit has been attached, then a request appears to carry out the **PREP** function:



All tubings and the cylinder are rinsed with the **PREP** (Preparing) function. The preparing of the buret unit is described in chapter *"Preparing the buret unit (PREP)", page 46*.

▪ Confirm the message with **[OK]**.
The display of this message can be deactivated in the system settings *(see "PREP warning", page 55)*.

The main dialog is displayed:



Switching off the instrument

The instrument is switched off with the **[STOP]** key. The fact that the key needs to be pressed down for an extended time prevents accidental switch off.

Proceed as follows:

1 ▪ Keep the red **[STOP]** key pressed down for at least 3 s.

A progress bar is displayed. If the key is released during this time, then the instrument will not be switched off.

5.2 Fundamentals of operation

5.2.1 The keypad

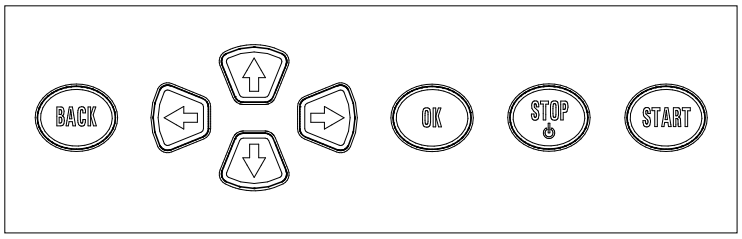
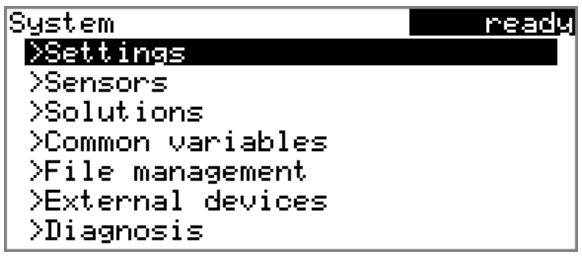


Figure 18 Keypad 848 Titrino plus

BACK	Apply the input and exit the dialog.
⇧ ⇩	Move the selection bar either up or down by one line at a time. Select the character to be entered in the text editor.
⇦ ⇨	Select the character to be entered in the text and number editor. Select the individual functions in the function bar.
OK	Confirm the selection.
STOP	Stop an ongoing method run or a manual function. Switch the instrument on or off.
START	Start a method run or a manual function.

5.2.2 Structure of the dialog windows



The current dialog title is displayed on the left-hand side of the title bar. The current status of the system is displayed in the upper right-hand corner:

ready	The instrument is in normal status.

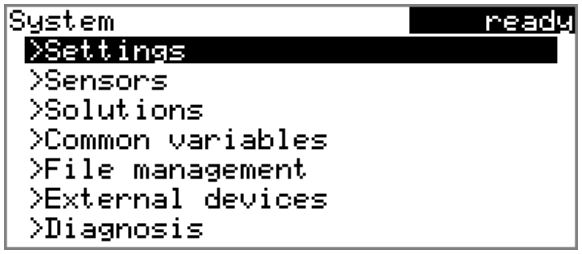
cond.busy	The working medium is being conditioned.
cond.ok	The working medium is conditioned.
busy	A method has been started.
hold	A method has been paused.

Some dialogs have a so-called function bar on the bottom line. The functions contained therein can be selected with the arrow keys **[⇦]** or **[⇨]** and executed with **[OK]**.

5.2.3 Navigating in the dialog

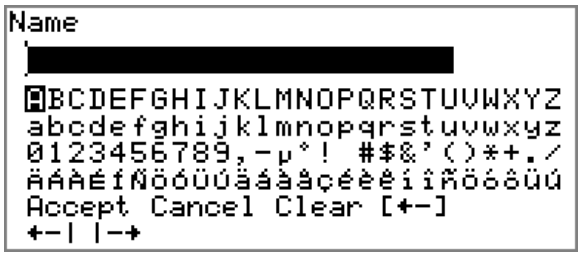
The selection bar is displayed in inverted style. Use the arrow keys **[⇧]** and **[⇩]** to move the selection bar upward or downward one line at a time. If a dialog text is marked with " **>** ", then additional settings are available in a subordinate dialog. Use **[OK]** to access this dialog.

Example: System settings



Use the **[BACK]** key to return to the next higher level.

5.2.4 Entering text and numbers



In the editing dialog for text input or numerical input, select the individual characters with the arrow keys. Use **[OK]** to apply the character in the input field. The following functions are available:

Editing function	Description
Accept	The modification is applied and the editing dialog is exited.
Cancel	The editing dialog is exited without applying the modification.
Clear	The content of the input field is deleted completely.
[←]	The character left of the cursor is deleted (backspace).
←|	Text editor only The cursor within the input field is shifted to the left by one character each time that **[OK]** is pressed.
|→	Text editor only The cursor within the input field is shifted to the right by one character each time that **[OK]** is pressed.
[BACK]	The modification is applied and the editing dialog is exited.

The **[BACK]** key has the same function as **Accept**.

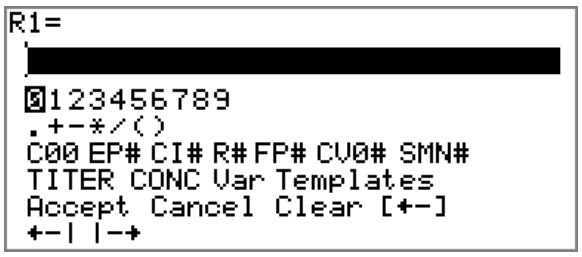
A commercially available USB keyboard can be connected to make it easier to enter text and numbers. The assignment of the keys on the PC keyboard is described in *chapter 9.4.2, page 120*.

5.2.5 Selecting from a selection list

In a selection list, select the individual entries with the arrow keys **[⇧]** and **[⇩]**. Accept the selection with **[OK]** or **[BACK]**.

5.3 Formula editor

The formulas for the calculations are entered with the formula editor. The formula editor is equipped with an automatic syntax check. This is triggered as soon as a formula is applied. The generally valid rules of priority apply for the calculation operations.



Variable	Description
C00	Sample size
EP#	Volume of endpoint EP# (# = 1…9)
CI#	Sample identification (# = 1…2)
R#	Result (# = 1…5)
FP#	Volume of fixed endpoint FP# (# = 1…9)
CV0#	Common variable (# = 1…5)
SMN#	Mean value of result R# (# = 1…5)
TITER	Titer of selected solution
CONC	Concentration of selected solution
Var	List of additional variables *(see "Variables", page 24)*
Templates	List of predefined calculation formulas *(see "Calculation templates", page 25)*

"#" stands for a sequential number that you must enter manually. Example: if you apply the variable **EP#** in the formula, only **EP** is entered. You will still need to enter the number yourself.

The meanings of the editing functions are explained in *chapter 5.2.4, page 22*.

Variables

Pressing **Var** displays a list with additional variables. You can enter these variables either directly into the formula or also by selecting them from the list and applying them with **[OK]**.

Variable	Description
MIM	Initial measured value, i.e. measured value prior to the processing of the start conditions
MSM	Start measured value, i.e. measured value after the processing of the start conditions
MCV	End volume, i.e. total dosed volume at the end of the titration
ET#	Temperature at endpoint EP# (# = 1…9)
EM#	Measured value of endpoint EP# (# = 1…9)
ED#	Time at endpoint EP# (# = 1…9)
MSV	Start volume
MEN	Electrode zero point pH(0)
MSL	Electrode slope
DD	Duration of the entire determination
MST	Start temperature
MCT	End temperature
FT#	Temperature at fixed endpoint FP# (# = 1…9)
FM#	Measured value of fixed endpoint FP# (# = 1…9)
FD#	Time at fixed endpoint FP# (# = 1…9)

For **Molw**, see the following section.

Calculation templates

Pressing **Templates** displays a list with calculation templates. You can apply these templates directly with **[OK]**.

NOTICE

Some templates contain the wildcard **Molw**, which stands for the molar mass of the sample. You must replace this wildcard with the correct value in the calculation formula.

The templates available:

Template	Description
Content %	Content in % Unit of the sample size = g

Template	Description
Content mmol/L	Content in mmol/L Unit of the sample size = mL
Content mol/L	Content in mol/L Unit of the sample size = mL
Content g/L	Content in g/L Unit of the sample size = mL
Content ppm	Content in ppm Unit of the sample size = g
Titer	Titer calculation Unit of the sample size = g
Blank mean value	Blank value as mean value of single results
Blank single value	Blank value as single value

5.4 Methods

5.4.1 Creating a new method

Proceed as follows to create a new method:

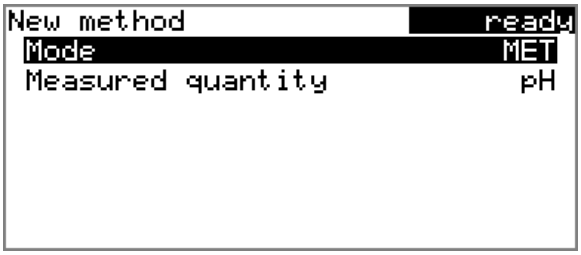
1 Open the method table

- In the main dialog, select **Method** and press **[OK]**.

The method table opens:

2 Select a titration and measuring mode

- In the function bar, select **New** and press **[OK]**.



- Select **Mode** and press **[OK]**.
- Select the desired titration mode in the selection list and apply with **[OK]**.
- Select **Measured quantity** and press **[OK]**.
- Select the desired measuring mode in the selection list and apply with **[OK]**.
- Press **[BACK]**.

The method is now loaded and is displayed in the main dialog under **Method**.

If a new method has been created, then the individual parameters can be modified under **Menu ▸ Parameters**.

5.4.2 Saving a method

If you modify method parameters, then you can save these as your own method. A maximum of 100 methods can be saved.

To save a method, proceed as follows:

1 Opening the method table

- In the main dialog, select **Method** and press **[OK]**.

The method table opens:

2 Modifying/applying the method name

- In the function bar, select **Store** and press **[OK]**.
  A method name will be suggested for new methods. If the method has already been saved once, then the method name will be displayed:

Applying the name:

- Press **[BACK]**.

The method will be saved and the method table is displayed.

Entering a new name:

- Press **[OK]**.
  The text editor opens.
- Enter a method name (max. 12 characters) and apply with **Accept** or **[BACK]**.
- Press **[BACK]**.

The method will be saved and the method table is displayed.

5.4.3 Loading a method

To load a method, proceed as follows:

1 Open the method table

- In the main dialog, select **Method** and press **[OK]**.

The method table with the stored methods opens:

2 Select a method

- Select the desired method.

3 Load the method

- In the function bar, select **Load** and press **[OK]**.

The method is now loaded and is displayed in the main dialog under **Method**.

5.4.4 Exporting a method

The methods can be exported to a connected USB flash drive.

NOTICE

This function is possible only if a USB flash drive is connected as an external storage medium.

To export a method, proceed as follows:

1 Opening the method table

- In the main dialog, select **Method** and press **[OK]**.

The method table with the stored methods opens:

2 Selecting the method

- Select the desired method.

3 Exporting the method

- In the function bar, select **Export** and press **[OK]**.

The method is being exported. The directory structure on the USB flash drive is listed in *chapter 6.5, page 63*.

5.5 Control

Menu ▸ Control

In the dialog **Control**, the settings for the execution of a single determination or of one sample series are defined.

Sample table

If this parameter is activated, the sample data for a sample series can be entered in a table *(see chapter 5.7, page 32)*.

Selection	**on** | **off**
Default value	**off**

Autostart

If this parameter is activated, a new determination is started automatically at the end of a determination. This continues until the number specified has been reached (see **Number of autostarts**).

Selection	**on** | **off**
Default value	**off**

Number of autostarts

This parameter is visible only when **Autostart** = **on**.

Number of automatic starts.

Input range	**1 - 50**
Selection	**table**
Default value	**table**

table
The number of automatic starts corresponds to the number of samples in the sample table.

NOTICE

It may be necessary to reset the autostart counter manually before the quantity defined above has been reached. Proceed as follows:

- Deactivate autostart.
- Exit the **Control** dialog.
- Activate autostart again.

5.6 Sample data

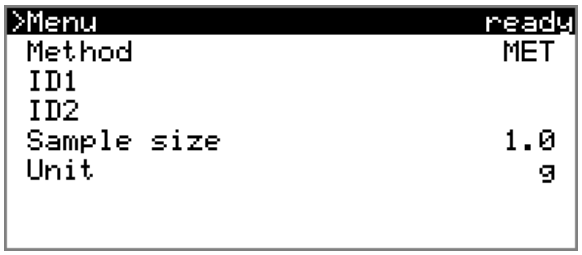
You can enter the sample data (identification, sample size, etc.) in a variety of ways:

- Directly in the main dialog.
- Using the sample table. This is particularly useful with sample series. The sample table is a table in which the sample data for up to 99 samples can be entered *(see chapter 5.7, page 32)*.
- Automatic request immediately after the start of the determination *(see chapter 5.6.2, page 32)*.

You can also send the sample size and the unit from a connected balance in any case. With some balances, the sample identification and method can be also sent *(see chapter 9.3, page 118)*.

5.6.1 Entering sample data in the main dialog

For a sample, you can enter the sample data directly in the main dialog, even while the determination is running *(see chapter 5.9, page 38)*.



ID1

Sample identification. The sample identification can be used in calculations as the variable **CI1**.

Entry	**max. 10 characters**
Default value	**empty**

ID2

Sample identification. The sample identification can be used in calculations as the variable **CI2**.

Entry	**max. 10 characters**
Default value	**empty**

Sample size

Sample size. The value of the sample size can be used in calculations as the variable **C00**.

Input range	**–999999999 - 9999999999**
Default value	**1.0**

Unit

Unit of the sample size.

Selection	**g** | **mg** | **µg** | **mL** | **µL** | **pieces** | **User-defined**
Default value	**g**

User-defined
A user-defined unit can be created. This will be added to the selection list. The previous entry will be overwritten as soon as the new unit has been defined.

5.6.2 Requesting sample data at the start of the determination

The sample data can be requested immediately after the start of the determination in order to ensure that the sample data entry is not forgotten. This automatic request is indispensable when you reweigh your samples.

The corresponding parameters must be activated under **Start conditions** for this purpose. If the parameter **Hold at request** is activated, then the run will be paused and must be continued with **[START]** after the input of the sample data. If **Hold at request** is deactivated, then the titration will be started in the background. This dialog will be displayed until the entering of the sample data is confirmed with **[START]**, even if the the titration is already completed. This ensures that the sample data is available for calculations.

5.7 Sample table

5.7.1 General

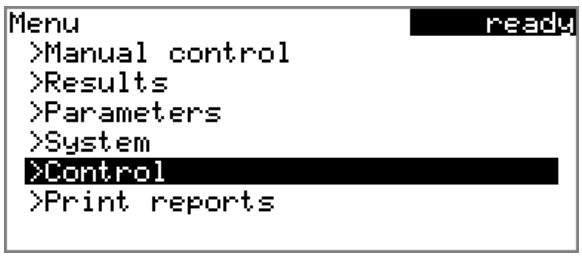
The sample table is a table in which the sample data for up to 99 samples can be entered. The sample data can also be entered while a determination is running *(see chapter 5.9.2, page 39)*.

Activating the sample table

Proceed as follows to activate the sample table (parameter **Sample table** = **on**).

1 Opening the main menu

- In the main dialog, select **Menu** and press **[OK]**.



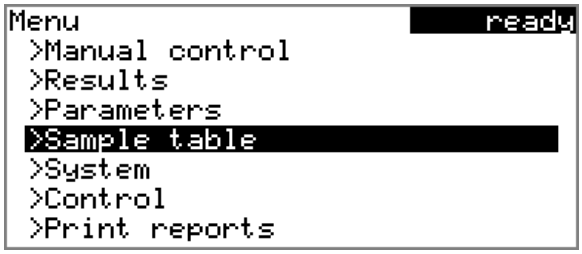
2 Opening the control dialog

- Select the menu item **Control** and press **[OK]**.

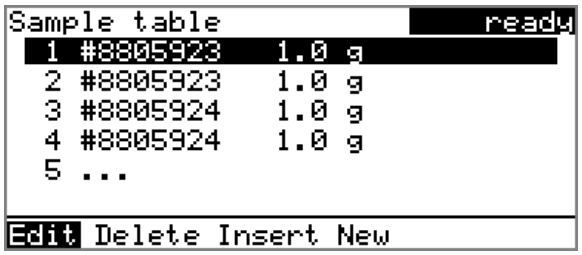
3 Activating the sample table

- Select **Sample table** and press **[OK]**.
- Select the entry **on** in the selection list and apply with **[OK]**.
- Press **[BACK]**.

The menu item **Sample table** is displayed in the main menu:



The sample table contains numbered lines. The identification (**ID1**) and the sample size of each sample are displayed.



Edit

Edit the data of the selected line, see following chapter.

Delete

Delete the selected line from the sample table.

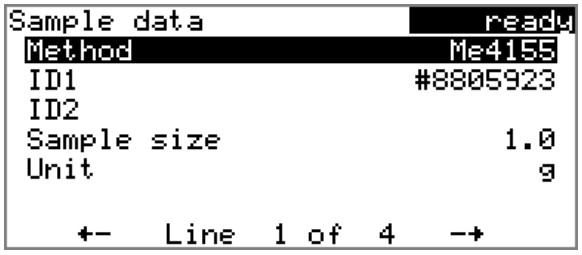
Insert

Insert a new line above the line selected.

New

Delete the sample table completely. This function is visible only if the instrument is in **ready** status.

5.7.2 Editing the sample data



You will see at the very bottom the line number of the selected line and the line number of the last line containing data. In this example, the first line is opened and the sample table contains four lines.

One can scroll between the individual data sets with the keys **[⇦]** and **[⇨]**.

