

Operation Manual Vacuum Controller V-850/855



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Read this manual carefully before installing and running your system and note the safety precautions in chapter 2 in particular. Store the manual in the immediate vicinity of the instrument, so that it can be consulted at any time.

No technical modifications may be made to the instrument without the prior written agreement of Buchi. Unauthorized modifications may affect the system safety or result in accidents.

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If you need another language version of this manual, you can download it at www.buchi.com.

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1 About this manual

This manual describes the vacuum controller and provides all information required for its safe operation and to maintain it in good working order.

It is addressed in particular to laboratory personnel and operators.

NOTE:

The symbols pertaining to safety (WARNINGS and ATTENTIONS) are explained in chapter 2.

1.1 Reference documents

For information on the Rotavapor R-210/215 and the Vacuum Pump V-700/710, please refer to the corresponding manuals available in English, German, French, Spanish and Italian:

- Rotavapor R-210/215, Operation Manual numbers 93076–93080
- Vacuum Pump, Operation Manual numbers 93090–93094

1.2 Trademarks

The following product names and any registered and unregistered trademarks mentioned in this manual are used for identification purposes only and remain the exclusive property of their respective owners:

- Rotavapor® is a registered trademark of Büchi Labortechnik AG
- Teflon® is a registered trademark of DuPont or its affiliates
- Kalrez® is a registered trademark of DuPont

1.3 Abbreviations

PBT: Polybutylene Terephthalate

PES: Polyester

PVC: Polyvinyl chloride

PEEK: Polyetheretherketone

2 Safety

This chapter points out the safety concept of the instrument and contains general rules of behavior and warnings from hazards concerning the use of the product.

The safety of users and personnel can only be ensured if these safety instructions and the safety-related warnings in the individual chapters are strictly observed and followed. Therefore, the manual must always be available to all persons performing the tasks described herein.

2.1 User qualification

The instrument may only be used by laboratory personnel and other persons who on account of training or professional experience have an overview of the dangers which can develop when operating the instrument.

Personnel without this training or persons who are currently being trained require careful instruction. The present Operation Manual serves as the basis for this.

2.2 Proper use

This instrument has been designed and built for laboratories. Its proper use includes regulating and displaying a vacuum in a working range between 0 mbar up to atmospheric pressure.

The vacuum controller is used for:

- Distillation instruments, especially rotary evaporators
- Vacuum drying cabinets

2.3 Improper use

Applications not mentioned above are improper. Also, applications, which do not comply with the technical data, are considered improper. The operator bears the sole risk for any damages caused by such improper use.

The following uses are expressly forbidden:

- Use of the instrument in rooms which require ex-protected instruments.
- Use as calibrating instrument for other instruments.
- Use in excess pressure.

2.4 Warning notices used in this manual



WARNING

Generally, the triangular warning symbol indicates the possibility of personal injury or even loss of life if the instructions are not followed.



WARNING

Hot surface.



ATTENTION

With the general "Read this" symbol, ATTENTIONs indicate the possibility of equipment damage, malfunctions or incorrect process results, if instructions are not followed.

NOTE

Useful tips for the easy operation of the instrument.

2.5 Product safety

The vacuum controller is designed and built in accordance with current state-of-the-art technology. Nevertheless, risks to users, property, and the environment can arise when the instrument is used carelessly or improperly.

The manufacturer has determined residual dangers emanating from the instrument

- if the instrument is operated by insufficiently trained personnel.
- if the instrument is not operated according to its proper use.

Appropriate warnings in this manual serve to make the user alert to these residual dangers.



WARNING

Electromagnetic radiation may affect the pressure measurement so that the measured pressure value can be adulterated.

- *Keep the instrument from the influence of electromagnetic radiation.*

2.6 General safety rules

Responsibility of the operator

The head of laboratory is responsible for training his personnel.

The operator shall inform the manufacturer without delay of any safety-related incidents which might occur during operation of the instrument. Legal regulations, such as local, state and federal laws applying to the instrument must be strictly followed.

Duty of maintenance and care

The operator is responsible for ensuring that the instrument is operated in proper condition only, and that maintenance, service, and repair jobs are performed with care and on schedule, and by authorized personnel only.

Spare parts to be used

Use only genuine consumables and genuine spare parts for maintenance to assure good system performance and reliability. Any modifications to the spare parts used are only allowed with the prior written permission of the manufacturer.

Modifications

Modifications to the instrument are only permitted after prior consultation with and with the written approval of the manufacturer. Modifications and upgrades shall only be carried out by an authorized Buchi technical engineer. The manufacturer will decline any claim resulting from unauthorized modifications.

3.1 Scope of delivery

3.1.1 Basic instrument



Product	Order number
Vacuum Controller V-850 stand alone (100 V–230 V), including power pack (47259)	47231
Vacuum Controller V-850 for R-210/215 and V-700/710 (100 V–230 V), including support and communication cable (47280)	47299
Vacuum Controller V-850 for R-200/205 (100 V–230 V), including support, communication cable R-200/205 and power pack (47259)	47297
Vacuum Controller V-850 for R-220 (100 V- 230 V), including support, communication cable R-220 and power pack (47259)	47295
Vacuum Controller V-850 for R-250 (100 V- 230 V), including support, communication cable R-250 and power pack (47259)	47293

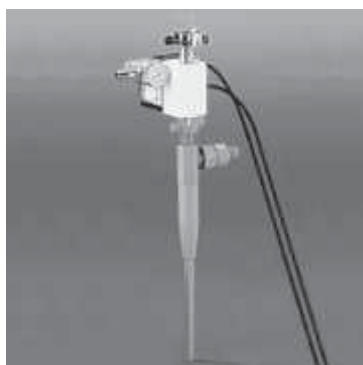
Product	Order number
Vacuum Controller V-855 stand alone (100 V–230 V) without automatic distillation probe 47235, including power pack (47259)	47232
Vacuum Controller V-855 for R-210/215 and V-700/710 (100 V–230 V) without automatic distillation probe 47235, including support and communication cable (47280)	47298
Vacuum Controller V-855 for R-200/205 (100 V–230 V) without automatic distillation probe 47235, including support, communication cable R-200/205 and power pack (47259)	47296
Vacuum Controller V-855 for R-220 (100 V- 230 V) without automatic distillation probe 47235, including support, communication cable R-220 and power pack (47259)	47294
Vacuum Controller V-855 for R-250 (100 V- 230 V) without automatic distillation probe 47235, including support, communication cable R-250 and power pack (47259)	47292

3.1.2 Standard accessories

Table 3-3: Standard accessories

Product	Order number
Operation Manual:	
English	93081
German	93082
French	93083
Italian	93084
Spanish	93085

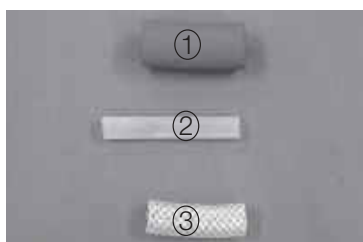
3.1.3 Optional accessories


Table 3-4: Optional accessories

Product	Order number
1 Valve unit 850 for Vacuum Controller V-850/855, including holder	47160
1 Holder for valve unit 850 on Rotavapor R-210 / 215	47164
Woulff bottle 850 complete including holder	47170
Woulff bottle 850 glass part, P+G coated	47233
Holder for Woulff bottle 850	47164
1 Remote control for V-850/855 complete	47230
Water jet pump unit B-767 with 2 magnetic valves 24 V for pump and cooling water (with a Kalrez backstroke valve)	31357
Water jet pump unit B-764 with magnetic valve 24 V (and a Kalrez backstroke valve) (shown as example on picture on the left)	31358