Inserting a new line

If you find yourself on the last line (i.e. **Line 4 of 4** in the above example), you can add a new line to the sample table by pressing **[⇨]** again. The sample data of the previous sample will be applied thereby.

Method

Method used for processing the sample.

Selection	**Selection of stored methods** | **empty**
Default value	**empty**

empty
The currently loaded method is used.

ID1

Sample identification. The sample identification can be used in calculations as the variable **CI1**.

Entry	**max. 10 characters**
Default value	**empty**

ID2

Sample identification. The sample identification can be used in calculations as the variable **CI2**.

Entry	**max. 10 characters**
Default value	**empty**

Sample size

Sample size. The value of the sample size can be used in calculations as the variable **C00**.

Input range	**–999999999 - 9999999999**
Default value	**1.0**

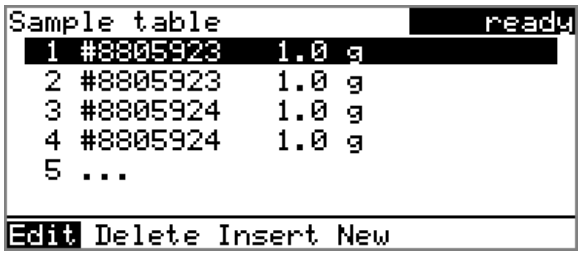
Unit

Unit of the sample size.

Selection	**g** | **mg** | **µg** | **mL** | **µL** | **pieces** | **User-defined**
Default value	**g**

User-defined
A user-defined unit can be created. This will be added to the selection list. The previous entry will be overwritten as soon as the new unit has been defined.

5.7.3 Sending the sample size from a balance



If the sample size is sent directly from the balance, then it will always be entered in a new line at the end of the sample table. It does not matter which line is selected or whether the sample table is even opened. In the above example, the sample size is entered in line 5.

NOTICE

If you would like to enter the sample size in a particular line, then you must open the corresponding editing dialog (i.e. the **Sample data** dialog is displayed).

If the editing dialog for the sample size is opened, then the sent value will be ignored.

5.8 Carrying out a determination

The sample size can be entered in the following ways when a determination is carried out:

- Enter manually on the instrument.
- Send automatically from a connected balance. To do so, consult the operating instructions for your balance.

The following instructions describe how to enter the sample size on the 848 Titrino plus.

1 Loading the method

- *See Chapter "Loading a method", Page 28*.

2 Preparing the sample

NOTICE

Calculate the amount of the sample so that it results in titrant consumption of 10 to 90% of the cylinder volume.

- Weigh in or measure the sample in a sample vessel.
- Add solvent.
- Place the sample vessel on the stirrer.
- Immerse the electrode and buret tip in the solution.

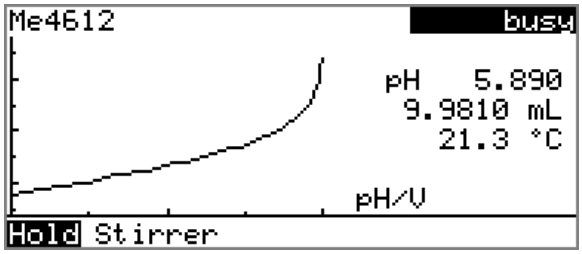
3 Entering the sample size

- In the main dialog, select **Sample size** and press **[OK]**.
  The editing dialog opens.
- Enter the sample size and apply with **Accept** or **[BACK]**.

4 Starting the titration

- Press **[START]**.

The titration starts and the curve is displayed:

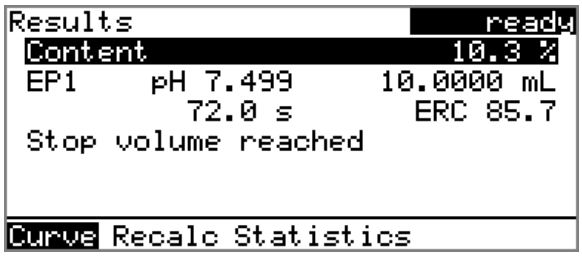


The axes are scaled automatically. Using **Hold** pauses the run. **Continue** then takes its place on the display. It can be used to resume the run.

The stirring rate can be modified during titration with the **Stirrer** function. The following dialog is opened by pressing **[OK]**:

Stir- can be used to decrease the stirring rate while **Stir+** increases it. **Off** switches off the stirrer. **On** then takes its place on the display. This can be used to switch the stirrer back on. The **[BACK]** key closes this dialog.

After the completion of the titration, the results dialog is displayed:



Canceling a determination manually

A determination can be canceled at any time with the **[STOP]** key.

5.9 Live modifications

5.9.1 Editing the sample data of the running determination

The sample data can be entered or modified in the main dialog while a determination is running. In calculations always the sample data entered at the end of the titration in the main dialog is used.

Proceed as follows to edit the sample data:

1 Displaying the main dialog

- Press **[BACK]**.

The main dialog is displayed. The determination continues to run in the background.

2 Editing the sample data

- Edit the sample data and apply with **Accept** or **[BACK]**.

3 Displaying the live dialog

- Press **[BACK]**.

or

- Select **Menu** and press **[OK]**.

- Select the menu item **Live dialog** and press **[OK]**.

The live dialog is displayed once again.

NOTICE

If the determination is finished while an editing dialog is opened (e.g. of the sample size), then this will be closed automatically and the results dialog will be displayed. The value entered must be entered once more and the determination must be recalculated.

Make sure that the editing dialogs are closed before the determination is finished.

5.9.2 Editing the sample table while a determination is running

You can insert new lines or delete existing ones or edit sample data while a determination is running.

NOTICE

We recommend that the editing dialogs always be closed in order to ensure that no problems occur during the run and that the current data is always available for calculation purposes.

Editing the sample table

Proceed as follows to edit the sample table:

1 Displaying the main dialog

- Press **[BACK]**.

The main dialog is displayed. The determination continues to run in the background.

2 Opening the main menu

- Select **Menu** and press **[OK]**.

3 Selecting the sample data

- Select the menu item **Sample table** and press **[OK]**.
- Select the desired line.
- In the function bar, select **Edit** and press **[OK]**.

4 Editing the sample data

- Edit the sample data and apply with **Accept** or **[BACK]**.

NOTICE

In addition to the sample data, the method can also be modified, except in cases where the determination is running.

5 Displaying the live dialog

- Select the menu item **Live dialog** in the main menu and press **[OK]**.

or

- Press **[BACK]** in the main dialog.

The live dialog is displayed once again.

Editing the sample data of the running determination

When you use the sample table, the editing of the sample data of the running determination proceeds as described in *chapter 5.9.1, page 38*. In addition, you have the option of editing these in the sample table. The first line always contains the sample data of the running determination. Simply select for this purpose the **Sample table***(see "Editing the sample table", page 39)* menu item in the main menu.

5.9.3 Editing the live parameters

Certain method parameters can be edited while a determination is being carried out. The only parameters that can be modified are those that can be selected. Nevertheless, all of the parameters are visible. The modified parameters are taken into account at once. If you modify, for instance, the start conditions after the start volume has been dosed, then these modifications will not be taken into account until the next determination.

Proceed as follows to edit the parameters:

1 Displaying the main dialog

- Press **[BACK]**.

The main dialog is displayed. The determination continues to run in the background.

2 Opening the main menu

- Select **Menu** and press **[OK]**.

3 Editing the method parameters

- Select the menu item **Parameters** and press **[OK]**.
- Change the desired parameters accordingly.

4 Displaying the live dialog

- Select the menu item **Live dialog** in the main menu and press **[OK]**.

or

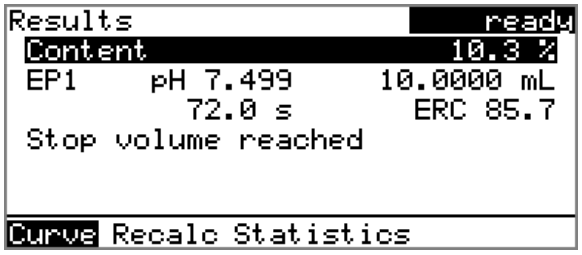
- Press **[BACK]** in the main dialog.

The live dialog is displayed once again.

5.10 Results

Menu ▸ Results

After the completion of the titration, the results dialog is displayed:



The calculated result and details concerning the endpoint are shown in the overview.

Curve

Display the curve of the current determination.

Recalculate

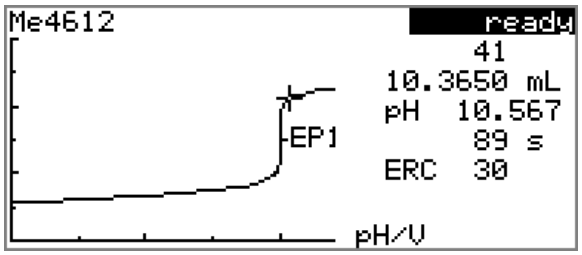
Recalculate the current determination. The procedure will be executed immediately.

Statistics

Display the statistical overview of a determination series *(see chapter 5.11, page 42)*.

Displaying the curve

The curve of the current determination can be displayed with the **Curve** function.



The arrow keys **[⇦]** and **[⇨]** can be used to move to the individual measuring points. A cross hair is used to show the current position on the curve. The data (volume, measured value, time, etc.) for the respective measuring point is indicated on the right-hand side.

Recalculating

NOTICE

Recalculation cannot be undone.

All of the results are recalculated with the **Recalculate** function. This is necessary if, for example, the calculation, the titer or the sample size has been modified.

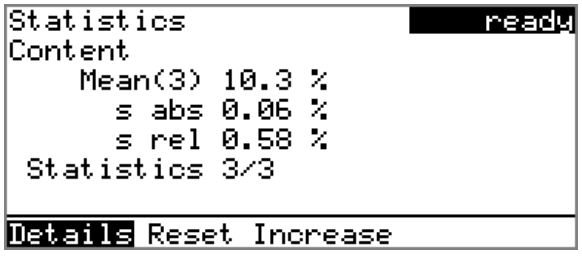
5.11 Statistics

Menu ▸ Results ▸ Statistics

The statistical overview of a determination series can be displayed in the **Results** dialog with the **Statistics** function.

NOTICE

This function is visible only if statistics has been activated.



The mean value (**Mean**), the absolute and the relative standard deviation (**s abs** and **s rel**) are displayed in the overview. For the mean value, the number of individual results from which it has been calculated is displayed in parentheses. In this example, it is 3. The **Statistics** line shows how many determinations have already been carried out and how many deter-

minations are to be carried out in total. All three determinations were carried out in this example.

Details

Display additional data.

Reset

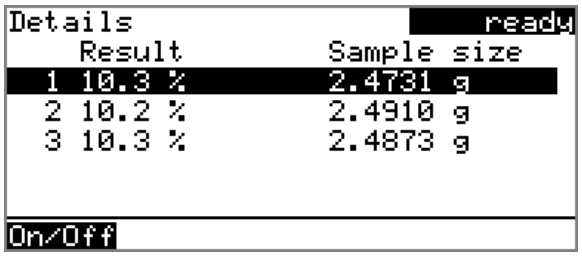
Delete all statistics data.

Increase

Add a further determination to the determination series.

Displaying statistical details

Additional data from the determination series can be displayed with the **Details** function.



The result and the sample size of each determination are shown.

On/Off

Remove the selected determination from the statistics. The line will then be marked with an asterisk (*), the statistics will be recalculated automatically. If several calculations are defined in the method, then all the results will be removed from the statistics.

Deleting statistical data

All statistical data is deleted with the **Reset** function. The statistics data is deleted automatically in the following cases:

- When all of the determinations of the determination series have been carried out and a new determination has been started afterwards.
- When a new method is loaded.

Adding a determination to a determination series

You can use the function **Increase** to add an additional sample to a determination series, e.g. because a determination was faulty and had to be removed from the statistics. The second number in the **Statistics** line will be increased automatically by one.

5.12 Printing a report manually

Menu ▸ Print reports

Proceed as follows to print a report manually:

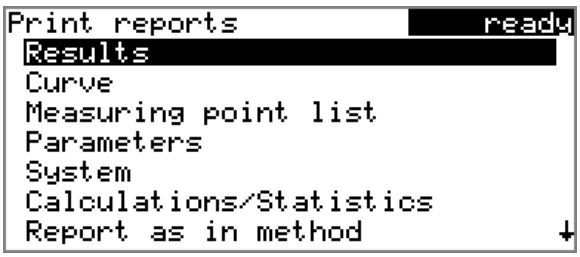
1 Opening the main menu

- In the main dialog, select **Menu** and press **[OK]**.

2 Opening the print dialog

- Select the menu item **Print reports** and press **[OK]**.

The dialog window with the available reports opens:



3 Selecting the report

- Select the desired report and press **[OK]**.

The report is printed out.

The following reports can be printed out manually:

Results	Result report with determination properties, sample data, calculated results, etc.
Curve	Curve report. The width of the curve is defined in the system settings *(see "Graphics width", page 65)*.
Measuring point list	Measuring point list report.

Parameters	Report with all method parameters of the loaded method.
System	System report with system settings, solution list, external devices, etc.
Calculations/Statistics	Calculation report. The statistics are also printed out in the case of multiple determinations. The individual determinations with the respective sample size, the mean value, the absolute and the relative standard deviation are printed out for each result.
PC/LIMS	Machine-readable report with all of the data for a determination. This report can be saved as a TXT file to a connected USB flash drive or sent to a terminal program or a LIMS via an RS-232 interface. The definition is made in the system settings *(see "PC/LIMS report", page 64)*.
Report as in method	The reports that are defined in the method will be printed out.

5.13 Manual control

Menu ▸ Manual control

The following functions are available in the manual control:

- Dosing
- Measuring
- Stirring

The available subfunctions are listed for each function in the function bar.

NOTICE

The **Stirrer** function can only be selected if a stirrer is connected.

5.13.1 Dosing

The following dosing functions are available in the manual control:

Prepare the buret unit (PREP)	Rinse the cylinder and tubings of the buret unit *(see chapter 9.1.2, page 117)*.
Continuous dosing (DOS)	Dose while the **[START]** key is pressed.
Dose a fixed volume (ADD)	Dose a specified volume.

Preparing the buret unit (PREP)

The **PREP** function is used to rinse the cylinder and tubings of the buret unit and fill them air bubble-free. You should carry out this function before the first determination or once per day.

Proceed as follows:

1 Open the manual control

- In the main dialog, select **Menu** and press **[OK]**.
  The main menu opens.
- Select the menu item **Manual control** and press **[OK]**.

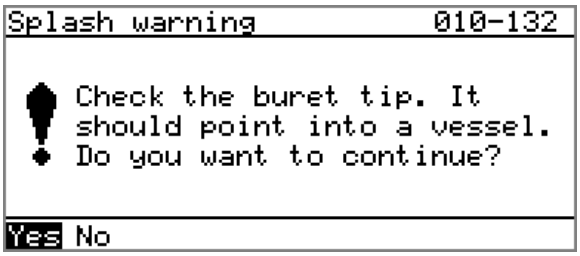
Manual control opens.

2 Select the dosing function

- Select the **Dosing** item.

- In the function bar, select **PREP** and press **[OK]**.

The following message is displayed:



3 Start the preparing

CAUTION

Make sure that the buret tip is directed into a vessel that can accommodate the cylinder volume of your buret unit several times over.

- Select **Yes** and confirm the message with **[OK]**.

Preparing is carried out.

Continuous dosing (DOS)

Continuous dosing will be carried out with the **DOS** function for as long as you keep the **[START]** key pressed down.

Proceed as follows:

1 Open the manual control

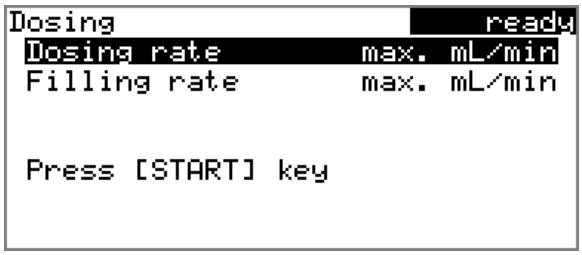
- In the main dialog, select **Menu** and press **[OK]**.
  The main menu opens.
- Select the menu item **Manual control** and press **[OK]**.

Manual control opens.

2 Select the dosing function

- Select the **Dosing** item.

- In the function bar, select **DOS** and press **[OK]**.



3 Configure the dosing function

NOTICE

- The dosing and filling rates should be decreased for viscous liquids.
- The maximum dosing and filling rates depend on the cylinder volume *(see chapter 9.1.1, page 117)*.

- Enter the dosing rate.
- Enter the filling rate.

4 Start dosing

- Press **[START]**.

The status changes to **busy**, the dosed volume is displayed. When the volume of one cylinder has been dosed, the dosing cylinder will be refilled automatically.

5 Fill the cylinder

- Press **[STOP]** or **[BACK]**.

The dosing cylinder is filled. If you start the filling with **[BACK]**, then the dialog will also be exited.

Dosing a particular volume (ADD)

You can dose a particular volume with the **ADD** function.

Proceed as follows:

1 Open the manual control

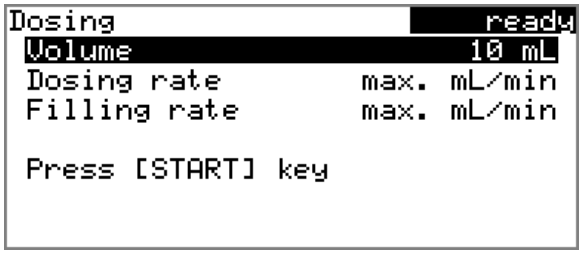
- In the main dialog, select **Menu** and press **[OK]**.
  The main menu opens.
- Select the menu item **Manual control** and press **[OK]**.

Manual control opens.

2 Select the dosing function

- Select the **Dosing** item.

- In the function bar, select **ADD** and press **[OK]**.



3 Configure the dosing function

NOTICE

- The dosing and filling rates should be decreased for viscous liquids.
- The maximum dosing and filling rates depend on the cylinder volume *(see chapter 9.1.1, page 117)*.

- Enter the desired volume.
- Enter the dosing rate.
- Enter the filling rate.

4 Start dosing

- Press **[START]**.

The status changes to **busy**, the dosed volume is displayed. When the volume of one cylinder has been dosed, the dosing cylinder will be refilled automatically.

5 Fill the cylinder

- Press **[STOP]** or **[BACK]**.

The dosing cylinder is filled. If you start the filling with **[BACK]**, then the dialog will also be exited.

5.13.2 Measuring

Open the dialog for manual measurement as follows:

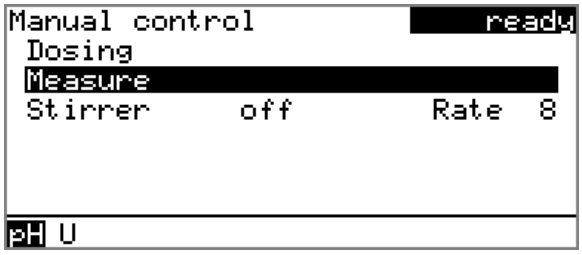
1 Open the manual control

- In the main dialog, select **Menu** and press **[OK]**.
  The main menu opens.
- Select the menu item **Manual control** and press **[OK]**.

Manual control opens.

2 Select a measuring mode

- Select the **Measure** item.



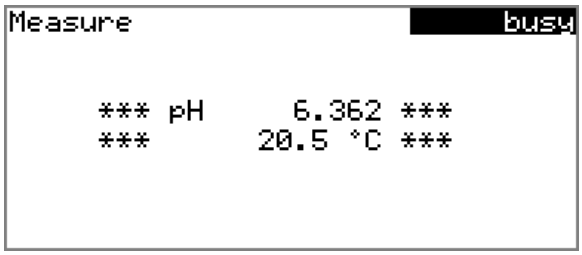
- In the function bar, select the measuring mode and press **[OK]**.

3 Configure the measuring mode

- Select the desired electrode from the sensor list.
  The selection depends on the measuring mode. Sensors are defined under **System ▸ Sensors**.
- Enter the measuring temperature if no temperature sensor is connected. If a temperature sensor is connected, then the temperature will be measured automatically.
  This temperature is used for automatic temperature compensation with pH measurements.

4 Start the measurement

- Press **[START]**.



The status changes to **busy**. The current measured value and the measuring temperature are displayed.

5 Stop the measurement

- Press **[STOP]** or **[BACK]**.

The measurement is stopped. The status changes back again to **ready**. If you stop the measurement with **[BACK]**, then the dialog will also be exited.

5.13.3 Stirring

You can control a connected stirrer manually.

Proceed as follows:

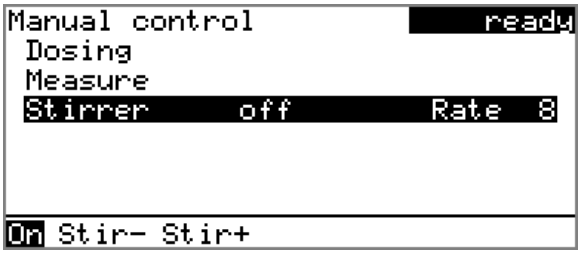
1 Opening the manual control

- In the main dialog, select **Menu** and press **[OK]**.
  The main menu opens.
- Select the menu item **Manual control** and press **[OK]**.

Manual control opens.

2 Setting the stirring rate

- Select the **Stirrer** item.



- In the function bar, select **Stir-** or **Stir+**.
  The stirring rate will be increased or decreased by one step each time the **[OK]** key is pressed.
  The algebraic sign changes the direction in which the stirring is done. When viewing the stirrer from above, this means:
  - "+": counterclockwise rotation
  - "–": clockwise rotation

3 Switching on the stirrer

- In the function bar, select **On** and press **[OK]**.

The stirrer is started and stirs at the rate which has been set. **Off** is now displayed in the function bar.

4 Switching off the stirrer

- In the function bar, select **Off** and confirm with **[OK]**.

The stirrer is stopped.

6 System settings

6.1 Basic settings

Menu ▸ System ▸ Settings

This chapter contains a description of general instrument settings.

User name

A user name can be entered here for the report. This parameter will only be printed if a user has been defined.

Entry	**max. 12 characters**
Default value	**empty**

Instrument name

A instrument name can be entered here for the report. This parameter will only be printed if a designation has been defined.

Entry	**max. 10 characters**
Default value	**empty**

Serial number

Serial number of the instrument. This is printed as a part of the instrument identification in the report header.

Program version

Version number of the instrument software. This is printed as a part of the instrument identification in the report header.

Time

Current time. Only valid numbers can be entered.

Format: hh:mm:ss

Date

Current date. Only valid numbers can be entered.

Format: YYYY:MM:DD

Language

Setting the dialog language. An additional language can be selected besides English.

NOTICE

In order to ensure that a second language can be selected, it must first be installed. This installation must be carried out by specialist personnel. In chapter *Language files, page 67*, you will find details regarding the installation of a second language.

Dialog type

The user dialog can be limited for routine operations. One can operate normally with methods in the limited dialog. However, no settings can be made or methods deleted.

The resetting of the dialog will take effect as soon as you exit the main menu.

The limitation of the dialog results in the following:

- The menu items **System**, **Parameters** and **Control** are not shown in the main menu.
- Methods can only be loaded, but not deleted, exported or created.

NOTICE

If the limited dialog for routine operation is activated, then the expert dialog cannot be activated during ongoing operation. To change the dialog type, the 848 Titrino plus must be switched off and then back on again. The expert dialog can be forced as soon as the instrument is started up again. Then it is possible to enter whatever settings one wishes, e.g. the changing of the dialog type. If the instrument is switched off again without changing the dialog type, then the routine dialog will remain activated.

Forcing the expert dialog:

- Switch on the instrument.
- Wait for the display of the instrument logo with the lettering **easy, safe, precise**.
- Press the **[STOP]** key once again and hold it down while also briefly pressing the **[BACK]** key.
- Release both keys once again.

Selection	**Expert** | **Routine**
Default value	**Expert**

Expert
Complete dialog.

Routine
Limited dialog for routine operations.

Contrast

The contrast of the display can be adjusted with the arrow keys **[⇦]** and **[⇨]**.

- **[⇦]**: the contrast will be decreased by one step each time the key is pressed.
- **[⇨]**: the contrast will be increased by one step each time the key is pressed.

Input range	**150 - 240**
Default value	**212**

NOTICE

Alternatively, the contrast can also be modified in the following manner:

Keep the red **[STOP]** key pressed down. As soon as the progress bar appears, also press the arrow key **[⇩]** or **[⇧]** repeatedly.

This method will, however, cause the contrast to be modified by several steps.

Beep

If this parameter is activated, then a short beep will sound in the following cases:

- When a key is pressed.
- At the end of the determination.
- When the system remains conditioned without interruption for 10 seconds.

Selection	**on** | **off**
Default value	**on**

PREP warning

If this parameter is activated, then the recommendation will be made to carry out the function **PREP** (Preparing):

- After the instrument is switched on.
- Each time a buret unit is attached.

All tubing and the cylinder are rinsed with this function *(see chapter 9.1.2, page 117)*.

Selection	**on** | **off**
Default value	**on**

Temperature sensor

The instrument supports the use of two different temperature measurement techniques:

- NTC (Negative Temperature Coefficient)
- Pt1000 (platinum resistance)

Select the type here that has been connected to the instrument. If you use an NTC sensor, it is required that two characteristics for the sensor be entered in addition. These characteristics are listed in the specifications of the sensor.

Selection	**Pt1000** | **NTC**
Default value	**Pt1000**

R (25 °C)

This parameter is visible only when **Temperature sensor** = **NTC**.

Nominal resistance of the NTC sensor at 25 °C.

Input range	**1000 - 99999 ohm**
Default value	**30000 ohm**

B value

This parameter is visible only when **Temperature sensor** = **NTC**.

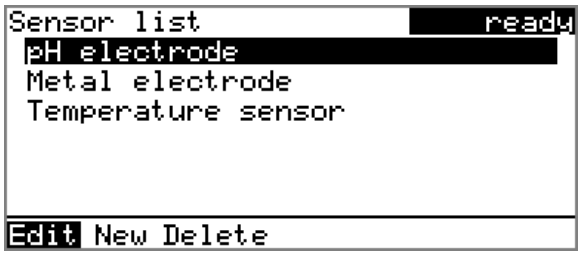
Material constant of the NTC sensor. B values of NTC sensors are frequently based on different reference temperatures (usually 25 °C and 50…100 °C).

Input range	**1000 - 9999 K**
Default value	**4100 K**

6.2 Managing sensors

6.2.1 General

Menu ▸ System ▸ Sensors



Three standard sensors are defined in the sensor list: **pH electrode**, **Metal electrode** and **Temperature sensor**. These sensors cannot be deleted or renamed. The sensor list can contain a maximum of 10 sensors.

Every sensor is identified with a unique name. This means that it is not possible to use the same name twice, e.g. for a pH electrode and for a metal electrode.

Edit

Edit the data of the selected sensor, see following chapter.

New

Add a new sensor to the list, see following chapter.

The following sensor types can be selected:

- pH electrode
- Metal electrode
- Temperature sensor
- Other sensor, e.g. Spectrosense

Delete

Delete the selected sensor from the list.

6.2.2 Editing the sensor data

Name

The designation of the sensor is used for unambiguous identification.

Entry	**max. 24 characters**
Default value	**empty**

Type

The sensor type is displayed.

Slope

This parameter is only visible with pH electrodes.

Slope of the pH electrode. With a 1-point calibration, only pH(0) can be calculated, 100.0% is used as the slope.

Input range	**–999.9 - 999.9 %**
Default value	**100.0 %**

pH(0)

This parameter is only visible with pH electrodes.

pH value of the pH electrode at 0 mV. Apart from the slope, pH(0) is the second characteristic of the calibration curve.

Input range	**–20.000 - 20.000**
Default value	**7.000**

Calibration temp.

This parameter is only visible with pH electrodes.

Temperature at which the last calibration was carried out.

Input range	**–20.0 - 150.0 °C**
Default value	**25.0 °C**

Calibration date

This parameter is only visible with pH electrodes.

Date of the last calibration.

Monitoring

This parameter is only visible with pH electrodes.

Activating and deactivating the calibration monitoring.

Selection	**on** | **off**
Default value	**off**

Time interval

This parameter is visible only when **Monitoring** = **on**.

You will be notified that this time interval (in days) has elapsed when starting a method. You can then select whether or not you would still like to start the method.

Input range	**1 - 999 d**
Default value	**999 d**

6.3 Managing solutions

6.3.1 General

Menu ▸ System ▸ Solutions

Solutions can be used in intelligent buret units or in non-intelligent buret units. Intelligent buret units have a built-in data chip on which the data for the reagent is stored. This data is automatically read out during attachment and entered in the solution list.

The name and the type are specified for each solution in the solution list. The asterisk (*****) on the right-hand side indicates that this buret unit is attached (only for intelligent buret units). An unlimited number of solutions in buret units with data chip can be added to the solution list. The number of solutions in buret units without data chip is limited to 10 items.

Meaning of the type:

- **EU**: exchange unit without data chip
- **IEU**: exchange unit with integrated data chip

Edit

Edit the data of the selected solution, see following chapter.

New

Add a new solution to the list, see following chapter.

Delete

Delete the selected solution from the list.

6.3.2 Editing the solution data

Name

The designation of the solution is used for unambiguous identification.

Entry	**max. 24 characters**
Default value	**empty**

Type

The model of the buret unit is displayed.

Cylinder volume

Cylinder volume of the buret unit in mL. The cylinder volume is automatically read out with intelligent buret units.

Selection	**1** | **5** | **10** | **20** | **50**
Default value	**20**

Concentration

Concentration of the solution.

Input range	**–999999999 - 9999999999**
Default value	**1.000**

Concentration unit

Unit of the concentration.

Selection	**µmol/mL** | **mmol/L** | **mol/L** | **g/L** | **mg/L** | **mg/mL** | **µg/L** | **ppm** | **%** | **mEq/L** | **User-defined**
Default value	**mol/L**

User-defined
A user-defined unit can be created. This will be added to the selection list. The previous entry will be overwritten as soon as the new unit has been defined. A blank entry can be generated this way as well.

Titer

Titer of the solution.

Input range	**–999999999 - 9999999999**
Default value	**1.000**

Titer unit

Unit of the titer.

Selection	**µmol/mL** | **mmol/L** | **mol/L** | **g/L** | **mg/L** | **mg/mL** | **µg/L** | **ppm** | **%** | **mEq/L** | **empty** | **User-defined**
Default value	**empty**

User-defined
A user-defined unit can be created. This will be added to the selection list. The previous entry will be overwritten as soon as the new unit has been defined. A blank entry can be generated this way as well.

Date titer det.

Date of the last titer determination.

Monitoring

Activating and deactivating the titer monitoring.

Selection	**on** | **off**
Default value	**off**

Time interval

This parameter is visible only when **Monitoring** = **on**.

You will be notified that this time interval (in days) has elapsed when starting a method. You can then select whether or not you would still like to start the method.

Input range	**1 - 999 d**
Default value	**999 d**

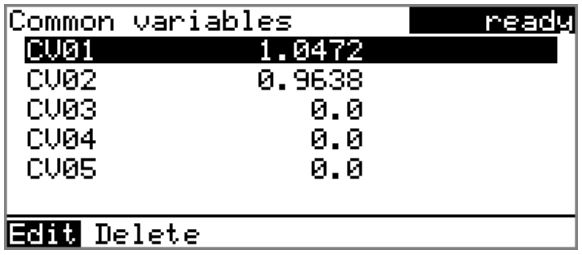
6.4 Managing common variables

6.4.1 General

Menu ▸ System ▸ Common variables

The instrument offers the possibility of saving five **method-independent variables**, so-called common variables. These variables remain saved in the instrument and can be used in future calculations. Common variables are useful, e.g. for the following applications:

- Determination of a blank value which will be taken into account during the content determination of the sample.
- Determination of the content of a standard solution, which will be taken into account during the content determination of the sample.



The common variables have the non-changeable designation **CV01… CV05**. The value is displayed for every variable. No unit can be assigned to the common variables.

Edit

See the following chapter for editing the data of the selected common variable.

Delete

Set the selected common variable to **invalid**.

6.4.2 Editing common variables

The common variables can be modified as follows:

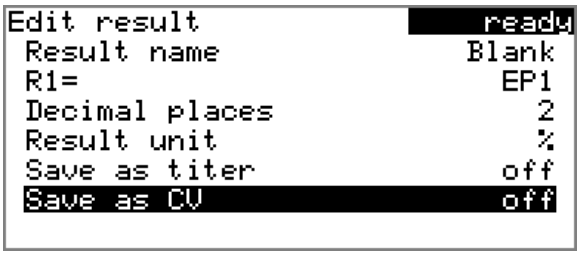
- Manually in this dialog.
- Automatic assignment from the determination run. A calculation result must be configured accordingly for this purpose (see below).

Assigning a result automatically to a common variable

Proceed as follows:

1 Opening the editing dialog of the result

- Select the menu item **Parameters** ▸ **Calculation** and press **[OK]**.
- Select the result whose value is to be assigned to a common variable.
- In the function bar, select **Edit** and press **[OK]**.



2 Adjusting the result properties

- Select the parameter **Save as CV** and press **[OK]**.
- Select the entry **on** in the selection list and apply with **[OK]**.

The assignment of the result to a common variable occurs automatically according to the following scheme:

- Result **R1** ⇨ Common Variable **CV01**
- Result **R2** ⇨ Common Variable **CV02**
- etc.

NOTICE

If you have set the parameter **Statistics** to **on**, then the mean value of the results will be assigned to the respective common variable.

6.5 File management

Menu ▸ System ▸ File management

NOTICE

This menu item is visible only if a USB flash drive has been connected as an external storage medium.

Methods can be imported and deleted from a USB flash drive in this dialog. Only methods located in the **Files** directory are displayed in the list *(see "Directory structure on the USB flash drive", page 63)*.

A backup of the system can be created (all data and settings). Similarly, an existing backup can be reloaded.

Import

Import the selected method.

Delete

Delete the selected method.

Backup

Create a backup of all data and settings on the USB flash drive.

NOTICE

Only **one** backup can be created on the same USB flash drive.

If a backup is already stored on the flash drive, then this will be overwritten as soon as the function is performed once again.

Restore

Load the backup from a connected USB flash drive.

Directory structure on the USB flash drive

A directory with the instrument number will be created on the USB flash drive. The structure within this directory appears as follows:

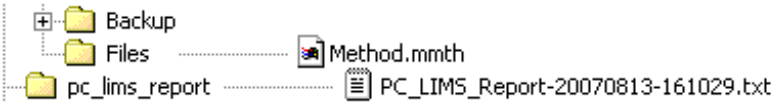


Figure 19 Directory structure on the USB flash drive

Backup	All of the files of the backup are stored in this directory. The directory is created as soon as a backup is created for the first time.
Files	Exported methods are stored in this directory. The directory is created as soon as a backup is exported for the first time. Only methods located in this directory can be imported.
pc_lims_report	PC/LIMS reports are stored in this directory as TXT files. The directory is created as soon as a PC/LIMS report is printed for the first time.

6.6 Configuring external devices

Menu ▸ System ▸ External devices

PC/LIMS report

Specification of the storage location for the PC/LIMS report. The PC/LIMS report is a machine-readable report with all of the important data for a determination. It can be saved as follows:

- as a TXT file on a USB flash drive.
- to a LIMS via an RS-232 interface. The 6.2148.030 RS-232/USB Box is required for this purpose.