**Table 3-4: Optional accessories (cont.)**

Product	Order number
Vacuum valve 24 V / 2.4 mm for use with a 1 l Rotavapor with Y-piece for vacuum controller	31353
Vacuum valve 24 V / 4 mm for use with a 20 l Rotavapor	31354
Vacuum valve 24 V / 4 mm for use with a 50 l Rotavapor (shown as example on picture on the left)	31355
Cooling water valve 24 V	31356
Water control valve 1/2 " (01308 + 03560 + 15860)	11606
Connecting cable V-850/855 for R-220 / R-250	40758
Control cable RJ 45, 330 mm (speed control) between vacuum controller and Vacuum Pump	44288
Control cable RJ 45, 2000 mm (speed control) between Rotavapor and Vacuum Pump	44989
Control cable Mini DIN 1500 mm between vacuum controller and vacuum pump (on/off) compatible with Vacuum Controller V-800/805 and Vacuum Pump V-500/1000	38010

**Table 3-4: Optional accessories (cont.)**

Product	Order number
Set cable and holder for R-210/215 including support for R-210/215, V- 700/710, including the following cables: control cable RJ 45 330 mm control cable RJ 45 2000 mm	47280
Power pack for V-850/855	47259
Automatic distillation probe to V-855 (only for glass assembly V + S)	47235
Vacuum tube 16/6 mm ①	17622
Cooling water tube silicone 9/6 mm ②	04133
Vacuum tube Nyflex 14 x 8 ③	04113

3.2 Technical data overview

Table 3-5: Technical data

	Vacuum Controller V-850/855
Dimensions casing (W x H x D)	160 x 105 x 120 mm
Weight	540 g
Power supply	30 VDC for connection Rotavapor R-210/215, Vacuum Pump V-700/710 or power pack 85-264 V
Frequency	50 / 60 Hz
Power consumption	10 W
Interfaces	USB (data transmission), RS 232/RS 485 (communication), remote control, cooling water valve, Switch Box, vacuum valve
Environmental conditions	For indoor use only, altitude up to 2000 m, 10–40 °C, maximum relative humidity 80 % for temperatures up to 30 °C
Magnetic valve supply	24 V
Vacuum connection	GL-14
Measuring principle	Capacitive
Measuring range	1400–0 mbar
Control range	1100–1 mbar
Accuracy	± 2 mbar (± 1 digit) following alignment at constant temperature
Temperature response	0.07 mbar/K ⁻¹
Display range	0–1400 mbar
Hysteresis	Automatic or 1–500 mbar
Overvoltage category	II
Pollution degree	2
Conformity	CSA / CE

3.3 Materials used

Table 3-6: Materials used

Component	Material designation
Pressure foil	Polyester
Casing	PBT
Diaphragm (aeration valve)	Kalrez
Aeration valve	PEEK

3.4 Solvent table

Table 3-7: Solvent table

Solvent	Formula	Molar mass in g / mol	Evaporation energy in J / g	Boiling point at 1013 mbar	Density in g / cm ³	Vacuum in mbar for boiling point at 40 °C
Acetone	CH ₃ H ₆ O	58.1	553	56	0.790	556
n-amylalcohol, n-pentanol	C ₅ H ₁₂ O	88.1	595	37	0.814	11
Benzene	C ₆ H ₆	78.1	548	80	0.877	236
n-butanol, tert. butanol	C ₄ H ₁₀ O	74.1	620	118	0.810	25
(2-methyl-2-propanol)	C ₄ H ₁₀ O	74.1	590	82	0.789	130
Chlorobenzene	C ₆ H ₅ Cl	112.6	377	132	1.106	36
Chloroform	CHCl ₃	119.4	264	62	1.483	474
Cyclohexane	C ₆ H ₁₂	84.0	389	81	0.779	235
Diethylether	C ₄ H ₁₀ O	74.0	389	35	0.714	atmospheric
1,2-dichloroethane	C ₂ H ₄ Cl ₂	99.0	335	84	1.235	210
1,2-dichloroethylene (cis)	C ₂ H ₂ Cl ₂	97.0	322	60	1.284	479
1,2-dichloroethylene (trans)	C ₂ H ₂ Cl ₂	97.0	314	48	1.257	751
Diisopropyl ether	C ₆ H ₁₄ O	102.0	318	68	0.724	375
Dioxane	C ₄ H ₈ O ₂	88.1	406	101	1.034	107
DMF (dimethyl-formamide)	C ₃ H ₇ NO	73.1		153	0.949	11
Acetic acid	C ₂ H ₄ O ₂	60.0	695	118	1.049	44
Ethanol	C ₂ H ₆ O	46.0	879	79	0.789	175
Ethylacetate	C ₄ H ₈ O ₂	88.1	394	77	0.900	240
Heptane	C ₇ H ₁₆	100.2	373	98	0.684	120
Hexane	C ₆ H ₁₄	86.2	368	69	0.660	335
Isopropylalcohol	C ₃ H ₈ O	60.1	699	82	0.786	137
Isoamylalcohol 3-methyl-1-butanol	C ₅ H ₁₂ O	88.1	595	129	0.809	14
Methylethylketone	C ₄ H ₈ O	72.1	473	80	0.805	243
Methanol	CH ₄ O	32.0	1227	65	0.791	337
Methylene chloride, dichloromethane	CH ₂ Cl ₂	84.9	373	40	1.327	atmospheric
Pentane	C ₅ H ₁₂	72.1	381	36	0.626	atmospheric
n-propylalcohol	C ₃ H ₈ O	60.1	787	97	0.804	67
Pentachloroethane	C ₂ HCl ₅	202.3	201	162	1.680	13
1,1,2,2-tetra-chloroethane	C ₂ H ₂ Cl ₄	167.9	247	146	1.595	35
Tetrachlorocarbon	CCl ₄	153.8	226	77	1.594	271
1,1,1-trichloroethane	C ₂ H ₃ Cl ₃	133.4	251	74	1.339	300
Tetra-chloro-ethylene	C ₂ Cl ₄	165.8	234	121	1.623	53
THF (tetrahydrofurane)	C ₄ H ₈ O	72.1		67	0.889	357
Toluene	C ₇ H ₈	92.2	427	111	0.867	77
Trichloroethylene	C ₂ HCl ₃	131.3	264	87	1.464	183
Water	H ₂ O	18.0	2261	100	1.000	72
Xylene (mixture)	C ₈ H ₁₀	106.2	389			25
o-xylene	C ₈ H ₁₀	106.2		144	0.880	
m-xylene	C ₈ H ₁₀	106.2		139	0.864	
p-xylene	C ₈ H ₁₀	106.2		138	0.861	

4 Description of function

This chapter explains the basic principle of the instrument, shows how it is structured and gives a functional description of the assemblies.

4.1 Functional principle

The Vacuum Controller V-850 and V-855 can be universally used for the display, adjustment and control of vacuum. The integrated aeration valve and the precision pressure sensor is resistant to chemicals making the Vacuum Controller a compact unit suitable for numerous applications in the Lab. The novel speed control feature when used with the Vacuum Pump V-700 or V-710 allows for hysteresis-free vacuum control with quiet operation.