Selection	**COM2** | **USB Stick**
Default value	**USB Stick**

COM2
The report is sent via the serial COM2 interface. The interface parameters set in the dialog **COM2 settings** are used *(see "Editing the COM2 settings", page 66)*.

USB Stick
The report will be saved as a TXT file on the USB flash drive in the folder **pc_lims_report**.

Printer

If a printer is connected, then the printer type needs to be defined here in order for the reports to be printed out correctly.

The printers that have the designation **ESC-POS** are so-called POS printers (point-of-sale printers), i.e. they print on continuous paper.

Selection	**Citizen (ESC-POS)** | **Custom (ESC-POS)** | **Epson** | **Epson (ESC-POS)** | **HP DeskJet** | **HP LaserJet** | **Seiko (ESC-POS)**
Default value	**HP DeskJet**

Graphics width

Adjust the width of the curve to be printed out to the paper width of the printer to be used. The default value depends on the selected printer. The height of the curve is 2/3 of the width.

Input range	**100 - 3000 Pixels**

Keyboard layout

A commercially available USB keyboard can be connected to make it easier to enter text and numbers. Specify the country-specific keyboard layout.

Selection	**English US** | **French FR** | **German CH** | **German DE** | **Spanish ES**
Default value	**English US**

Balance

If you have connected a balance, then you must define the balance type here.

Selection	**AND** | **Mettler** | **Mettler AT** | **Mettler AX** | **Ohaus** | **Precisa** | **Sartorius** | **Shimadzu**
Default value	**Sartorius**

The following table indicates the balance type that needs to be selected for the balance model:

Balance	Balance type
AND	**AND**
Mettler AB, AE, AG, AM, AJ, PE, PM, PJ, PR, XP, XS	**Mettler**
Mettler AT	**Mettler AT**
Mettler AX, MX, UMX, PG, AB-S, PB-S	**Mettler AX**
Ohaus Voyager, Explorer, Analytical Plus	**Ohaus**
Precisa	**Precisa**
Sartorius	**Sartorius**
Shimadzu BX, BW	**Shimadzu**

Editing the COM1 settings

Menu ▸ System ▸ External devices ▸ COM1 settings

The interface parameters for the connected balance are set under **COM1 settings**.

Baud rate

Transfer rate in characters per second.

Selection	**1200** | **2400** | **4800** | **9600** | **19200** | **38400** | **57600** | **115200**
Default value	**9600**

Data bits

Number of data bits.

Selection	**7** | **8**
Default value	**8**

Stop bits

Number of stop bits.

Selection	**1** | **2**
Default value	**1**

Parity

Type of parity testing.

Selection	**even** | **none** | **odd**
Default value	**none**

Handshake

Type of the data transfer protocol.

Selection	**hardware** | **software** | **none**
Default value	**hardware**

NOTICE

If communications problems occur, set the parameter **Handshake** to **software**, and make another attempt.

Editing the COM2 settings

Menu ▸ System ▸ External devices ▸ COM2 settings

The interface parameters for instruments connected to the **RS-232/2** connector of the RS-232/USB Box (e.g. PC) are set under **COM2 settings**. The parameters and input ranges are identical to those for the COM1 interface.

6.7 Instrument diagnosis

6.7.1 Loading program versions and language files

Menu ▸ System ▸ Diagnosis

New program versions or language files can be loaded from a USB flash drive. The corresponding file must be saved on the USB flash drive in a directory with the instrument number (e.g. 848 or 863).

You can distinguish between language files and program files by noting how the file name is constructed.

Program files

They are instrument-specific. The file name has the following structure:

5XXXyyyy.bin where

XXX = Instrument type (e.g. 848 for the 848 Titrino plus)

yyyy = Program version

Language files

They can be recognized by means of the two-digit language code in the file name. A language file contains the dialog texts for various instrument types. It is not instrument-specific. The file name has the following structure:

5848xxxxYY.bin where

xxxx = Version number

YY = Language, e.g. DE (German), FR (French), ES (Spanish)

Loading a file

Proceed as follows:

1 Connecting the USB flash drive

- Plug in the USB flash drive with the 6.2151.100 adapter (USB MINI (OTG) - USB A) at the instrument's USB port.
- Switch on the instrument.

2 Opening the update dialog

- Under **Menu ▸ System ▸ Diagnosis**, select the menu item **Software update**.
- Press **[OK]**.

3 Opening the file selection

- Press **[OK]**.

The selection list with the program and language files present on the USB flash drive opens.

4 Selecting the file

- Use the arrow keys to select the required file.
- Press **[OK]**.

5 Starting the update

- Press **[START]**.

The update process is started, it runs automatically. At the end of the process, the instrument will be switched off automatically and switched back on again. No user intervention is required.

6.7.2 Diagnosis functions

Electronic and mechanical functional groups in Metrohm instruments can and should be checked as part of regular maintenance by specialist personnel from Metrohm. Please ask your local Metrohm representative regarding the precise terms and conditions involved in concluding a corresponding maintenance agreement.

7 Parameters

7.1 Dynamic equivalence point titrations (DET)

7.1.1 Start conditions

Menu ▸ Parameters ▸ Start conditions

The parameters that are carried out before the start of titration are defined under **Start conditions**.

Activation pulse

Output of an activation pulse on a remote line. This activation pulse starts a connected Dosimat.

Selection	**on** | **off**
Default value	**off**

Start delay time

Waiting time after the start of the determination, before titration is started. During this period, substances such auxiliary solution can be added with a Dosimat (parameterization on the Dosimat). However, this requires that the **Activation pulse** be enabled.

Input range	**0 - 999,999 s**
Default value	**0 s**

Start volume

Volume that is dosed prior to the start of the titration.

Input range	**0.00000 - 9,999.99 mL**
Default value	**0.00000 mL**

Dosing rate

Rate at which the start volume is dosed. The maximum dosing rate depends on the cylinder volume *(see chapter 9.1.1, page 117)*.

Input range	**0.01 - 166.00 mL/min**
Selection	**max.**
Default value	**max.**

Pause

Waiting time, e.g. for the electrode to settle down after the start or a reaction time after the dosing of a start volume.

Input range	**0 - 999,999 s**
Default value	**0 s**

Request sample ID

Selection of the sample identification that is queried in the method run.

Selection	**off** | **ID1** | **ID2** | **ID1&ID2**
Default value	**off**

Request sample size

If this parameter is activated, then the value for the sample size will be requested.

Selection	**on** | **off**
Default value	**off**

Request sample unit

If this parameter is activated, then the unit for the sample size will be requested.

Selection	**on** | **off**
Default value	**off**

Hold at request

If this parameter is activated, then the run will be paused during the request. If the parameter is switched off, the titration will be started in the background.

Selection	**on** | **off**
Default value	**on**

7.1.2 Titration parameters

Menu ▸ Parameters ▸ Titration parameters

Under **Titration parameters**, the parameters influencing the run of the entire titration are defined.

Titration rate

Three predefined sets of parameters can be selected for the titration rate.

Selection	**slow** | **optimal** | **fast** | **user**
Default value	**optimal**

slow
For titrations in which the finest details are also to be visible. This could, however, also lead to an increase in noise, which could result in unwanted equivalence points.

optimal
For all standard titrations. The parameters have been optimized for the most frequent applications.

fast
For fast and less critical titrations.

user
The individual titration parameters can be modified.

NOTICE

Select **optimal** as titration rate when you are developing a new titration method. This parameter is suitable for virtually all titrations and only needs adaptation in special cases.

The settings of the individual titration rates are listed in *table 1, page 73*.

Meas. point density

This parameter is visible only when **Titration rate** = **user**.

A small value means small volume increments, i.e. a high measuring point density. The curve then shows all the finest details which also include noise; this could cause unwanted equivalence points to be found. A larger value, i.e. a smaller measuring point density, permits quicker titrations. If you are using a dosing device with a small cylinder volume then a smaller measuring point density value may be beneficial. However, you should also set a smaller signal drift and a higher EP criterion at the same time.

Input range	**0 - 9**
Default value	**4**

Min. increment

This parameter is visible only when **Titration rate** = **user**.

This smallest permitted volume increment is added at the start of the titration and with steep curves in the region of the equivalence point. Very small values should only be used if a low titrant consumption is expected; otherwise unwanted equivalence points could be evaluated.

Input range	**0.05 - 999.90 µL**
Default value	**10.00 µL**

Max. increment

This parameter is visible only when **Titration rate** = **user**.

A maximum volume increment should be selected in the following cases:

- when titration consumption is very low up until the equivalence point is reached.
- when a start volume is dosed up until shortly before the equivalence point is reached.

- when the change of direction in the jumping range is very abrupt, because otherwise it is easily possible that an excessively large volume could be dosed in the region of the equivalence point.

The value should not be less than 1/100 cylinder volume.

Input range	**0.1 - 9,999.9 µL**
Selection	**off**
Default value	**off**

NOTICE

It is not advisable to select similar volumes for the minimum and the maximum increment. Monotonic equivalence point titration (MET) is appropriate for these applications.

Dosing rate

This parameter is visible only when **Titration rate** = **user**.

Rate at which the volume increments are dosed. The maximum dosing rate depends on the cylinder volume *(see chapter 9.1.1, page 117)*.

Input range	**0.01 - 166.00 mL/min**
Selection	**max.**
Default value	**max.**

Signal drift

This parameter is visible only when **Titration rate** = **user**.

Maximum permissible drift for the measured value acceptance, i.e. maximum change of the measured value per minute. This type of titration is often referred to as equilibrium titration.

NOTICE

A constant measured value is often only reached after a certain time, as mixing and the reaction itself require a certain time. The response time of an electrode can also increase with time, i.e., reaching a constant measured value takes longer and longer. Drift-controlled measured value acceptance is particularly advisable in such cases, as the measured values are only accepted when equilibrium has almost been reached.

Measuring mode pH, U and Ipol:

Input range	**0.1 - 999.0 mV/min**
Default value	**50.0 mV/min**
Selection	**off**

off
Measured value acceptance will take place after the maximum waiting time has elapsed. This can be useful when the titration reaction proceeds slowly or the electrode is slow to respond.

Measuring mode Upol:

Input range	**0.01 - 99.90 µA/min**
Default value	**50.00 µA/min**
Selection	**off**

off
Measured value acceptance will take place after the maximum waiting time has elapsed. This can be useful when the titration reaction proceeds slowly or the electrode is slow to respond.

Min. waiting time

This parameter is visible only when **Titration rate** = **user**.

The measured value is not accepted until the minimum waiting time has elapsed, even if the signal drift has already been reached. The minimum waiting time is only important for drift-controlled measurements.

Input range	**0 - 999,999 s**
Default value	**0 s**

Max. waiting time

This parameter is visible only when **Titration rate** = **user**.

If the signal drift has been switched off or has not yet been reached, then the measured value will be accepted when the maximum waiting time has elapsed.

Input range	**0 - 999,999 s**
Default value	**26 s**

Table 1 Default values of the predefined titration rates for DET

	Titration rate		
	slow	**optimal**	**fast**
Meas. point density	2	4	6
Min. increment	10.00 µL	10.00 µL	30.00 µL
Max. increment	off	off	off
Dosing rate	max.	max.	max.

	Titration rate		
	slow	**optimal**	**fast**
Signal drift – pH, U and Ipol – Upol	 20.0 mV/min 20.0 µA/min	 50.0 mV/min 50.0 µA/min	 80.0 mV/min 80.0 µA/min
Min. waiting time	0 s	0 s	0 s
Max. waiting time	38 s	26 s	21 s

Temperature

Manually entered titration temperature. If a temperature sensor is connected then the temperature will be measured continuously. This value is used for temperature correction in pH measurements.

Input range	**–20.0 - 150.0 °C**
Default value	**25.0 °C**

Sensor

Selection of the sensor from the sensor list. The selection depends on the measuring mode. Sensors are defined under **System ▸ Sensors**.

Selection	**Selection of configured sensors**

Solution

Selection of the solution from the solution list. We recommend always selecting the solution. This ensures that the correct data (titer, concentration, etc.) is always used for the calculation. Solutions are defined under **System ▸ Solutions**.

For buret units with integrated data chip, a check is made in the method run to verify whether the correct solution has been attached and whether the type of dosing drive matches. For buret units without integrated data chip, the cylinder volume and the type of dosing drive are checked. The validity of the titer is checked for the selected solution at the start of the determination.

Selection	**Selection of configured solutions** | **not defined**
Default value	**not defined**

not defined
No check takes place.

I(pol)

The polarization current is the current that is applied to a polarizable electrode during voltametric measurement. This parameter is available only with I(pol) determinations.

Input range	**–125 - 125 µA** (Increment: **1**)
Default value	**5 µA**

U(pol)

The polarization voltage is the voltage applied to the polarizable electrode during an amperometric measurement. This parameter is available only with U(pol) determinations.

Input range	**–1,250 - 1,250 mV** (Increment: **10**)
Default value	**400 mV**

Electrode test

In the case of polarizable electrodes, an electrode test can be carried out. A check is made that the electrode is properly connected and that no short-circuit is present. The electrode test is carried out when the determination is started. This parameter is available only with I(pol) and U(pol) determinations.

Selection	**on** | **off**
Default value	**off**

Stirrer

The stirrer is switched on at the start of the determination when this parameter is activated.

Selection	**on** | **off**
Default value	**on**

Stirring rate

Setting the stirring rate. It can be set in steps of –15 to +15. The default setting **8** corresponds to 1,000 rpm. The formula for calculating the rotational speed is specified in *chapter 9.2, page 118*. The optimum stirring rate can be tested in the manual control.

The algebraic sign of the stirring rate changes the stirring direction. When the stirrer is viewed from above, this means:

- "+": counterclockwise rotation
- "–": clockwise rotation

Input range	**–15 - 15**
Default value	**8**

7.1.3 Stop conditions

Menu ▶ Parameters ▶ Stop conditions

The conditions for canceling the titration are defined under **Stop conditions**.

Stop volume

The titration is canceled when the specified volume has been dosed since the start of the titration. This volume should be adjusted to the size of the titration vessel in order to prevent the contents from running over.

Input range	**0.00000 - 9,999.99 mL**
Default value	**100.000 mL**
Selection	**off**

Stop meas. value

The titration is canceled when the specified measured value has been reached since the start of the titration.

Measuring mode pH:

Input range	**–20.000 - 20.000**
Selection	**off**
Default value	**off**

Measuring mode U, Ipol:

Input range	**–1,250.0 - 1,250.0 mV**
Selection	**off**
Default value	**off**

Measuring mode Upol:

Input range	**–125.0 - 125.0 µA**
Selection	**off**
Default value	**off**

Stop EP

The titration is canceled when the specified number of equivalence points has been found.

Input range	**1 - 9**
Default value	**9**
Selection	**off**

Volume after EP

This volume will be added when the number of equivalence points defined under **Stop EP** has been found. The curve shape after the equivalence point can also be seen this way.

Input range	**0.01000 - 9,999.99 mL**
Selection	**off**
Default value	**off**

Stop time

The titration is canceled when the specified time has elapsed since the start of the titration.

Input range	**0 - 999,999 s**
Selection	**off**
Default value	**off**

Filling rate

Rate at which the dosing cylinder is filled after the titration. The maximum filling rate depends on the cylinder volume *(see chapter 9.1.1, page 117)*.

Input range	**0.01 - 166.00 mL/min**
Selection	**max.**
Default value	**max.**

7.1.4 Evaluation

Menu ▸ Parameters ▸ Evaluation

The parameters for the evaluation of the titration curve are defined under **Evaluation**.

Window

Activate this parameter if equivalence points are to be recognized only in a specific measured value range (window). Only one window can be defined.

Selection	**on** | **off**
Default value	**off**

Lower limit

This parameter is visible only when **Window** = **on**.

Measured value for the lower limit.

Measuring mode pH:

Input range	**–20.000 - 20.000**
Default value	**–20.000**

Measuring mode U, Ipol:

Input range	**–1,250.0 - 1,250.0 mV**
Default value	**–1,250.0 mV**

Measuring mode Upol:

Input range	**–125.00 - 125.00 µA**
Default value	**–125.00 µA**

Upper limit

This parameter is visible only when **Window** = **on**.

Measured value for the upper limit.

Measuring mode pH:

Input range	**–20.000 - 20.000**
Default value	**20.000**

Measuring mode U, Ipol:

Input range	**–1,250.0 - 1,250.0 mV**
Default value	**1,250.0 mV**

Measuring mode Upol:

Input range	**–125.00 - 125.00 µA**
Default value	**125.00 µA**

EP criterion

The equivalence point criterion found (ERC = Equivalence point Recognition Criterion) is compared with this value. Equivalence points whose ERC is less than the value defined here will be ignored.

Input range	**0 - 200**
Default value	**5**

EP recognition

This parameter allows you to filter out only the equivalence points that are being sought.

for Window = off

Selection	**all** | **greatest** | **last** | **off**
Default value	**all**

all
All equivalence points will be recognized.

greatest
Only the equivalence point with the greatest ERC value, i.e. the steepest jump, will be recognized.

last
Only the last equivalence point will be recognized.

off
No evaluation takes place.

for Window = on

Selection	**first** | **greatest** | **last**
Default value	**first**

first
Only the first equivalence point will be recognized.

greatest
Only the equivalence point with the greatest ERC value, i.e. the steepest jump, will be recognized.

last
Only the last equivalence point will be recognized.

Fixed EP1 at

The associated volume will be interpolated from the measuring point list for the measured value entered. The fixed endpoint must lie between the first and the final entry in the measuring point list.

Measuring mode pH:

Input range	**–20.000 - 20.000**
Selection	**off**
Default value	**off**

Measuring mode U, Ipol:

Input range	**–1,250.0 - 1,250.0 mV**
Selection	**off**
Default value	**off**

Measuring mode Upol:

Input range	**–125.00 - 125.00 µA**
Selection	**off**
Default value	**off**

Fixed EP2 at

See **Fixed EP1 at**.

Evaluation and equivalence point criterion with DET

The equivalence points (EP) are localized in a way similar to the Tubbs method [1][2]. The volume value of the equivalence point (V_E) is shifted from the inflection point (see arrow) towards the smaller circle of curvature for real asymmetric titration curves.

[1] C. F. Tubbs, *Anal. Chem.* **1954**, *26*, 1670–1671.

[2] E. Bartholomé, E. Biekert, H. Hellmann, H. Ley, M. Weigert, E. Weise, *Ullmanns Encyklopädie der technischen Chemie*, Vol. 5, Verlag Chemie, Weinheim, 1980, p. 659.

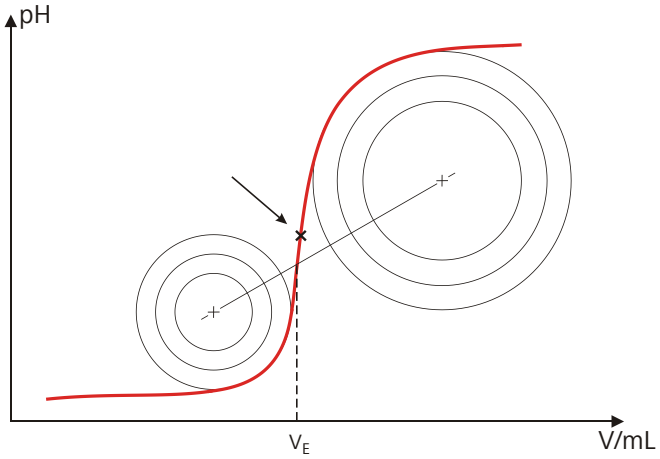


Figure 20 Tubbs method for determining the equivalence point

The figure shows that the evaluation still requires measured values from the measuring point list also after the equivalence point.

For the recognition of the EPs found, the set EP criterion is compared to the ERC (Equivalence point Recognition Criterion) found. The ERC is the first derivative of the titration curve combined with a mathematical function which is more sensitive for flat jumps than for steeper ones. EPs whose ERC is smaller than the defined EP criterion will not be recognized. The ERC is displayed in the results dialog for each discovered and recognized EP. If you adjust the EP criterion after the fact in order to recognize more or fewer EPs, then you can initiate the reevaluation in the results dialog with the **[Recalculate]** key.

7.1.5 Calculation

7.1.5.1 General

Menu ▸ Parameters ▸ Calculation

A maximum of five calculations can be defined in one method. A series of variables (raw data from the determination, previously calculated results) is available for the calculations. A definition can be made for each calculation as to whether the result is to be saved as a titer or as a common variable.

The result name is specified in the list for each calculation.

Edit

See the following chapter for editing the data of the selected calculation.

Delete

Delete the selected calculation.

7.1.5.2 Editing a calculation

Menu ▸ Parameters ▸ Calculation ▸ Edit

Result name

The result name is the text which will be shown in the results display and in the report.

Entry	**12 characters**
Default value	**empty**

R1=…R5=

Shows the calculation formula. A special editor is opened for the definition *(see chapter 5.3, page 24)*.

Entry	**44 characters**
Default value	**empty**

Decimal places

Number of decimal places used to display the result.

Input range	**0 - 5**
Default value	**2**

Result unit

The result unit is displayed and saved along with the result.

Selection	**%** | **mol/L** | **mmol/L** | **g/L** | **mg/L** | **mg/mL** | **ppm** | **g** | **mg** | **mL** | **mg/piece** | **°C** | **µL** | **mL/min** | **User-defined**
Default value	**%**

User-defined
A user-defined unit can be created. This will be added to the selection list. The previous entry will be overwritten as soon as the new unit has been defined. A blank entry can be generated this way as well.

Save as titer

The result can be saved as titer for the selected solution. If statistics has been switched on, then the current mean value of the determination series will be saved.

Selection	**on** | **off**
Default value	**off**

Save as CV

The calculated result can be saved as a method-independent variable, called a common variable. The result is then also available in other methods for calculations. If statistics has been switched on, then the current mean value of the determination series will be saved.

Selection	**on** | **off**
Default value	**off**

7.1.6 Statistics

Menu ▸ Parameters ▸ Statistics

The statistics calculation of a multiple determination is activated under **Statistics** and definition is made as to how many determinations the series contains.

Statistics

If this function is activated, then statistics calculations will be carried out for all of the defined results.

Selection	**on** | **off**
Default value	**off**

Number of determinations

The number of determinations that are carried out for the statistics calculations.

If an additional determination has to be added to the determination series, because one determination has been incorrect, for example, then this can be accomplished in the statistical overview *(see chapter 5.11, page 42)*.

Input range	**2 - 20**
Default value	**3**

7.1.7 Reports

Menu ▸ Parameters ▸ Reports

The reports that will be printed out automatically in connection with a determination are defined under **Reports**.

Results

The result report contains the calculated results, equivalence points and endpoints, sample data, etc.

Selection	**on** | **off**
Default value	**off**

Curve

Curve report. The width of the curve is defined in the system settings *(see "Graphics width", page 65)*.

Selection	**on** | **off**
Default value	**off**

Calculations/Statistics

Output of the calculation formulas for the individual results. Results are specified with full accuracy. This makes recalculation with an external program possible. If Statistics has been activated, then the following data will be printed out as well:

- Result and sample size of the individual determinations
- Mean value as well as absolute and relative standard deviation

Selection	**on** | **off**
Default value	**off**

Measuring point list

Output of the measuring point list.

Selection	**on** | **off**
Default value	**off**

Parameters

All of the parameters of the current method are printed out in the parameter report.

Selection	**on** | **off**
Default value	**off**

PC/LIMS

The PC/LIMS report is a machine-readable report with all of the data important for a determination. The PC/LIMS report can be saved as a TXT file on a USB storage medium or sent via an RS-232 interface to a LIMS. The output location is defined in the system settings *(see "PC/LIMS report", page 64)*.

The file name of the TXT file is constructed as follows: *PC_LIMS_Report-ID1-YYYYMMDD-hhmmss.txt*.

Selection	**on** | **off**
Default value	**off**

7.2 Monotonic equivalence point titrations (MET)

7.2.1 Start conditions

Menu ▸ Parameters ▸ Start conditions

The parameters that are carried out before the start of titration are defined under **Start conditions**.

Activation pulse

Output of an activation pulse on a remote line. This activation pulse starts a connected Dosimat.

Selection	**on** | **off**
Default value	**off**

Start delay time

Waiting time after the start of the determination, before titration is started. During this period, substances such auxiliary solution can be added with a Dosimat (parameterization on the Dosimat). However, this requires that the **Activation pulse** be enabled.

Input range	**0 - 999,999 s**
Default value	**0 s**

Start volume

Volume that is dosed prior to the start of the titration.

Input range	**0.00000 - 9,999.99 mL**
Default value	**0.00000 mL**

Dosing rate

Rate at which the start volume is dosed. The maximum dosing rate depends on the cylinder volume *(see chapter 9.1.1, page 117)*.

Input range	**0.01 - 166.00 mL/min**
Selection	**max.**
Default value	**max.**

Pause

Waiting time, e.g. for the electrode to settle down after the start or a reaction time after the dosing of a start volume.

Input range	**0 - 999,999 s**
Default value	**0 s**

Request sample ID

Selection of the sample identification that is queried in the method run.

Selection	**off** | **ID1** | **ID2** | **ID1&ID2**
Default value	**off**

Request sample size

If this parameter is activated, then the value for the sample size will be requested.

Selection	**on** | **off**
Default value	**off**

Request sample unit

If this parameter is activated, then the unit for the sample size will be requested.

Selection	**on** | **off**
Default value	**off**

Hold at request

If this parameter is activated, then the run will be paused during the request. If the parameter is switched off, the titration will be started in the background.

Selection	**on** | **off**
Default value	**on**

7.2.2 Titration parameters

Menu ▸ Parameters ▸ Titration parameters

Under **Titration parameters**, the parameters influencing the run of the entire titration are defined.

Titration rate

Three predefined sets of parameters can be selected for the titration rate.

Selection	**slow** | **optimal** | **fast** | **user**
Default value	**optimal**

slow
For titrations in which the finest details are also to be visible. This could, however, also lead to an increase in noise, which could result in unwanted equivalence points.

optimal
For all standard titrations. The parameters have been optimized for the most frequent applications.

fast
For fast and less critical titrations.

user
The individual titration parameters can be modified.

NOTICE

Select **optimal** as titration rate when you are developing a new titration method. This parameter is suitable for virtually all titrations and only needs adaptation in special cases.

The settings of the individual titration rates are listed in *table 2, page 88*.

Volume increment

This parameter is visible only when **Titration rate** = **user**.

Volume dosed at each dosing increment. High accuracy requires using the correct volume increment. A good guideline is 1/20 of the expected endpoint volume. The volume increment should be closer to 1/100 of the endpoint volume for steep jumps and closer to 1/10 for flat jumps.

Small volume increments are used for determining blank values or with very asymmetrical curves. The accuracy of the evaluation cannot be increased by using smaller increments as the measured value changes between two measuring points are then of the same order of magnitude as the noise.

Input range	**0.00005 - 999.900 mL**
Default value	**0.10000 mL**

Dosing rate

This parameter is visible only when **Titration rate** = **user**.

Rate at which the volume increments are dosed. The maximum dosing rate depends on the cylinder volume *(see chapter 9.1.1, page 117)*.

Input range	**0.01 - 166.00 mL/min**
Selection	**max.**
Default value	**max.**

Signal drift

This parameter is visible only when **Titration rate** = **user**.

Maximum permissible drift for the measured value acceptance, i.e. maximum change of the measured value per minute. This type of titration is often referred to as equilibrium titration.

NOTICE

A constant measured value is often only reached after a certain time, as mixing and the reaction itself require a certain time. The response time of an electrode can also increase with time, i.e., reaching a constant measured value takes longer and longer. Drift-controlled measured value acceptance is particularly advisable in such cases, as the measured values are only accepted when equilibrium has almost been reached.

Measuring mode pH, U and Ipol:

Input range	**0.1 - 999.0 mV/min**
Default value	**50.0 mV/min**
Selection	**off**

off
Measured value acceptance will take place after the maximum waiting time has elapsed. This can be useful when the titration reaction proceeds slowly or the electrode is slow to respond.

Measuring mode Upol:

Input range	**0.01 - 99.90 µA/min**
Default value	**50.00 µA/min**
Selection	**off**

off
Measured value acceptance will take place after the maximum waiting time has elapsed. This can be useful when the titration reaction proceeds slowly or the electrode is slow to respond.

Min. waiting time

This parameter is visible only when **Titration rate** = **user**.

The measured value is not accepted until the minimum waiting time has elapsed, even if the signal drift has already been reached. The minimum waiting time is only important for drift-controlled measurements.

Input range	**0 - 999,999 s**
Default value	**0 s**

Max. waiting time

This parameter is visible only when **Titration rate** = **user**.

If the signal drift has been switched off or has not yet been reached, then the measured value will be accepted when the maximum waiting time has elapsed.

Input range	**0 - 999,999 s**
Default value	**26 s**

Table 2 Default values of the predefined titration rates for MET

	Titration rate		
	slow	**optimal**	**fast**
Volume increment	0.05000 mL	0.10000 mL	0.20000 mL
Dosing rate	max.	max.	max.
Signal drift – pH, U and Ipol – Upol	 20.0 mV/min 20.0 µA/min	 50.0 mV/min 50.0 µA/min	 80.0 mV/min 80.0 µA/min
Min. waiting time	0 s	0 s	0 s
Max. waiting time	38 s	26 s	21 s

Temperature

Manually entered titration temperature. If a temperature sensor is connected then the temperature will be measured continuously. This value is used for temperature correction in pH measurements.

Input range	**–20.0 - 150.0 °C**
Default value	**25.0 °C**

Sensor

Selection of the sensor from the sensor list. The selection depends on the measuring mode. Sensors are defined under **System ▸ Sensors**.

Selection	**Selection of configured sensors**

Solution

Selection of the solution from the solution list. We recommend always selecting the solution. This ensures that the correct data (titer, concentration, etc.) is always used for the calculation. Solutions are defined under **System ▸ Solutions**.

For buret units with integrated data chip, a check is made in the method run to verify whether the correct solution has been attached and whether the type of dosing drive matches. For buret units without integrated data chip, the cylinder volume and the type of dosing drive are checked. The validity of the titer is checked for the selected solution at the start of the determination.

Selection	**Selection of configured solutions | not defined**
Default value	**not defined**

not defined
No check takes place.

I(pol)

The polarization current is the current that is applied to a polarizable electrode during voltametric measurement. This parameter is available only with I(pol) determinations.

Input range	**–125 - 125 µA** (Increment: **1**)
Default value	**5 µA**

U(pol)

The polarization voltage is the voltage applied to the polarizable electrode during an amperometric measurement. This parameter is available only with U(pol) determinations.

Input range	**–1,250 - 1,250 mV** (Increment: **10**)
Default value	**400 mV**

Electrode test

In the case of polarizable electrodes, an electrode test can be carried out. A check is made that the electrode is properly connected and that no short-circuit is present. The electrode test is carried out when the determination is started. This parameter is available only with I(pol) and U(pol) determinations.

Selection	**on** | **off**
Default value	**off**

Stirrer

The stirrer is switched on at the start of the determination when this parameter is activated.

Selection	**on** | **off**
Default value	**on**

Stirring rate

Setting the stirring rate. It can be set in steps of –15 to +15. The default setting **8** corresponds to 1,000 rpm. The formula for calculating the rotational speed is specified in *chapter 9.2, page 118*. The optimum stirring rate can be tested in the manual control.

The algebraic sign of the stirring rate changes the stirring direction. When the stirrer is viewed from above, this means:

- "+": counterclockwise rotation
- "–": clockwise rotation

Input range	**–15 - 15**
Default value	**8**

7.2.3 Stop conditions

Menu ▶ Parameters ▶ Stop conditions

The conditions for canceling the titration are defined under **Stop conditions**.

Stop volume

The titration is canceled when the specified volume has been dosed since the start of the titration. This volume should be adjusted to the size of the titration vessel in order to prevent the contents from running over.

Input range	**0.00000 - 9,999.99 mL**
Default value	**100.000 mL**
Selection	**off**

Stop meas. value

The titration is canceled when the specified measured value has been reached since the start of the titration.

Measuring mode pH:

Input range	**–20.000 - 20.000**
Selection	**off**
Default value	**off**

Measuring mode U, Ipol:

Input range	**–1,250.0 - 1,250.0 mV**
Selection	**off**
Default value	**off**

Measuring mode Upol:

Input range	**–125.0 - 125.0 µA**
Selection	**off**
Default value	**off**

Stop EP

The titration is canceled when the specified number of equivalence points has been found.

Input range	**1 - 9**
Default value	**9**
Selection	**off**

Volume after EP

This volume will be added when the number of equivalence points defined under **Stop EP** has been found. The curve shape after the equivalence point can also be seen this way.

Input range	**0.01000 - 9,999.99 mL**
Selection	**off**
Default value	**off**

Stop time

The titration is canceled when the specified time has elapsed since the start of the titration.

Input range	**0 - 999,999 s**
Selection	**off**
Default value	**off**

Filling rate

Rate at which the dosing cylinder is filled after the titration. The maximum filling rate depends on the cylinder volume *(see chapter 9.1.1, page 117)*.

Input range	**0.01 - 166.00 mL/min**
Selection	**max.**
Default value	**max.**

7.2.4 Evaluation

Menu ▸ Parameters ▸ Evaluation

The parameters for the evaluation of the titration curve are defined under **Evaluation**.

Window

Activate this parameter if equivalence points are to be recognized only in a specific measured value range (window). Only one window can be defined.

Selection	**on** | **off**
Default value	**off**

Lower limit

This parameter is visible only when **Window** = **on**.

Measured value for the lower limit.

Measuring mode pH:

Input range	**–20.000 - 20.000**
Default value	**–20.000**

Measuring mode U, Ipol:

Input range	**–1,250.0 - 1,250.0 mV**
Default value	**–1,250.0 mV**

Measuring mode Upol:

Input range	**–125.00 - 125.00 µA**
Default value	**–125.00 µA**

Upper limit

This parameter is visible only when **Window** = **on**.

Measured value for the upper limit.

Measuring mode pH:

Input range	**–20.000 - 20.000**
Default value	**20.000**

Measuring mode U, Ipol:

Input range	**–1,250.0 - 1,250.0 mV**
Default value	**1,250.0 mV**

Measuring mode Upol:

Input range	**–125.00 - 125.00 µA**
Default value	**125.00 µA**

EP criterion

The equivalence point criterion found (ERC = Equivalence point Recognition Criterion) is compared with this value. Equivalence points whose ERC is less than the value defined here will be ignored.

Measuring mode pH:

Input range	**0.10 - 9.99**
Default value	**0.50**

Measuring mode U, Ipol:

Input range	**1 - 999 mV**
Default value	**30 mV**

Measuring mode Upol:

Input range	**0.1 - 99.9 µA**
Default value	**2.0 µA**

EP recognition

This parameter allows you to filter out only the equivalence points that are being sought.

for Window = off

Selection	**all** | **greatest** | **last** | **off**
Default value	**all**

all
All equivalence points will be recognized.

greatest
Only the equivalence point with the greatest ERC value, i.e. the steepest jump, will be recognized.

last
Only the last equivalence point will be recognized.

off
No evaluation takes place.

for Window = on

Selection	**first** | **greatest** | **last**
Default value	**first**

first
Only the first equivalence point will be recognized.

greatest
Only the equivalence point with the greatest ERC value, i.e. the steepest jump, will be recognized.

last
Only the last equivalence point will be recognized.