4.1.1 Control keys of Vacuum Controller V-850/855

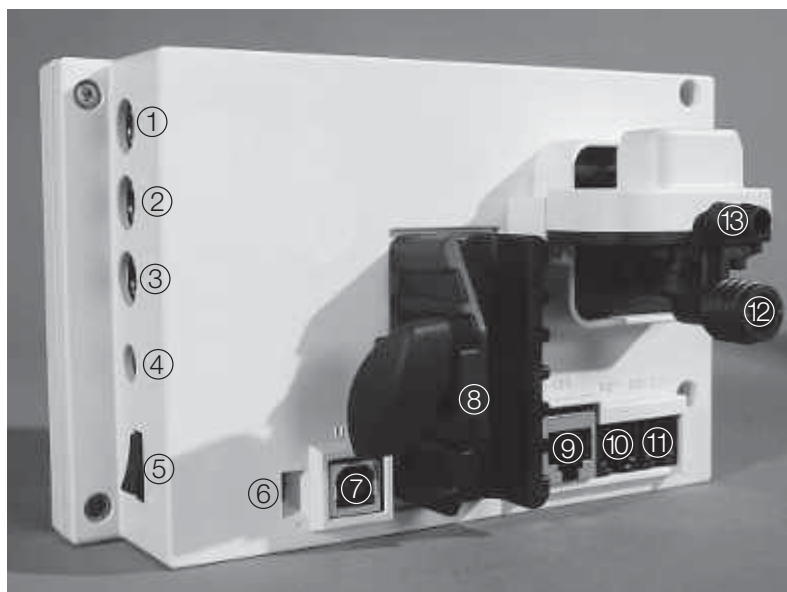


- ① Selection knob
- ② Functional buttons
- ③ Display

- ④ START button
- ⑤ STOP button

Fig. 4.1: Overview of the vacuum controller

4.1.2 Rear connections



- | | |
|--|---|
| ① Connection for AutoDest probe/switch box (AS/SB) | ⑦ USB for data output |
| ② Connection for cooling water valve (CW) | ⑧ Fixation for support rod |
| ③ Connection for valve unit 850 and vacuum valve (VALVE) | ⑨ RS 485 connection to V-700/710 or R-210/215 |
| ④ Power supply connection for stand alone mode 30 VDC | ⑩ Remote control (RC 81) |
| ⑤ Mains switch On/Off | ⑪ RS 232 connection for Rotavapor (R-200/205/220/250) |
| ⑥ Service switch (upper position = Standard mode) | ⑫ Vacuum connection to valve unit 850 / Woulff bottle 850 |
| | ⑬ Aeration valve and inert gas connection |

Fig. 4.2: Rear connections of the controller

4.2 Controller operation modes

4.2.1 Manual mode

The Manual mode serves to maintain and control an preset pressure. The pressure setpoint can be adjusted by means of the selection knob when the pump is running or, before operation, via the corresponding menu when pressing the menu button **P Set**.

4.2.2 Timer mode

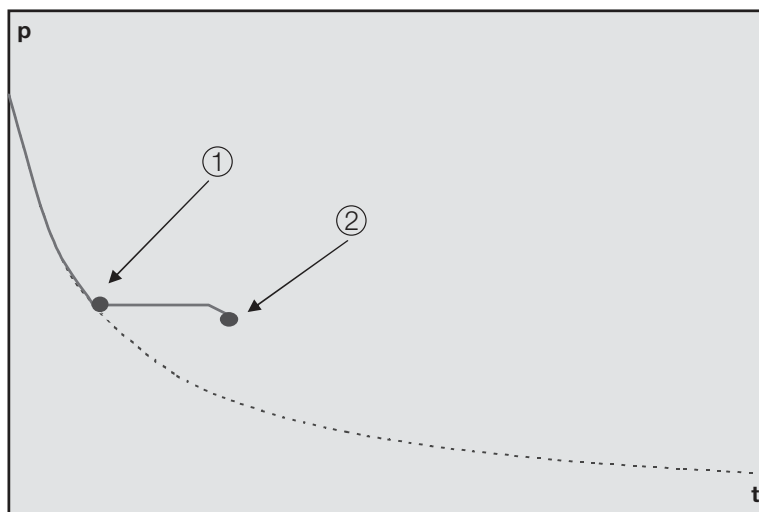
The Timer mode serves to control the pressure over a predefined time interval. When the time interval is over, the process stops.

4.2.3 AutoDest mode (V-855 only)

The AutoDest mode serves to carry out an automatic distillation based on a temperature differences within the condenser. Thanks to the AutoDest probe mixtures can be distilled gently and automatically and the redistillation is recognized.

4.2.4 EasyVac mode (V-855 only)

The EasyVac mode serves to carry out an automatic distillation based on the vapor pressure of the solvent. The process is started at the push of a button and the start point of the distillation is found automatically. Then the pressure is adapted according to the vapor pressure curve and the end point of the distillation is determined. Based on sophisticated algorithms the process is executed in a robust, gentle way. This mode is suited for distilling single solvents.



① Detection start of distillation

② Detection end of distillation

Fig. 4.3: Pressure course in EasyVac mode

4.2.5 Gradient mode (V-855 only)

The Gradient mode serves to define up to 15 programs in the most complex way, step by step. For a description of how to define programs, see chapter 6.7.3.

4.2.6 Repeat mode (V-855 only)

The Repeat mode serves to reproduce a distillation: The pressure course of the last distillation carried out manually or automatically can be saved and reused as setpoint setting to supply optimum process conditions.

4.2.7 LabVac mode (V-855 only)

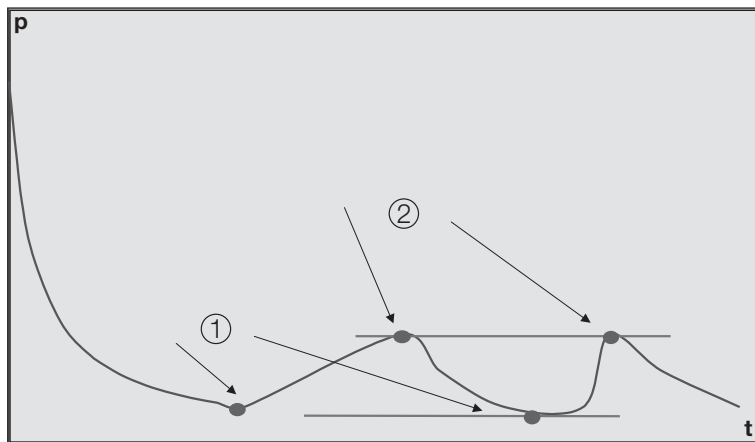
The LabVac mode serves to control the pump within a laboratory vacuum system.

The pump operation is switched off when the vacuum has reached the lowest possible value and is switched on again when the pressure has increased by a preset value (hysteresis [dp]). The pump operation is also switched on, as soon as a load is present in the vacuum system.

When the menu button **CONT.** is pressed the pump operates in Continuous mode to obtain a vacuum as low as possible independent of the connected load.

NOTE

EasyVac and the Autodistillation function are not recommended to be used in the standard LabVac mode due to pressure fluctuations (hysteresis). Therefore you have to run the LabVac system in the Continuous mode.



① Pump not running

② Pump running

Fig. 4.4: Pressure course in LabVac mode

5 Putting into operation

This chapter describes how the instrument is installed and gives instructions on initial startup.

NOTE:

Inspect the instrument for damages during unpacking. If necessary, prepare a status report immediately to inform the postal company, railway company or transportation company.

Keep the original packaging for future transport.

5.1 Setting up the Rotavapor with the Vacuum Controller V-850/855

5.1.1 Installation

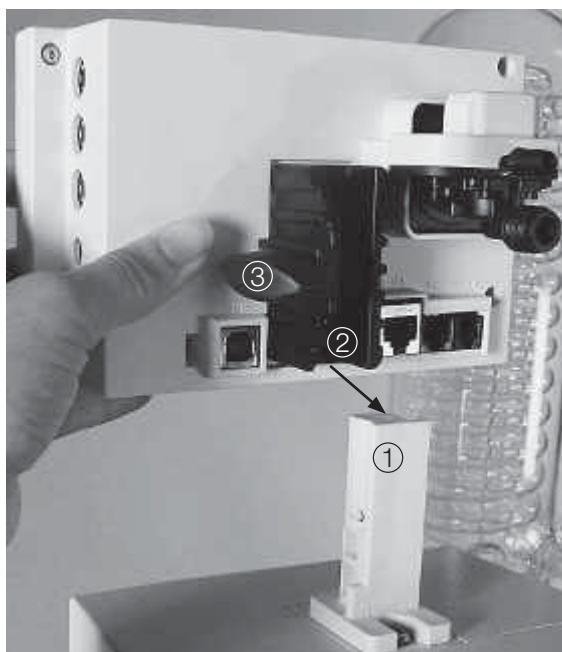
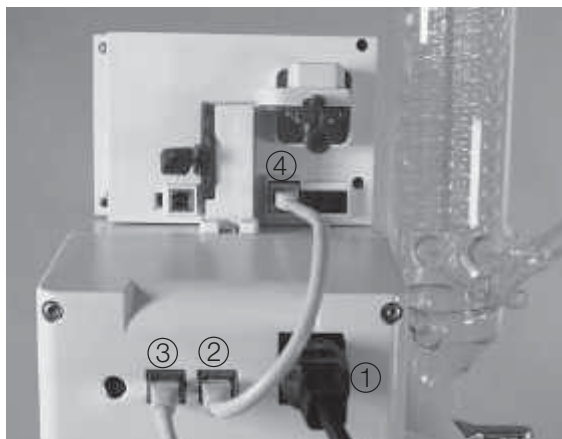


Fig. 5.1: Installing the vacuum controller

To install the vacuum controller to the Rotavapor, proceed as follows:

- Screw the holder ① for the vacuum controller to the top of the Rotavapor.
- Slide the guide rail ② of the vacuum controller over the holder.
- Fix the vacuum controller to the holder by tightening the knurled nut ③.

5.1.2 Cable connections to the Rotavapor



① Mains connection

② Communication vacuum controller / Rotavapor

③ Communication vacuum pump / Rotavapor

④ Communication vacuum controller / Rotavapor

Fig. 5.2: Rear cable connections

To connect the vacuum controller to the Rotavapor electrically, proceed as follows:

- Connect the communication ④ of the vacuum controller to the Rotavapor ②.
- Connect the communication ③ of the vacuum controller to the Vacuum Pump V-700 / 710.
- Connect the mains supply ① of the Rotavapor to the mains.

5.2 Communication of Rotavapor and Vacuum Controller V-850/855

The Rotavapor and the vacuum controller are connected, so that the starting and stopping of the rotation and the raising and lowering of the evaporating flask is carried out via the vacuum controller. When the configuration of the vacuum controller is accordingly:

- the distillation is started via the vacuum controller, the evaporating flask moves into the heating bath and the rotation is started.
- the distillation is stopped via the vacuum controller, the rotation is stopped and the evaporating flask is raised from the bath.

5.3 Installing the AutoDest probe

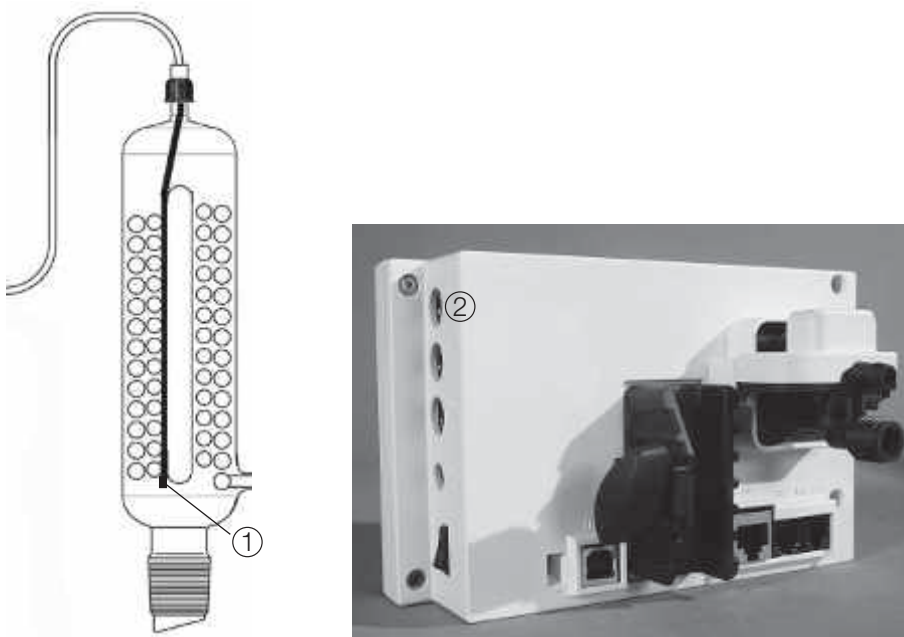


Fig. 5.3: Installing the AutoDest probe

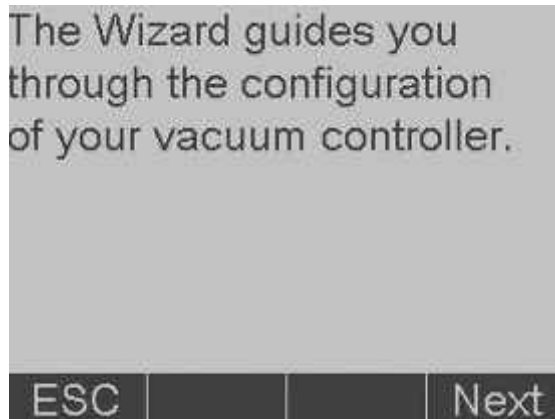
To install the AutoDest probe proceed as follows:

- Calibrate the AutoDest probe, see also chapter 6.7.5.
- Insert the AutoDest probe into the opening at the top of the condenser.
- Push the probe down between the inner condenser coil and the vacuum tube in the center of the condenser.
- Position the probe as shown in Fig. 5.3. Make sure that the probe tip position corresponds to position ① in Fig. 5.3.
- Tightened screw cap at the top of the condenser.
- Plug the cable of the AutoDest probe into the AS/SB socket of the controller (position ② in the figure above).

5.4 Initial software settings

When you switch on the vacuum controller for the first time, a wizard will guide you through the initial settings to carry out.

To change the default settings within the screens, use the selection knob at the vacuum controller. Turning it to the left moves you further down within the context menus, turning it to the right moves you up again. By pressing **OK** the currently highlighted setting is accepted.



Configure your vacuum controller by following the instructions on the screen.

Press **Next** to continue.