Fixed EP1 at

The associated volume will be interpolated from the measuring point list for the measured value entered. The fixed endpoint must lie between the first and the final entry in the measuring point list.

Measuring mode pH:

Input range	**–20.000 - 20.000**
Selection	**off**
Default value	**off**

Measuring mode U, Ipol:

Input range	**–1,250.0 - 1,250.0 mV**
Selection	**off**
Default value	**off**

Measuring mode Upol:

Input range	**–125.00 - 125.00 µA**
Selection	**off**
Default value	**off**

Fixed EP2 at

See **Fixed EP1 at**.

Evaluation and equivalence point criterion with MET

The equivalence points (EPs) are localized by a method based on the Fortuin method which has been adapted by Metrohm for numerical methods. A search is made for the largest measured value change (Δ_n). The exact EP is determined by using an interpolation factor ρ which depends on the Δ values before and after Δ_n.

$$V_{EP} = V_0 + \rho \cdot \Delta V$$

V_{EP}: EP volume

V_0: Dosed total volume before Δ_n

ΔV: Volume increment

ρ: Interpolation factor according to Fortuin

For the recognition of the EPs found, the set EP criterion is compared to the ERC (Equivalence point Recognition Criterion) found. The ERC is the sum of the measured value changes before and after the jump:

$$|\Delta_{n-2}| + |\Delta_{n-1}| + |\Delta_n| + |\Delta_{n+1}| + |\Delta_{n+2}|$$

In certain cases only three or only a single summand are taken into account.

EPs whose ERC is smaller than the defined EP criterion will not be recognized. The ERC is displayed in the results dialog for each discovered and recognized EP. If you adjust the EP criterion after the fact in order to recognize more or fewer EPs, then you can initiate the reevaluation in the results dialog with the **[Recalculate]** key.

7.2.5 Calculation

7.2.5.1 General

Menu ▸ Parameters ▸ Calculation

A maximum of five calculations can be defined in one method. A series of variables (raw data from the determination, previously calculated results) is available for the calculations. A definition can be made for each calculation as to whether the result is to be saved as a titer or as a common variable.

The result name is specified in the list for each calculation.

Edit

See the following chapter for editing the data of the selected calculation.

Delete

Delete the selected calculation.

7.2.5.2 Editing a calculation

Menu ▸ Parameters ▸ Calculation ▸ Edit

Result name

The result name is the text which will be shown in the results display and in the report.

Entry	**12 characters**
Default value	**empty**

R1=…R5=

Shows the calculation formula. A special editor is opened for the definition *(see chapter 5.3, page 24)*.

Entry	**44 characters**
Default value	**empty**

Decimal places

Number of decimal places used to display the result.

Input range	**0 - 5**
Default value	**2**

Result unit

The result unit is displayed and saved along with the result.

Selection	**%** | **mol/L** | **mmol/L** | **g/L** | **mg/L** | **mg/mL** | **ppm** | **g** | **mg** | **mL** | **mg/piece** | **°C** | **µL** | **mL/min** | **User-defined**
Default value	**%**

User-defined
A user-defined unit can be created. This will be added to the selection list. The previous entry will be overwritten as soon as the new unit has been defined. A blank entry can be generated this way as well.

Save as titer

The result can be saved as titer for the selected solution. If statistics has been switched on, then the current mean value of the determination series will be saved.

Selection	**on** | **off**
Default value	**off**

Save as CV

The calculated result can be saved as a method-independent variable, called a common variable. The result is then also available in other methods for calculations. If statistics has been switched on, then the current mean value of the determination series will be saved.

Selection	**on** | **off**
Default value	**off**

7.2.6 Statistics

Menu ▸ Parameters ▸ Statistics

The statistics calculation of a multiple determination is activated under **Statistics** and definition is made as to how many determinations the series contains.

Statistics

If this function is activated, then statistics calculations will be carried out for all of the defined results.

Selection	**on** | **off**
Default value	**off**

Number of determinations

The number of determinations that are carried out for the statistics calculations.

If an additional determination has to be added to the determination series, because one determination has been incorrect, for example, then this can be accomplished in the statistical overview *(see chapter 5.11, page 42)*.

Input range	**2 - 20**
Default value	**3**

7.2.7 Reports

Menu ▸ Parameters ▸ Reports

The reports that will be printed out automatically in connection with a determination are defined under **Reports**.

Results

The result report contains the calculated results, equivalence points and endpoints, sample data, etc.

Selection	**on** | **off**
Default value	**off**

Curve

Curve report. The width of the curve is defined in the system settings *(see "Graphics width", page 65)*.

Selection	**on** | **off**
Default value	**off**

Calculations/Statistics

Output of the calculation formulas for the individual results. Results are specified with full accuracy. This makes recalculation with an external program possible. If Statistics has been activated, then the following data will be printed out as well:

- Result and sample size of the individual determinations
- Mean value as well as absolute and relative standard deviation

Selection	**on** | **off**
Default value	**off**

Measuring point list

Output of the measuring point list.

Selection	**on** | **off**
Default value	**off**

Parameters

All of the parameters of the current method are printed out in the parameter report.

Selection	**on** | **off**
Default value	**off**

PC/LIMS

The PC/LIMS report is a machine-readable report with all of the data important for a determination. The PC/LIMS report can be saved as a TXT file on a USB storage medium or sent via an RS-232 interface to a LIMS. The output location is defined in the system settings *(see "PC/LIMS report", page 64)*.

The file name of the TXT file is constructed as follows: *PC_LIMS_Report-ID1-YYYYMMDD-hhmmss.txt*.

Selection	**on** | **off**
Default value	**off**

7.3 Endpoint titrations (SET)

7.3.1 Conditioning

Menu ▸ Parameters ▸ Conditioning

The conditions required for conditioning are defined under **Conditioning**.

Conditioning

If this parameter is switched on, then the first time the titration is started the working medium will be titrated to the endpoint with the specified control parameters. The status is kept stable. The actual method run does not begin until **[START]** has been pressed once more. Conditioning will be carried out again automatically after the titration.

Selection	**on** | **off**
Default value	**off**

Start drift

Conditioning OK will be displayed as soon as this volume drift has been reached and the titration can be started.

Input range	**1 - 999 µL/min**
Default value	**20 µL/min**

Drift correction

The endpoint volume can be corrected for drift. This involves multiplying the volume drift by the drift correction time and then subtracting the resulting value from the endpoint volume. The drift correction time is the time interval between the end of the conditioning process and the end of the determination.

Selection	**auto** | **manual** | **off**
Default value	**off**

auto
The value of the current volume drift is automatically applied at the start of the titration.

manual
If the volume drift is known throughout a longer period of time, this can be entered manually.

off
No drift correction takes place.

Drift value

This parameter is visible only when **Drift correction** = **manual**.

Volume drift for manual drift correction.

Input range	**0.0 - 99.9 µL/min**
Default value	**0.0 µL/min**

Cond. stop volume

Maximum permissible volume that can be dosed during conditioning. Conditioning is stopped when the specified volume is dosed. If conditioning is continued by pressing **[START]** once again, then the titrant volume that has already been dosed will not be taken into account; i.e. the dosing starts again at zero. The stop volume should be adjusted to the size of the titration cell in order to prevent any overflow.

Input range	**0.00000 - 9,999.99 mL**
Default value	**20.0000 mL**
Selection	**off**

Cond. stop time

Maximum permissible time over which conditioning may take place. Conditioning is stopped when the specified time has elapsed.

Input range	**0 - 999,999 s**
Selection	**off**
Default value	**off**

7.3.2 Start conditions

Menu ▸ Parameters ▸ Start conditions

The parameters that are carried out before the start of titration are defined under **Start conditions**.

Activation pulse

Output of an activation pulse on a remote line. This activation pulse starts a connected Dosimat.

Selection	**on** | **off**
Default value	**off**

Start delay time

Waiting time after the start of the determination, before titration is started. During this period, substances such auxiliary solution can be added with a Dosimat (parameterization on the Dosimat). However, this requires that the **Activation pulse** be enabled.

Input range	**0 - 999,999 s**
Default value	**0 s**

Start volume

Volume that is dosed prior to the start of the titration.

Input range	**0.00000 - 9,999.99 mL**
Default value	**0.00000 mL**

Dosing rate

Rate at which the start volume is dosed. The maximum dosing rate depends on the cylinder volume *(see chapter 9.1.1, page 117)*.

Input range	**0.01 - 166.00 mL/min**
Selection	**max.**
Default value	**max.**

Pause

Waiting time, e.g. for the electrode to settle down after the start or a reaction time after the dosing of a start volume.

Input range	**0 - 999,999 s**
Default value	**0 s**

Request sample ID

Selection of the sample identification that is queried in the method run.

Selection	**off** | **ID1** | **ID2** | **ID1&ID2**
Default value	**off**

Request sample size

If this parameter is activated, then the value for the sample size will be requested.

Selection	**on** | **off**
Default value	**off**

Request sample unit

If this parameter is activated, then the unit for the sample size will be requested.

Selection	**on** | **off**
Default value	**off**

Hold at request

If this parameter is activated, then the run will be paused during the request. If the parameter is switched off, the titration will be started in the background.

Selection	**on** | **off**
Default value	**on**

7.3.3 Titration parameters

Menu ▸ Parameters ▸ Titration parameters

Under **Titration parameters**, the parameters influencing the run of the entire titration are defined.

Solution

Selection of the solution from the solution list. We recommend always selecting the solution. This ensures that the correct data (titer, concentration, etc.) is always used for the calculation. Solutions are defined under **System ▸ Solutions**.

For buret units with integrated data chip, a check is made in the method run to verify whether the correct solution has been attached and whether the type of dosing drive matches. For buret units without integrated data chip, the cylinder volume and the type of dosing drive are checked. The validity of the titer is checked for the selected solution at the start of the determination.

Selection	**Selection of configured solutions** | **not defined**
Default value	**not defined**

not defined
No check takes place.

Sensor

Selection of the sensor from the sensor list. The selection depends on the measuring mode. Sensors are defined under **System ▸ Sensors**.

Selection	**Selection of configured sensors**

I(pol)

The polarization current is the current that is applied to a polarizable electrode during voltametric measurement. This parameter is available only with I(pol) determinations.

Input range	**–125 - 125 µA** (Increment: **1**)
Default value	**5 µA**

U(pol)

The polarization voltage is the voltage applied to the polarizable electrode during an amperometric measurement. This parameter is available only with U(pol) determinations.

Input range	**–1,250 - 1,250 mV** (Increment: **10**)
Default value	**400 mV**

Electrode test

In the case of polarizable electrodes, an electrode test can be carried out. A check is made that the electrode is properly connected and that no short-circuit is present. The electrode test is carried out when the determination is started. This parameter is available only with I(pol) and U(pol) determinations.

Selection	**on** | **off**
Default value	**off**

Stirrer

The stirrer is switched on at the start of the determination when this parameter is activated.

Selection	**on** | **off**
Default value	**on**

Stirring rate

Setting the stirring rate. It can be set in steps of –15 to +15. The default setting **8** corresponds to 1,000 rpm. The formula for calculating the rotational speed is specified in *chapter 9.2, page 118*. The optimum stirring rate can be tested in the manual control.

The algebraic sign of the stirring rate changes the stirring direction. When the stirrer is viewed from above, this means:

- "+": counterclockwise rotation
- "–": clockwise rotation

Input range	**–15 - 15**
Default value	**8**

Temperature

Manually entered titration temperature. If a temperature sensor is connected then the temperature will be measured continuously. This value is used for temperature correction in pH measurements.

Input range	**–20.0 - 150.0 °C**
Default value	**25.0 °C**

Titration direction

The titration direction is normally determined automatically from the initial measured value and the set endpoint. It is recommended that you specify whenever possible whether the change of the measured value is positive or negative. If two endpoints have been set then the titration direction will be defined automatically. In this case the setting will be ignored.

Selection	**+** | **-** | **auto**
Default value	**auto**

+
Positive measured value change, i.e. in the direction of a higher pH value, greater voltage or greater current.

-
Negative measured value change, i.e. in the direction of a lower pH value, lesser voltage or lesser current.

auto
The titration direction is determined automatically from the initial measured value and the set endpoint.

Extraction time

Minimum duration of the titration. The titration will not be canceled during the extraction time, even if the endpoint has already been reached. The titration is, however, canceled if a stop condition is fulfilled during this time *(see chapter 7.3.6, page 106)*. The entry of an extraction time may be advisable, for instance, for the titration of sparingly soluble samples.

Input range	**0 - 999,999 s**
Default value	**0 s**

Time interval MP

Time interval for entering a measuring point in the measuring point list. The measuring point list is limited to 1000 measuring points.

Input range	**0.1 - 999,999.0 s**
Default value	**2.0 s**

7.3.4 Control parameters EP1

Menu ▸ Parameters ▸ Control parameters EP1

The control parameters for the first endpoint are defined under **Control parameters EP1**.

Endpoint 1 at

Measured value for the first endpoint.

Measuring mode pH:

Input range	**–20.000 - 20.000**
Selection	**off**
Default value	**off**

Measuring mode U and Ipol:

Input range	**–1,250.0 - 1,250.0 mV**
Selection	**off**
Default value	**off**

Measuring mode Upol:

Input range	**–125.00 - 125.00 µA**
Selection	**off**
Default value	**off**

Titration rate

Three predefined sets of parameters can be selected for the titration rate.

Selection	**slow** | **optimal** | **fast** | **user**
Default value	**optimal**

slow
For steep titration curves for which dosing must be carried out in small steps at the endpoint.

optimal
For all standard titrations. The parameters have been optimized for the most frequent applications.

fast
For flat titration curves for which the endpoint is reached only slowly.

user
The individual titration parameters can be modified.

The settings of the individual titration rates are listed in *table 3, page 105*.

Dynamics

This parameter is visible only when **Titration rate** = **user**.

This parameter defines the control range before the specified endpoint. Individual volume steps are dosed in the control range, the dosing is finely controlled. The closer the endpoint, the slower the dosing until the dosing rate defined under **Min. rate** has been reached. The larger the control range, the slower the titration. Outside the control range, dosing is carried out continuously, and the dosing rate is defined under **Max. rate**.

Measuring mode pH:

Input range	**0.001 - 20.000**
Default value	**2.000**
Selection	**off**

Measuring mode U and Ipol:

Input range	**0.1 - 1,250.0 mV**
Default value	**100.0 mV**
Selection	**off**

Measuring mode Upol:

Input range	**0.01 - 125.00 µA**
Default value	**10.00 µA**

Selection	**off**

Max. rate

This parameter is visible only when **Titration rate** = **user**.

Rate at which dosing is carried out outside of the control range. The maximum dosing rate depends on the cylinder volume *(see chapter 9.1.1, page 117)*.

Input range	**0.01 - 166.00 mL/min**
Default value	**10.00 mL/min**
Selection	**max.**

Min. rate

This parameter is visible only when **Titration rate** = **user**.

Rate at which dosing is carried out at the very beginning of the titration and in the control range at the end of the titration. This parameter has a decisive influence on the titration rate and thus also on the accuracy. The smaller the selected minimum rate, the slower the titration.

Input range	**0.01 - 9999.00 µL/min**
Default value	**25.00 µL/min**

Table 3 Default values of the predefined titration rates for SET

	Titration rate		
	slow	**optimal**	**fast**
Dynamics			
– pH	5.000	2.000	0.500
– U und Ipol	300.0 mV	100.0 mV	30.0 mV
– Upol	40.00 µA	10.00 µA	5.00 µA
Max. rate	1.00 mL/min	10.00 mL/min	maximum
Min. rate	5.00 µL/min	25.00 µL/min	50.00 µL/min

Stop criterion

The titration is canceled when the endpoint has been reached and this stop criterion has been fulfilled. If no stop criterion has been selected then the titration will not be canceled. The stop conditions *(see chapter 7.3.6, page 106)* always lead to a stop, even if the stop criterion has not been reached.

Selection	**drift** | **time** | **off**
Default value	**drift**

drift
The titration is canceled when the stop drift has been reached.

time
The titration is canceled if the endpoint has been exceeded during a certain time period (**Delay time**).

off
The titration will not be canceled until the stop conditions have been fulfilled.

Stop drift

This parameter is visible only when **Stop criterion** = **drift**.

The titration is canceled when the endpoint and the stop drift have been reached.

Input range	**1 - 999 µL/min**
Default value	**20 µL/min**

Delay time

This parameter is visible only when **Stop criterion** = **time**.

When the endpoint has been reached, the specified time is allowed to elapse after the last dosing and the titration is then stopped.

Input range	**0 - 999 s**
Default value	**10 s**

7.3.5 Control parameters EP2

Menu ▸ Parameters ▸ Control parameters EP2

The control parameters for the second endpoint are defined under **Control parameters EP2**. The parameters and input ranges are identical with those for the first endpoint.

7.3.6 Stop conditions

Menu ▸ Parameters ▸ Stop conditions

The conditions for canceling the titration are defined under **Stop conditions**, if this does not occur automatically. This could be the case when the endpoint set is not reached or if the stop criterion *(see "Stop criterion", page 105)* is not fulfilled.

Stop volume

The titration is canceled when the specified volume has been dosed since the start of the titration. This volume should be adjusted to the size of the titration vessel in order to prevent the contents from running over.

Input range	**0.00000 - 9,999.99 mL**
Default value	**100.000 mL**
Selection	**off**

Stop time

The titration is canceled when the specified time has elapsed following the termination of the start conditions.

Input range	**0 - 999,999 s**
Selection	**off**
Default value	**off**

Filling rate

Rate at which the dosing cylinder is filled after the titration. The maximum filling rate depends on the cylinder volume *(see chapter 9.1.1, page 117)*.