Fig. 5.4: Wizard - Introduction

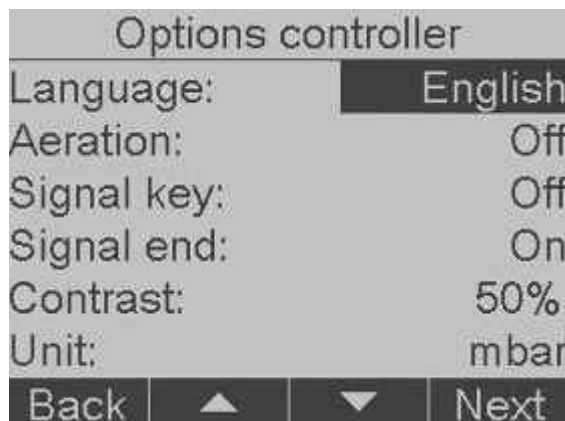


Fig. 5.5: Wizard - Options controller

In the Options controller you can define several system settings by turning the selection knob and pressing **OK**:

- **Language:** Select the screen language from the available languages English, German, French, Italian, Spanish, and Japanese.

NOTE

When you select Japanese as language by mistake, you will see that the word „language“ will remain in English. Just move the focus upward again with the Move up button and change the language again by means of the selection knob.

- **Aeration On/Off:** When the aeration is switched on, the system is automatically aerated when the STOP button is pressed or the distillation is stopped by an automatic function, otherwise the system remains evacuated and the STOP button has to be pressed a second time for aeration.
- **Signal key On/Off:** When the signal key is switched on a confirmation sound is audible when a function key is pressed.
- **Signal end On/Off:** When the signal end is switched on a confirmation sound is audible when an automatic distillation or a program is finished.
- **Contrast:** Select a screen contrast between 0 and 100 %.
- **Unit:** Select the unit in which the pressure is displayed from the available units mbar, Torr and hPa.
- Press **Next** to continue.

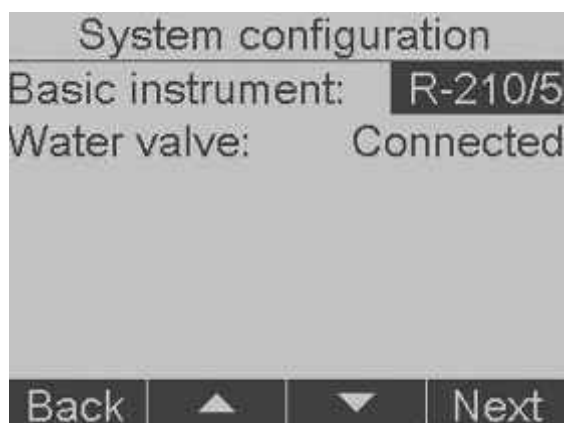


Fig.5.6: Wizard - System configuration

On the System configuration screen you can specify the following:

- **Basic instrument:** The basic instrument you are working with (R-200/5, R-210/5, R-220, R-250, or others).
- **Water valve:** Whether a water valve is connected to your system or not.

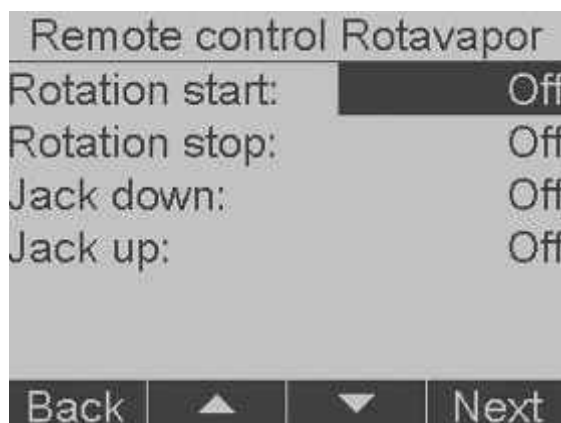


Fig. 5.7: Wizard - Remote Control Rotavapor

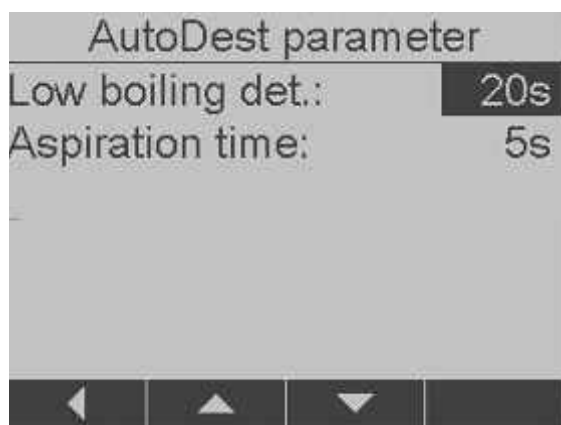


Fig. 5.8: Wizard - AutoDest parameter

On the Remote control Rotavapor screen you can define the following remote control parameters:

- **Rotation start On/Off:** Automatic rotation start of flask when controller is started On/Off
- **Rotation stop On/Off:** Automatic rotation stop of flask when controller is stopped On/Off
- **Jack down On/Off:** Automatic lowering of the flask into the heating bath when controller is started On/Off
- **Jack up On/Off:** Automatic raising of the flask from the heating bath when controller is stopped On/Off

On the AutoDest parameter screen you can define several parameters for auto distillation:

- **Low boiling det.:** Warm-up time for evaporating flask. The default value is 20 s. For sample volumes of more than 2 l, we recommend to increase the value by ca. 10 s.
- **Aspiration time:** Time interval after which a new pressure setpoint has to be reached (the pressure setpoints are predefined within the system). This value must be adapted according to the pump performance. The default value is 5 s. We recommend to increase the value for pumps with a low aspiration capacity, i.e. water jet pumps, or when the error message "Because of a leak the distillation process was cancelled" appears.

6 Operation

This chapter explains the operating elements and possible operating modes. It gives instructions on how to operate the instrument properly and safely.

6.1 Menu structure of the Vacuum Controller V-850/855 software

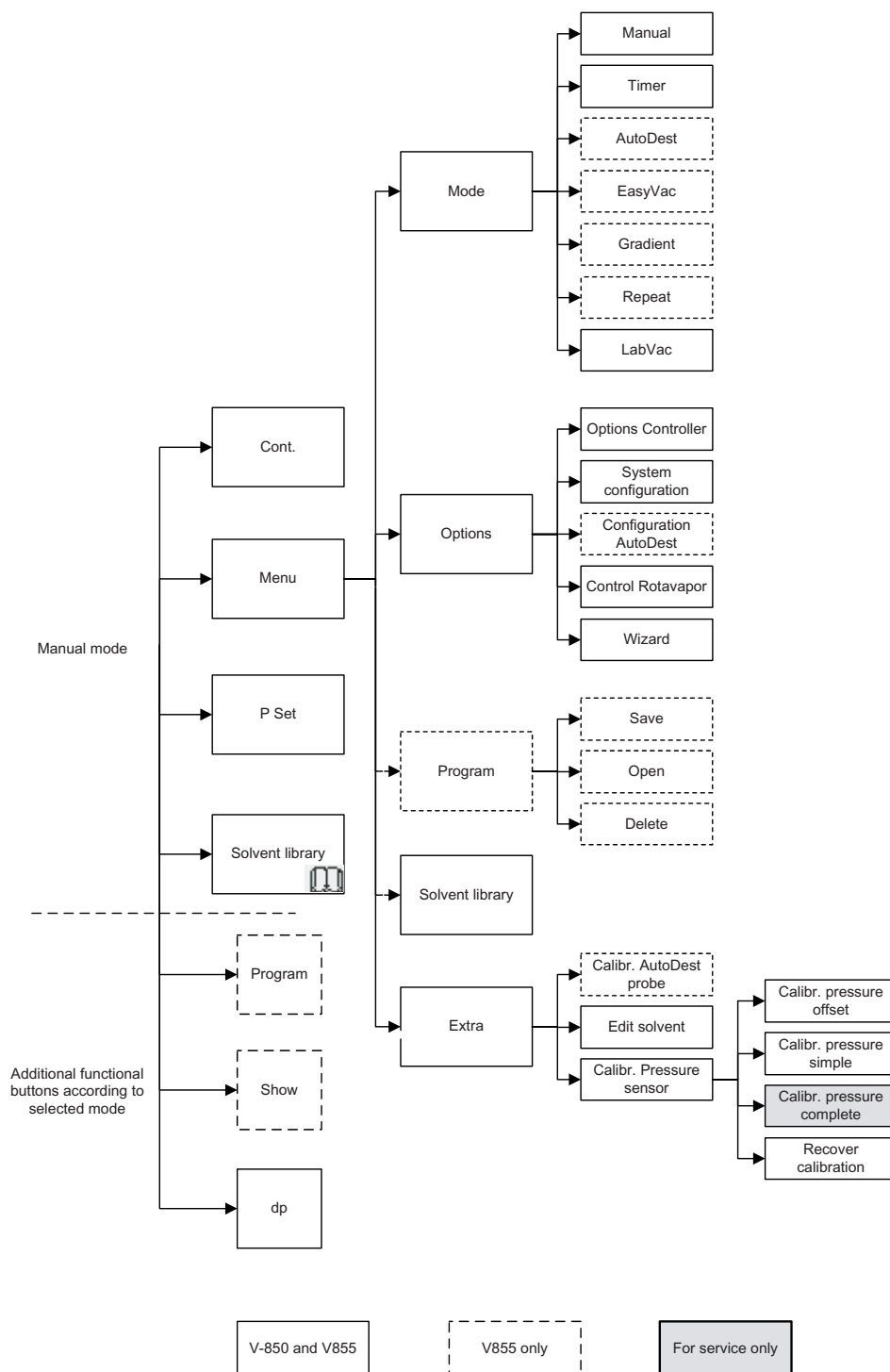


Fig. 6.1: Possible menu structure of the Vacuum Controller V-850/855 software according to the selected modes

6.2 Vacuum Controller V-850/855 main screen in Manual mode

When you switch on the vacuum controller, first the instrument type and the software version are displayed, then the main screen appears:

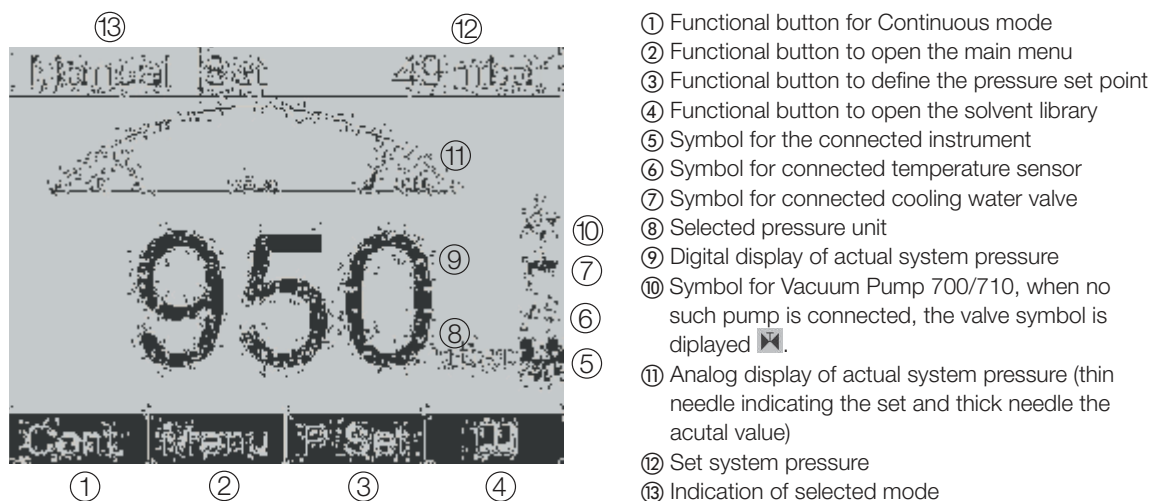


Fig. 6.2: Main screen in Manual mode

6.3 Selecting the distillation conditions

To achieve optimal distillation conditions, the distillation energy supplied by the heating bath must be removed by the condenser.

To ensure this, operate the instrument according to the following rule of thumb:

Cooling water: max. 20 °C Vapor: 40 °C Bath: 60 °C

How are these conditions achieved?:

- Set the bath temperature to 60 °C.
- Set the cooling water temperature not higher than 20 °C.
- Allow cooling water to flow through the condenser at approximately 40 – 50 l/h.
- Define the operating vacuum in such a way, that the boiling point of the solvent is 40 °C. The corresponding pressure can be seen from the Solvent Table in chapter 3.

Advantages associated with bath temperatures of 60 °C:

- The evaporating flask can be replaced without risk of burns.
- The evaporation rate of the water from the heating bath is low (low energy loss).
- The heating bath energy is used at a good degree of efficiency.

This rule can also be applied to lower bath temperatures, e.g.:

Cooling water: 0 °C Vapor: 20 °C Bath: 40 °C

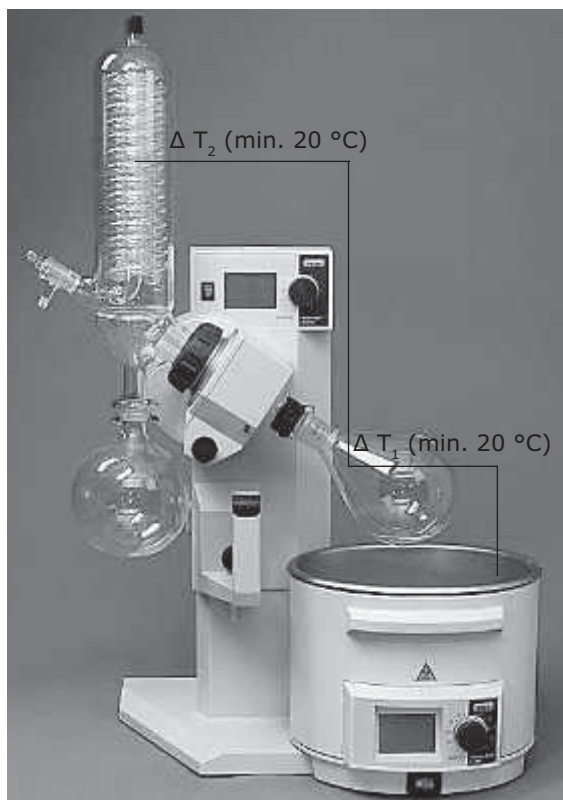


Fig. 6.3: 20-40-60 ° rule

6.4 Starting a distillation

6.4.1 Quick start of manual distillation

To start a distillation, proceed as follows:

- Switch on the vacuum controller at the on/off switch at the right hand-side.
- When you are not in the Manual mode, change to this mode.
- Press the menu button **P Set**. When you are working with a Vacuum Pump V-700/710, the following screen appears:



Fig. 6.4: Pressure setpoint with connected Vacuum Pump V-700/710

When you are not working with a Vacuum Pump V-700/710, the following screen appears:



Fig. 6.5: Pressure setpoint without Vacuum Pump V-700/710

The hysteresis is needed for a precise pressure regulation by means of the vacuum control valve.