Input range	**0.01 - 166.00 mL/min**
Selection	**max.**
Default value	**max.**

7.3.7 Calculation

7.3.7.1 General

Menu ▸ Parameters ▸ Calculation

A maximum of five calculations can be defined in one method. A series of variables (raw data from the determination, previously calculated results) is available for the calculations. A definition can be made for each calculation as to whether the result is to be saved as a titer or as a common variable.

The result name is specified in the list for each calculation.

Edit

See the following chapter for editing the data of the selected calculation.

Delete

Delete the selected calculation.

7.3.7.2 Editing a calculation

Menu ▸ Parameters ▸ Calculation ▸ Edit

Result name

The result name is the text which will be shown in the results display and in the report.

Entry	**12 characters**
Default value	**empty**

R1=...R5=

Shows the calculation formula. A special editor is opened for the definition *(see chapter 5.3, page 24)*.

Entry	**44 characters**
Default value	**empty**

Decimal places

Number of decimal places used to display the result.

Input range	**0 - 5**
Default value	**2**

Result unit

The result unit is displayed and saved along with the result.

Selection	**%** | **mol/L** | **mmol/L** | **g/L** | **mg/L** | **mg/mL** | **ppm** | **g** | **mg** | **mL** | **mg/piece** | **°C** | **µL** | **mL/min** | **User-defined**
Default value	**%**

User-defined
A user-defined unit can be created. This will be added to the selection list. The previous entry will be overwritten as soon as the new unit has been defined. A blank entry can be generated this way as well.

Save as titer

The result can be saved as titer for the selected solution. If statistics has been switched on, then the current mean value of the determination series will be saved.

Selection	**on** | **off**
Default value	**off**

Save as CV

The calculated result can be saved as a method-independent variable, called a common variable. The result is then also available in other meth-

ods for calculations. If statistics has been switched on, then the current mean value of the determination series will be saved.

Selection	**on** | **off**
Default value	**off**

7.3.8 Statistics

Menu ▸ Parameters ▸ Statistics

The statistics calculation of a multiple determination is activated under **Statistics** and definition is made as to how many determinations the series contains.

Statistics

If this function is activated, then statistics calculations will be carried out for all of the defined results.

Selection	**on** | **off**
Default value	**off**

Number of determinations

The number of determinations that are carried out for the statistics calculations.

If an additional determination has to be added to the determination series, because one determination has been incorrect, for example, then this can be accomplished in the statistical overview *(see chapter 5.11, page 42)*.

Input range	**2 - 20**
Default value	**3**

7.3.9 Reports

Menu ▸ Parameters ▸ Reports

The reports that will be printed out automatically in connection with a determination are defined under **Reports**.

Results

The result report contains the calculated results, equivalence points and endpoints, sample data, etc.

Selection	**on** | **off**
Default value	**off**

Curve

Curve report. The width of the curve is defined in the system settings *(see "Graphics width", page 65)*.

Selection	**on** | **off**
Default value	**off**

Calculations/Statistics

Output of the calculation formulas for the individual results. Results are specified with full accuracy. This makes recalculation with an external program possible. If Statistics has been activated, then the following data will be printed out as well:

- Result and sample size of the individual determinations
- Mean value as well as absolute and relative standard deviation

Selection	**on** | **off**
Default value	**off**

Measuring point list

Output of the measuring point list.

Selection	**on** | **off**
Default value	**off**

Parameters

All of the parameters of the current method are printed out in the parameter report.

Selection	**on** | **off**
Default value	**off**

PC/LIMS

The PC/LIMS report is a machine-readable report with all of the data important for a determination. The PC/LIMS report can be saved as a TXT file on a USB storage medium or sent via an RS-232 interface to a LIMS. The output location is defined in the system settings *(see "PC/LIMS report", page 64)*.

The file name of the TXT file is constructed as follows: *PC_LIMS_Report-ID1-YYYYMMDD-hhmmss.txt*.

Selection	**on** | **off**
Default value	**off**

7.4 pH calibration (CAL)

7.4.1 Calibration parameters

Menu ▸ Parameters ▸ Calibration parameters

Under **Calibration parameters**, the parameters influencing the run of the entire calibration are defined.

Signal drift

Maximum permissible drift for the measured value acceptance, i.e. maximum change of the measured value per minute.

Input range	**0.1 - 999.0 mV/min**
Default value	**2.0 mV/min**
Selection	**off**

off
Measured value acceptance will take place after the maximum waiting time has elapsed. This can be useful when the electrode is slow to respond.

Min. waiting time

The measured value is not accepted until the minimum waiting time has elapsed, even if the signal drift has already been reached. The minimum waiting time is only important for drift-controlled measurements.

Input range	**0 - 999,999 s**
Default value	**10 s**

Max. waiting time

If the signal drift has been switched off or has not yet been reached, then the measured value will be accepted when the maximum waiting time has elapsed.

Input range	**0 - 999,999 s**
Default value	**110 s**

Temperature

Manually entered calibration temperature. If a temperature sensor is connected then the temperature will be measured continuously.

The temperature can also be entered during the run.

Input range	**–20.0 - 150.0 °C**
Default value	**25.0 °C**

Sensor

Selection of the sensor from the sensor list. The selection depends on the measuring mode. Sensors are defined under **System ▸ Sensors**.

Selection	**Selection of configured sensors**

Stirrer

The stirrer is switched on at the start of the determination when this parameter is activated.

Selection	**on** | **off**
Default value	**on**

Stirring rate

Setting the stirring rate. It can be set in steps of –15 to +15. The default setting **8** corresponds to 1,000 rpm. The formula for calculating the rotational speed is specified in *chapter 9.2, page 118*. The optimum stirring rate can be tested in the manual control.

The algebraic sign of the stirring rate changes the stirring direction. When the stirrer is viewed from above, this means:

- "+": counterclockwise rotation
- "–": clockwise rotation

Input range	**–15 - 15**
Default value	**8**

Sample changer

This parameter must be switched on for automatic calibrations with sample changers (e.g. 869 Compact Sample Changer). Because the buffers are changed by the sample changer, the run is not paused in order to request values. The 848 Titrino plus sends a signal (EOD) to the sample changer via the remote connection as soon as the measurement of one buffer has been completed *(see figure 25, page 125)*. The sample changer switches to the next buffer at that time.

The parameterization of the sample changer is described in the corresponding manual.

NOTICE

When calibrating with a sample changer, we recommend connecting the stirrer to the sample changer. However, the **Stirrer** parameter has to be disabled in this case.

Selection	**on** | **off**
Default value	**off**

7.4.2 Buffers

Menu ▸ Parameters ▸ Buffers

The buffer type and the number of buffers is defined under **Buffers**.

Buffer type

Selection of a predefined buffer series or definition of special buffers. In the case of predefined buffer series, the instrument automatically recognizes which buffer is involved.

Selection	**Baker** | **Beckman** | **DIN** | **Fisher** | **Fluka Basel** | **Hamilton** | **Merck CertiPUR** | **Merck Titrisol** | **Metrohm** | **Mettler** | **NIST** | **Precisa** | **Radiometer** | **Special**

Merck CertiPUR
Reference temperature = 25 °C. When using Merck CertiPUR buffers (20 °C) the buffer type **Merck Titrisol** must be selected.

Special
Up to five calibration buffers can be defined in the method. The automatic buffer recognition is not activated in this case. The buffers must be measured precisely in the specified sequence.

Number of buffers

Number of buffers that are used for calibration. If calibration is accomplished with more than two buffers, then they can be used repeatedly in order to give them more statistical weight. The first two buffers must, however, always be different from one another.

Selection	**1** | **2** | **3** | **4** | **5**
Default value	**2**

Buffer 1 pH

This parameter is visible only when **Buffer type** = **Special**.

Input range	**–20.000 - 20.000**
Default value	**7.000**

Buffer 2 pH

This parameter is visible only when **Buffer type** = **Special**.

Input range	**–20.000 - 20.000**
Default value	**4.000**
Selection	**off**

Buffer 3 pH

This parameter is visible only when **Buffer type** = **Special**.

Input range	**–20.000 - 20.000**
Selection	**off**
Default value	**off**

Buffer 4 pH

See **Buffer 3 pH**.

Buffer 5 pH

See **Buffer 3 pH**.

7.4.3 Reports

Menu ▸ Parameters ▸ Reports

The reports that will be printed out automatically in connection with a calibration are defined under **Reports**.

Results

The result report contains the specifications for the calibration (slope, pH(0), etc.).

Selection	**on** | **off**
Default value	**off**

Parameters

All of the parameters of the current method are printed out in the parameter report.

Selection	**on** | **off**
Default value	**off**

PC/LIMS

The PC/LIMS report is a machine-readable report with all of the data important for a determination. The PC/LIMS report can be saved as a TXT file on a USB storage medium or sent via an RS-232 interface to a LIMS. The output location is defined in the system settings *(see "PC/LIMS report", page 64)*.

The file name of the TXT file is constructed as follows: *PC_LIMS_Report-ID1-YYYYMMDD-hhmmss.txt*.

Selection	**on** | **off**
Default value	**off**

8 Troubleshooting

8.1 SET titration

Problem	Cause	Remedy
The titration will not be finished.	*The minimum dosing rate is too low.*	Define **Titration rate** = **user** and increase the minimum rate (**Min. rate**) *(see chapter 7.3.4, page 103)*.
	The stop criterion is unsuitable.	Adjust the control parameters *(see chapter 7.3.4, page 103)*: ▪ Increase the stop drift. ▪ Select a short delay time.
The sample is overtitrated.	*The control parameters are unsuitable.*	Adjust the control parameters *(see chapter 7.3.4, page 103)*: ▪ Select **Titration rate** = **slow**. ▪ Define **Titration rate** = **user** and increase the control range. ▪ Define **Titration rate** = **user** and reduce the maximum rate (**Max. rate**). ▪ Define **Titration rate** = **user** and reduce the minimum rate (**Min. rate**). ▪ Stir faster. ▪ Arrange the electrode and buret tip to an optimum.
	The electrode responds too slowly.	Replace the electrode.
The titration time is too long.	*The control parameters are unsuitable.*	Adjust the control parameters *(see chapter 7.3.4, page 103)*: ▪ Select **Titration rate** = **optimal** or **fast**. ▪ Define **Titration rate** = **user** and reduce the control range. ▪ Define **Titration rate** = **user** and increase the maximum rate (**Max. rate**). ▪ Define **Titration rate** = **user** and increase the minimum rate (**Min. rate**).
The results are spread widely.	*The minimum dosing rate is too high.*	Define **Titration rate** = **user** and reduce the minimum rate (**Min. rate**) *(see chapter 7.3.4, page 103)*.

Problem	Cause	Remedy
	The electrode responds too slowly.	Replace the electrode.

8.2 Miscellaneous

Problem	Cause	Remedy
No report is printed.	*The printer is not recognized by the instrument.*	▪ Switch the 848 Titrino plus off and then back on again. ▪ Use a USB hub and connect the printer to the USB hub.
	The printer model is not compatible.	Use a printer which fulfills the required specifications *(see chapter 9.4.4, page 121)*.
The USB keyboard or the PC mouse does not function.	*The keyboard or mouse is not recognized by the instrument.*	▪ Switch the 848 Titrino plus off and then back on again. ▪ Use a USB hub and connect the keyboard and mouse to the USB hub.
	The keyboard or the mouse is not compatible.	Use a model which fulfills the required specifications *(see chapter 9.4, page 119)*.
The display is no longer readable.	*The contrast is set incorrectly.*	Adjust the contrast correctly *(see chapter 6.1, page 53)*.
Mettler XP balances send "R" or "O ----" as ID1.	*The automatic calibration of the balance is activated.*	Deactivate the automatic calibration.
Message 020-511 "Action not possible" is displayed.	*The USB flash drive is no longer connected.*	1. Connect the USB flash drive. 2. Switch the instrument off and then back on again.
	The USB flash drive is full.	▪ Use a different USB flash drive. ▪ Delete files with the aid of a PC.

9 Appendix

9.1 Exchange unit

9.1.1 Maximum dosing and filling rate

The maximum dosing rate and maximum filling rate for the exchange unit depend on the cylinder volume:

Cylinder volume	Maximum rate
1 mL	3.00 mL/min
5 mL	15.00 mL/min
10 mL	30.00 mL/min
20 mL	60.00 mL/min
50 mL	150.00 mL/min

Independent of the cylinder volume, values ranging from 0.01 to 166.00 mL/min can always be entered. When the function is carried out the rate will be, if necessary, decreased automatically to the highest possible value.

9.1.2 Parameters for the preparing (PREP)

The **PREP** function (Preparing) is used to rinse the cylinder and tubings of the exchange unit and fill them air bubble-free. You should carry out this function before the first determination or once per day.

Preparing is carried out with the following, non-alterable settings:

- The entire cylinder volume is dosed twice with the maximum dosing rate.

9.2 Stirring rate

The stirring rate can be adjusted in steps from –15 to +15.

The approximate rotational speed for the internal magnetic stirrer (depends on the product version) can be calculated with the following formula:

Rotational speed/min (r/min) = 125 · Stirring rate

Example:

Configured stirring rate: 8

Rotational speed in revolutions per minutes = 125 · 8 = 1,000

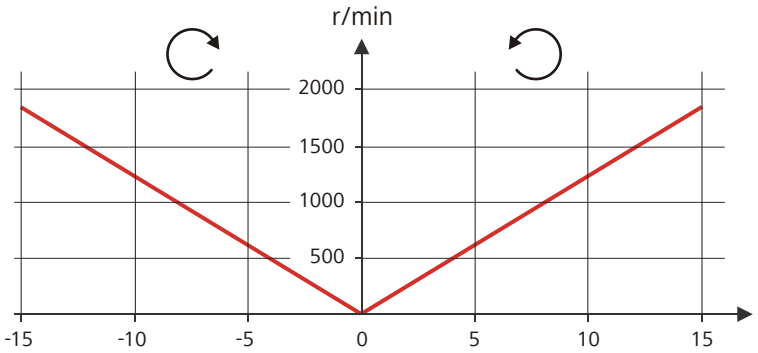


Figure 21 Rotational speed depending on the stirring rate

The information on the separately connectable 802 propeller stirrer can be found in the "802 Stirrer" manual.

9.3 Balance

The sample size and the associated unit can be sent from a connected balance. The sample size is transmitted as a number with up to ten characters (including algebraic sign and decimal point).

Sample size and unit are sent as a single character string. They are separated by a space character. The string is terminated with the ASCII characters **CR** and **LF**.

If the balance sends a negative sample size (e.g. when you are reweighing a sample), then the algebraic sign is adopted. The algebraic sign is, however, ignored for the calculations.

NOTICE

With some balances, the sample identification and the method can be sent in addition to the sample size.

Make sure that the balance does not send the sample size until the end.

Mettler AX

For the Mettler AX balance, the fields that contain the sample identification or the method must be designated as follows:

- Designation for the field with the method name: **METHOD**
- Designation for the field with sample identification 1: **ID1**
- Designation for the field with sample identification 2: **ID2**

9.4 USB devices

NOTICE

USB peripheral devices that are to be connected must support either the *USB 1.0/1.1 (Full Speed)* or the *USB 2.0 (High Speed)* standard. The maximum data transfer rate is however in any case 12 MBit/s.

Keyboards, PC mice and barcode readers are so-called HID devices (**H**uman **I**nterface **D**evice) and can be connected via a USB hub only.

Printers should also be connected via a USB hub. Depending on the manufacturer or printer type a direct connection is however possible.

9.4.1 6.2147.000 numerical USB keypad

The **[Num Lock]** key must be pressed for navigating in the dialog. The arrow keys are effective in conjunction with it.

The respective editing dialog must be opened for the numerical input.

Table 4 Key assignment

Key of the 848 Titrino plus or function in the editing dialog	Key on the numerical USB keypad
[BACK]	**[Home]**
[⇧] [⇩]	**[↑] [↓]**
[⇦] [⇨]	**[←] [→]**
[OK]	**[Enter]**

Key of the 848 Titrino plus or function in the editing dialog	Key on the numerical USB keypad
[+–]	**[BS]** (backspace)
Clear	**[Del]**
Accept	**[Home]**

9.4.2 Key assignment of a USB keyboard

A commercially available USB keyboard can be connected to make it easier to enter text and numbers.

The respective editing dialog must be opened for the text input and numerical input.

Table 5 Key assignment

Key of the 848 Titrino plus or function in the editing dialog	Key on the USB keyboard
[BACK]	**[Esc]**
[⇧] [⇩]	**[↑] [↓]**
[⇦] [⇨]	**[←] [→]**
[OK]	**[↵]** (enter key) *or* **[Enter]** on the numerical keypad
[STOP]	**[Ctrl]** + **[S]**
[START]	**[Ctrl]** + **[G]**
[+–]	**[←]** (backspace)
Clear	**[Delete]**
Cancel	**[Ctrl]** + **[Q]**
Accept	**[Esc]**

NOTICE

The lettering of the USB keyboard may differ from above lettering, depending on the country-specific keyboard used.

9.4.3 PC mouse

In order to make navigating in the dialog of the 848 Titrino plus easier, a PC mouse can be connected.

Table 6 Mouse functions

Key of the 848 Titrino plus	Mouse function
[OK]	Left mouse button
[BACK]	Right mouse button
[⇧] [⇩] [⇦] [⇨]	Mouse movement vertical/horizontal
[⇧] [⇩]	Scroll wheel vertical

9.4.4 Printer

The range of USB printers available is extremely varied and constantly changing. The following points must be taken into account when selecting a printer:

- USB interface necessary
- Printer language: HP-PCL, Canon BJL Commands, Epson ESC P/2 or ESC/POS

NOTICE

Inexpensive printers are often designed solely for use with a PC and may not be equipped with one of the printer languages listed above. Such models are not suitable for this reason.