When the Vacuum Pump V-700/710 is not used, no automatic frequency control is provided.

Use the selection knob of the vacuum controller to define the pressure setpoint and the hysteresis, if applicable, for your evaporation process. Turn the knob to the right to increase the value or to the left to diminish the value and confirm your setting(s) with **OK**.

NOTE

To find out, which settings are appropriate for your solvent, consult the solvent library, see chapter 6.4.2.

When you press **ESC**, the screen changes to the original setting, i.e. to the previous setpoint.

- Press the START button to start the distillation process or to return to the main screen.

ATTENTION

Risk of overflowing.



- With a controller configured in a way that the flask is immersed automatically into the heating bath, make sure that the heating bath is only filled up to a level which cannot overflow in this case.
- Track the system pressure by means of the selection knob at the vacuum controller as needed.
- To stop the process, press the STOP button. The evaporating flask stops rotating and is removed from the heating bath automatically, if configured accordingly.

NOTE

Depending on whether you have selected Aeration On/Off in the Options controller, the system is either aerated directly after the STOP button was pressed (Aeration ON) or when the STOP button is pressed a second time (Aeration OFF).

6.4.2 Advanced settings

To start a distillation, proceed as follows:

- Switch on the vacuum controller at the on/off switch at the right hand-side.
- Press the Library button. The solvent library screen opens.

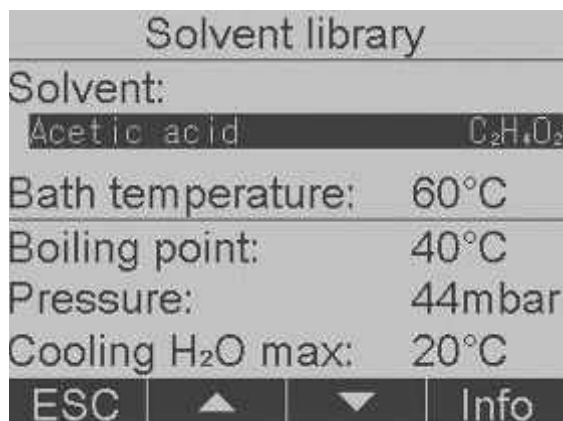


Fig. 6.6: Solvent library screen

- To define the solvent you are operating with, use the selection knob of the vacuum controller. Turn the knob to the left to go down within the alphabetical solvent list or turn it to the right to go up.



Fig. 6.7: Solvent library screen - Selecting a solvent

- Select the highlighted solvent by pressing **OK**. The proposed heating bath temperature can now be set at the heating bath. You can also change the proposed heating bath temperature and adapt the setting at the heating bath accordingly.
- To change the temperature, use the selection knob at the vacuum controller. Turning it to the left decreases the bath temperature value, turning it to the right increases it. By pressing **OK** the currently highlighted setting is saved and the value for pressure is adapted accordingly.

NOTE

The values indicated for boiling point and cooling H₂O max only serve for information purposes.

- Press **Accept** to confirm your settings and get back to the main screen.

NOTE

Depending on whether you have selected Aeration On/Off in the Options controller, the system is either aerated directly after the STOP button was pressed (Aeration ON) or when the STOP button is pressed a second time (Aeration OFF).

NOTE

Press the Info button to get some useful tips concerning recommended settings and update possibilities of your solvent library.

6.5 Vacuum Controller V-850/855 main screen in Gradient mode

When you switch on the vacuum controller, first the instrument type and the software version are displayed, then the main screen appears.

NOTE

The screen shown on the picture below is an example of the main screen in the gradient mode (only V-855).

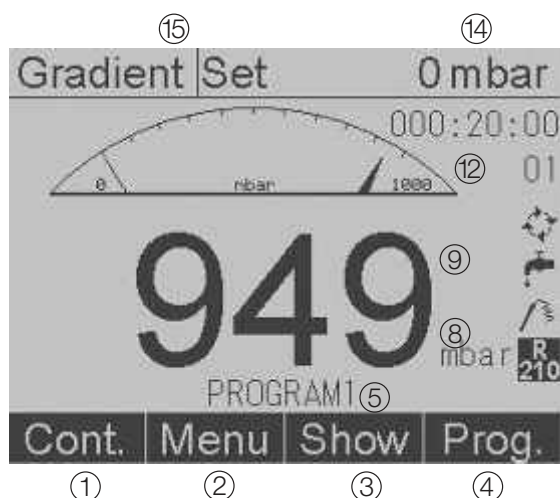


Fig. 6.8: Main screen in Gradient mode

- ① Functional button for Continuous mode
- ② Functional button to open the main menu
- ③ Functional button to show the pressure course curve
- ④ Functional button to define a new program or edit an existing one
- ⑤ Name of program currently running
- ⑥ Symbol for the connected instrument
- ⑦ Symbol for connected temperature sensor
- ⑧ Selected pressure unit
- ⑨ Digital display of actual system pressure
- ⑩ Symbol for connected cooling water valve
- ⑪ Symbol for Vacuum Pump 700/710, when no such pump is connected, the valve symbol is displayed
- ⑫ Analog display of actual system pressure (thin needle indicating the set and thick needle the actual value)
- ⑬ Number of step currently running and time current step is already active
- ⑭ Set system pressure
- ⑮ Indication of selected mode

6.6 General information on buttons


6.6.1 Control buttons

The following control buttons are available in the software for navigation and input confirmation:

	Get more information about the solvent library and about the settings required for a selected solvent
	Get back to the previous screen
	Get on to the next screen
	Confirm and save a setting and get back to the main screen
	Leave the current screen and get back to the main screen
	Accept the settings and get back to the main screen
	Get back to the start screen without saving possible settings
	Backward button to move backward within in the submenu structure
	Forward button to move forward within in the submenu structure
	Move up within the entries of a screen
	Move down within the entries of a screen
	Define the time and pressure for a program in Timer, Gradient and Repeat mode
	Affirm a screen message
	Negate a screen message
	Show gradient curve in Gradient and Repeat mode
	Edit a program in the Gradient and Repeat mode
	Save a program under the entered name
	Confirm the entry of a character when naming a program
	Create a new program in the Gradient and Repeat mode
	Swich through the steps of a program in Repeat mode
	Define the hysteresis in LabVac mode

6.6.2 Menu buttons

The following menu buttons are available in the software to call up certain menu functions:

Cont.	Continuous pump operation (100 % full speed to 0 % single struck mode)
Man.	Manual pump operation
Auto	Switch to the AutoDest mode
Menu	Open the main menu
P Set	Set the sytem pressure
	Library button to open the solvent library
H Off	Switch Hold mode off
P ↑	Increase the system pressure or interrupt a pressure drop during the start phase. The instrument is aerated and changes to the Hold mode when a distillation is running.
P ↓	Diminish the sytem pressure during calibration of the pressure sensor.

6.7 Main menu

To open the main menu, on the main screen press the **Menu** button.