9.5 System initialization

In very rare instances, a faulty file system (e.g. because of a program crash) may lead to an impairment of program functioning. The internal file system must be initialized in such cases.

CAUTION

All user data (methods, solutions, etc.) are deleted if a system initialization is carried out. Afterwards, the instrument will have the factory settings again.

We recommend creating a backup of the system at regular intervals in order to avoid data losses.

After a system initialization the program versions and language files do not have to be reloaded. Only the selection of the dialog language may have to be reset in the system settings.

Proceed as follows for the system initialization:

1 Switching off the instrument

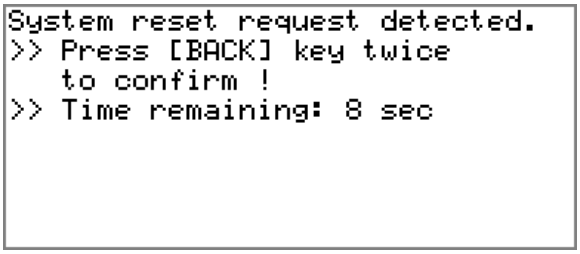
- Keep the red **[STOP]** key pressed down for at least 3 s.

A progress bar is displayed. If the key is released during this time, then the instrument will not be switched off.

2 Switching on the instrument

- Keep the red **[STOP]** key pressed down for approx. 10 s.

The dialog for confirmation of the initialization is displayed for 8 s. The initialization must be confirmed during this time.



3 Confirming the initialization

NOTICE

If the request is not confirmed within 8 s, then the procedure will be canceled.

- Press **[BACK]** twice.

Initialization is started. The process takes approximately 80 s. The instrument will be automatically restarted after successful initialization.

9.6 Remote interface

9.6.1 Pin assignment of the remote interface

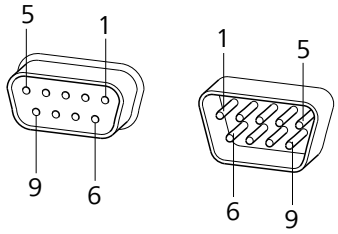


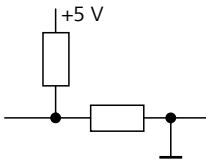
Figure 22 Pin assignment of remote socket and remote plug

The above figure of the pin assignment applies for all Metrohm instruments with 9-pin D-Sub remote connector.

Table 7 Inputs and outputs of the remote interface

Pin No.	Assignment	Function
1	Output 0	Ready/EOD
2	Output 1	Activate/Dosimat
3	Output 2	Titration
4	Output 3	Cond OK
5	Output 4	Error
6	0 volt (GND)	
7	+5 volts	
8	Input 0	Start
9	Input 1	Stop

Inputs

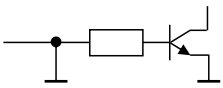


approx. 5 kΩ Pull-up

t_p > 100 ms

active = low, inactive = high

Outputs



Open Collector

t_p > 200 ms

active = low, inactive = high

I_C = 20 mA, V_{CEO} = 40 V

+5 V: maximum load = 20 mA

9.6.2 Status diagram of the remote interface

Titration mode DET/MET

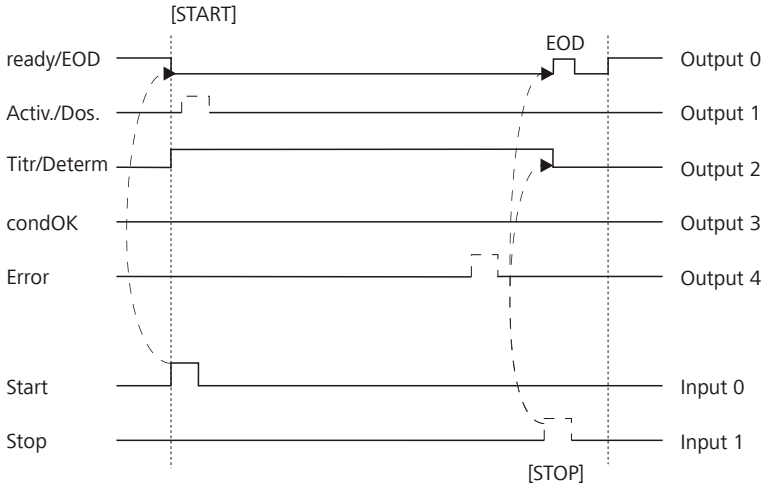


Figure 23 Remote status diagram DET/MET

Titration mode SET

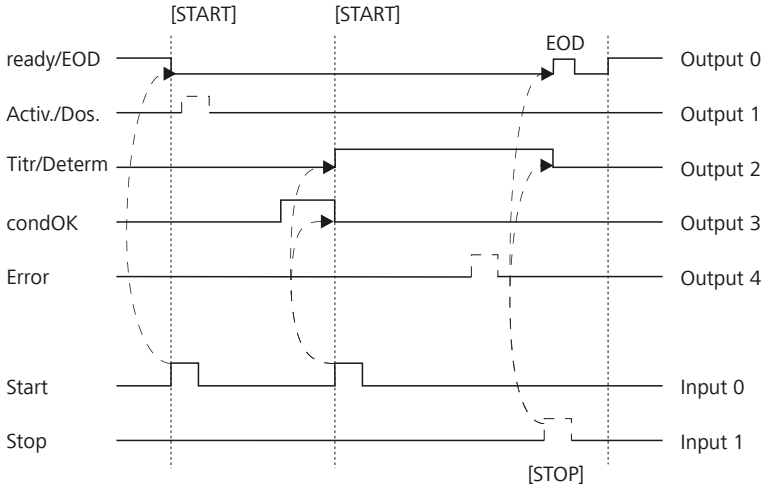


Figure 24 Remote status diagram SET

Measuring mode CAL

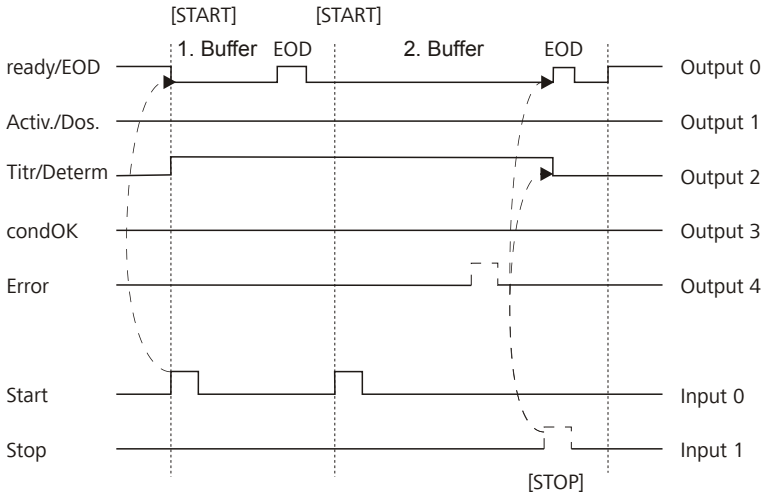


Figure 25 Remote status diagram CAL

EOD = End of Determination

9.7 Remote control via an RS-232 connection

The 848 Titrino plus can be remote controlled via an RS-232 connection. For this, a **6.2148.030 RS-232/USB Box** is necessary. Connect the RS-232/USB Box to the USB interface of the instrument.

The RS-232/USB Box has two connectors for RS-232 instruments. The RS-232 remote control functions only through the connector **RS-232/2**. The connector RS-232/1 is designed for connection with a balance. Connect the **RS-232/2** connector of the RS-232/USB Box to a serial interface (COM interface marked with the symbol **IOIOI**) of a PC. Use a **6.2134.040 connection cable**.

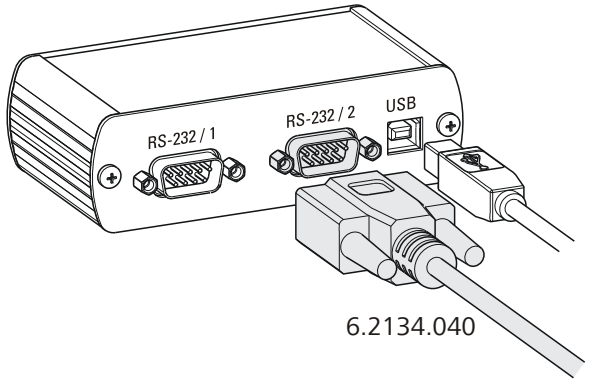


Figure 26 Connecting the RS-232/USB Box to the PC

Interface parameters

We recommend the following parameters for the RS-232 interface **COM2**:

- Baud rate: **19200**
- Data bits: **8**
- Stop bits: **1**
- Parity: **none**
- Handshake: **software**

On the 848 Titrino plus, adjust the interface parameters under **Menu ▸ System ▸ External devices ▸ COM2 settings**.

Transfer protocol

The data communication is synchronous. On each command there is an acknowledgement by the instrument.

A command must be sent to the instrument with the control characters **CR LF** as terminator. The acknowledgements of the instrument will also be transferred with **CR LF** as terminator.

The instrument does not send spontaneous messages.

9.7.1 Commands and variables

Command	Function	Comment
$G	Start/Continue	Corresponds to the key **[START]** or **[Continue]**
$S	Stop	Corresponds to the key **[STOP]**
$H	Hold	Hold the method run
$D	Scan instrument status	Acknowledgements: *Ready;0*, *Busy;0* or *Hold;0* (0 = no message) If a message on the instrument requires the interaction of the user, the acknowledgement of the status scan displays the corresponding message number. Example: Busy;010-119 = "Check buret unit" The message can be confirmed with **[OK]** or **[Cancel]**, see below.

Command	Function	Comment
$A	Confirm message	Confirm the message on the instrument with **[OK]** A mandatory status scan providing the message number must take place immediately before confirming the message, see above.
$A(OK), **$A(CANCEL)**	Confirm message	Confirm the message with **[OK]** or **[Cancel]**
$A(YES), **$A(NO)**	Confirm message	Confirm the message with **[Yes]** or **[No]**
$L(*method name*)	Load method	The method name has to be known and unique.
$Q(*variable*)	Request variable value	Examples for variables: *EP1*, *R1*, *C00*. Complete list of the variables, *see page 24*.

The values of the variables are only available after the end of a determination (in the status 'ready').

Acknowledgement of the instrument	Comment
OK	Command executed
E1	Method not found
E2	Invalid variable
E3	Invalid command

9.8 Arithmetic algorithms in the 848 Titrino plus

Numerical format

The software of the 848 Titrino plus calculates in accordance with the widespread standard IEEE 754 (IEEE Standard for Binary Floating-Point Arithmetic for Microprocessor Systems). This means that the numbers are used in calculations in "double precision" (64 bit). Decimal numbers are converted into binary numbers in the computer and used in this form for calculations. The output on the display and in reports once again contains decimal numbers; the binary numbers are thus converted back into decimal numbers. In order to be able to check the internal calculations performed by the computer yourself in accordance with IEEE 754, the numbers are reproduced in the calculation report in complete accuracy. A mini-

mal difference may arise between an originally entered decimal number and the internal computer representation in complete accuracy in the range of the rear decimal places. This difference results from the fact that an exact binary equivalent does not exist for every decimal number. If, for example, you enter the sample size 50.3 mg, this will be depicted in the calculation report in "double precision" with 5.02999999999999E+01.

Rounding-off process

Measured values and results are rounded to the defined number of decimal places (commercial rounding, in accordance with the US Pharmacopeia USP). If the digit at the first dropped decimal place is **1, 2, 3 or 4**, then it will be rounded off; if this digit is **5, 6, 7, 8 or 9**, then it will be rounded up. Negative digits will be rounded in accordance with their amount, i.e. away from zero.

Examples:

2.33 yields **2.3**

2.35 yields **2.4**

2.47 yields **2.5**

–2.38 yields **–2.4**

–2.45 yields **–2.5**

Statistics

The arithmetic mean value and the absolute and relative standard deviations of results are calculated:

You can statistically evaluate a maximum of five results ($1 \leq k \leq 5$) calculated in a determination. A statistical series can contain a maximum of 20 determinations ($1 \leq n \leq 20$).

The following convention applies to the subsequent formulas:

$1 \leq n \leq 20$ and $1 \leq k \leq 5$.

Mean value:

$$\bar{x}_k = \frac{1}{n} \cdot \sum_{i=1}^{n} R_{k,i}$$

Absolute standard deviation:

$$S\,abs_k = +\sqrt{\frac{\sum_{i=1}^{n} \left(R_{k,i} - \bar{x}_k\right)^2}{n-1}}$$

Relative standard deviation (in %):

$$S\,rel_k = 100 \cdot \frac{S\,abs_k}{\bar{x}_k}$$

Explanations

The individual values are incorporated in the statistics with full accuracy.

15 significant places are yielded when the 64 bit numerical format is applied for the floating-point number in decimal presentation.

The accuracy can be controlled by the selection of the prefix of the unit (milli, micro) and the number of decimal places.

Example:

The result displayed, **1234.56789158763 mg/L**, has 15 significant places. It should be rounded off to three decimal places according to the above rounding-off process:

- **1234.568 mg/L**.

If the same result is expressed in "**g/L**" (**1.23456789158763 g/L**), and is also rounded off to three decimal place, this yields

- **1.235 g/L**.

I.e. you obtain the lowest losses in accuracy with rounding when you select the application and the numerical format in such a way that the numbers displayed have as many places before the decimal point as possible.

A complete recalculation of the statistics using a pocket calculator or PC calculation programs may exhibit deviations. This can be explained by the different binary numerical formats used by these computers.

NOTICE

The above losses of accuracy by rounding off in the range of significant places are only relevant theoretically. They are generally several orders of magnitude less than measurement technique uncertainties (balance errors, dosing errors, measuring errors).

10 Technical specifications

10.1 Measuring inputs

The measuring cycle is 100 ms for all measuring modes.

10.1.1 Potentiometry

A high-ohm measuring input (**Ind.**) for pH electrodes and redox electrodes and a measuring input for separate reference electrodes (**Ref.**).

Input resistance	$> 1 \cdot 10^{12}$ Ω
Offset current	$< 1 \cdot 10^{-12}$ A
Measuring mode pH	
Measuring range	–13 - +20
Resolution	0.001
Measuring accuracy	±0.003 (±1 digit, without sensor error, under reference conditions)
Measuring mode U	
Measuring range	–1,200 - +1,200 mV
Resolution	0.1 mV
Measuring accuracy	±0.2 mV (±1 digit, without sensor error, under reference conditions)

10.1.2 Polarizer

One measuring input (**Pol.**) for polarizable electrodes.

Measuring mode Ipol	Determination with adjustable polarization current.
Polarization current	–120 - +120 µA (increment: 1 µA) –125 - –121 µA / +121 - +125 µA: non-guaranteed values, dependent on reference voltage +2.5 V
Measuring range	–1,200 - +1,200 mV
Resolution	0.1 mV
Measuring accuracy	±0.2 mV (±1 digit, without sensor error, under reference conditions)

Measuring mode Upol	Determination with adjustable polarization voltage.
Polarization voltage	–1,200 - +1,200 mV (increment: 10 mV) –1,250 - –1,210 mV / +1,210 - +1,250 mV: non-guaranteed values, dependent on reference voltage +2.5 V
Measuring range	–120 - +120 µA
Resolution	0.01 µA
Measuring accuracy	–

10.1.3 Temperature

A measuring input (**Temp.**) for temperature sensors of the Pt1000 or NTC type with automatic temperature compensation.

R (25 °C) and B value can be configured for NTC sensors.

Measuring range	
Pt1000	–150 - +250 °C
NTC	–5 - +250 °C (For an NTC sensor with R (25 °C) = 30,000 Ω and B (25/50) = 4,100 K)
Resolution	
Pt1000	0.1 °C
NTC	0.1 °C
Measuring accuracy	
Pt1000	±0.2 °C (applies for measuring range –20 - +150 °C)
NTC	±0.6 °C (applies for measuring range +10 - +40 °C)

10.2 Dosing drive

Resolution	10,000 steps per cylinder volume
Exchange unit	
Cylinder volume	▪ 1 mL ▪ 5 mL ▪ 10 mL ▪ 20 mL ▪ 50 mL
Accuracy	Fulfills ISO/DIN standard 8655-3

10.3 Interfaces

USB (OTG) connector	For connecting USB devices.
MSB connector	For connecting a stirrer.
Remote connector	For connecting instruments with a remote interface.

10.4 Power connection

Supply voltage	100 - 240 V (±10%)
Frequency	50 - 60 Hz
Power consumption	45 W
Fuse	2 × 2.0 ATH, electronic overload protection

10.5 Ambient temperature

Nominal function range	+5 - +45 °C (at a maximum of 85% humidity)
Storage	–20 - +60 °C
Transport	–40 - +60 °C

10.6 Reference conditions

Ambient temperature	+25 °C (±3 °C)
Relative humidity	≤ 60%
Operating temperature status	Instrument in operation at least 30 min
Validity of the data	After adjustment

10.7 Dimensions

Material of housing	Poly(butylene terephthalate) (PBT)
Material of display cover	Glass
Width	142 mm
Height	164 mm
Depth	310 mm
Weight	2,950 g

11 Accessories

Up-to-date information on the scope of delivery and optional accessories for your product can be found on the Internet. You can download this information using the article number as follows:

Downloading the accessories list

1. Enter *https://www.metrohm.com/* into your Internet browser.
2. Enter the article number (e.g. **Variable Produktnummer**) into the search field.

   The search result is displayed.
3. Click on the product.

   Detailed information regarding the product is shown on various tabs.
4. On the **Included parts** tab, click on **Download the PDF**.

   The PDF file with the accessories data is created.

NOTICE

Once you have received your new product, we recommend downloading the accessories list from the Internet, printing it out and keeping it together with the manual for reference purposes.

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