To change the default settings within the screens of the main menu, use the selection knob at the vacuum controller. Turning it to the left moves you further down within the context menus, turning it to the right moves you up again. By pressing **OK** the currently highlighted setting is accepted.

To open the main menu, press the **Menu** button. The following screen opens:

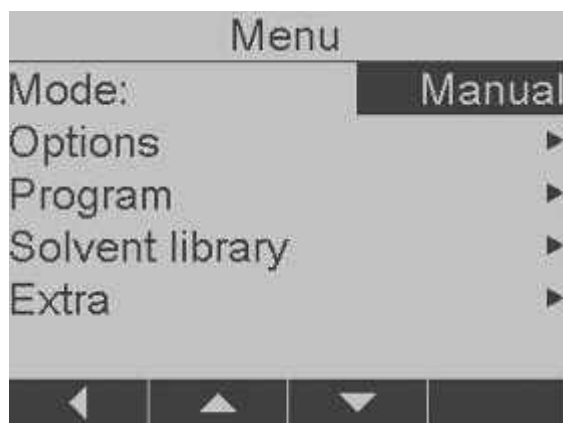


Fig. 6.9: Main menu

6.7.1 Mode

Depending on the controller you are working with, several modes are available, enabling you to work in different environments and use different programs, see chapter 4.2.

6.7.2 Options

The submenu Options contains the same system configuration screens as the Wizard and the Wizard itself. From the submenu Options you can access the configuration screens Options Controller, System configuration, Configuration AutoDest, Control Rotavapor individually, while, when entering the Wizard, you are guided through the configuration screens step by step, see also chapter 5.4.

6.7.3 Program

The program submenu only contains programs, if you have previously defined and saved programs yourself. Programs can be defined within the Gradient, the Timer and the Repeat mode. In the following, the program definition is shown, considering the Gradient mode as example.

Defining a program

To define a program in the Gradient mode, proceed as follows:

- Press **Prog.** on the main screen. The following screen appears:

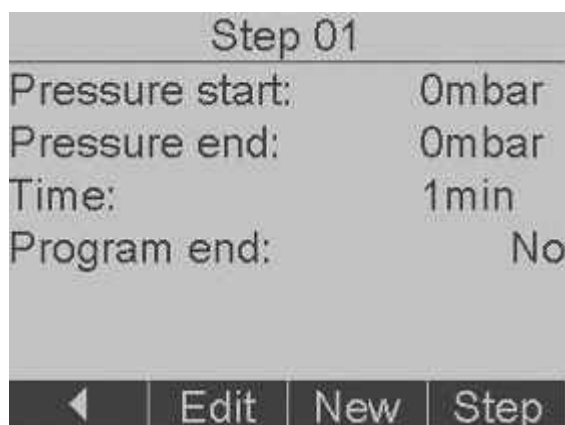


Fig. 6.10: Step 01

- To define a new program, press **New**. You are now in the edit mode, where you can define the individual settings and save your changes.

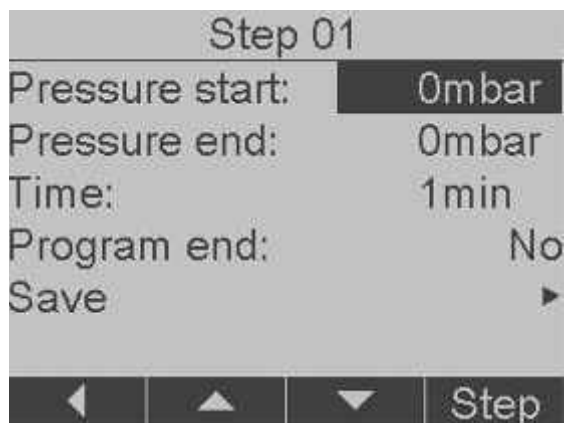


Fig. 6.11: Step 01

- Use the selection knob of the vacuum controller to define the start and end pressure of Step 01 and its duration. Turn the knob to the right to increase the value or to the left to diminish the value.
- To define a second step, press **Step** and proceed with the definition as for the step before.

NOTE

You can define up to 20 steps.

- To save your settings up to now as a program, select **Save**. The following screen appears:



Fig. 6.12: Enter name

Use the selection knob at the vacuum controller to move the “cursor” from one character to the other and press **Enter** each time you want to take a character over into the field at the top. Press **Save** to save the program under the entered name.

Working with programs

When you select the Program submenu, the following screen opens:

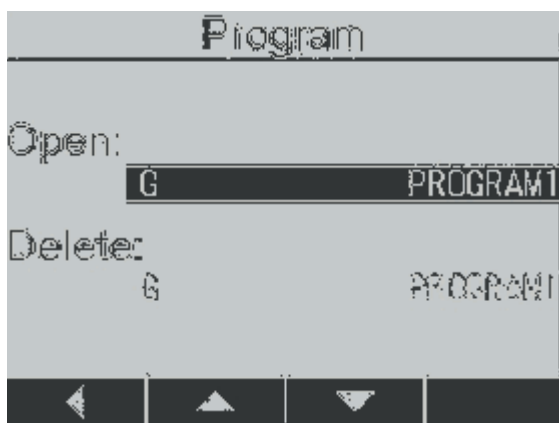


Fig. 6.13: Program screen

You can now open or delete a previously saved program, if available.

In case you are in one of the Modes, where predefined programs can be used, the screen provides an additional Save option.



Fig. 6.14: Program screen with Save option

The Save option is especially interesting in the Repeat mode. The last distillation carried out with the system, e.g. a distillation in Manual mode, is saved in the buffer and can be repeated within the Repeat mode. To save such a distillation as a program, highlight the Save option and press the Forward button. You can now enter a name under which you want to save the distillation as a program.

Use the selection knob at the vacuum controller to move the “cursor” from one character to the other and press **Enter** each time you want to take a character over into the field at the top. Press **Save** to save the program under the entered name.

6.7.4 Solvent library

The submenu Solvent library contains the same solvent library settings as accessible via the Library button, see chapter 6.4.2.

6.7.5 Extra

When you select the Extra submenu, the following screen opens:



Fig. 6.15: Extra screen

Calibr. AutoDest probe

By means of this submenu you can calibrate your AutoDest probe, if applicable. For this purpose, follow the instructions on the screen.

NOTE

During the calibration procedure the system carries out a plausibility check on the measured values and displays an error message when the confirmed values are implausible.

Edit solvent

When you select this menu and press the Forward button, the following screen appears:

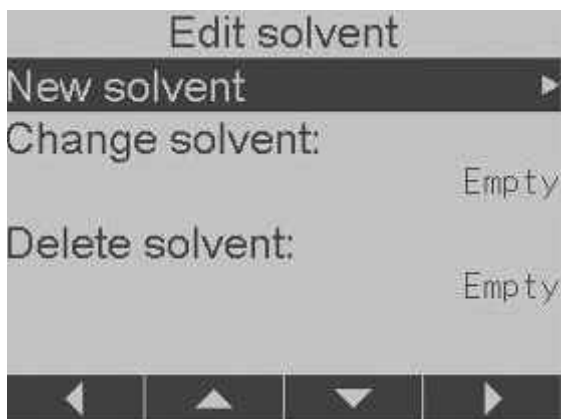


Fig. 6.16: Edit solvent - 1

Here you can define up to 15 new solvents or change and delete an existing one. When you want to define a new or change an existing solvent and press the Forward button, the following screen appears:

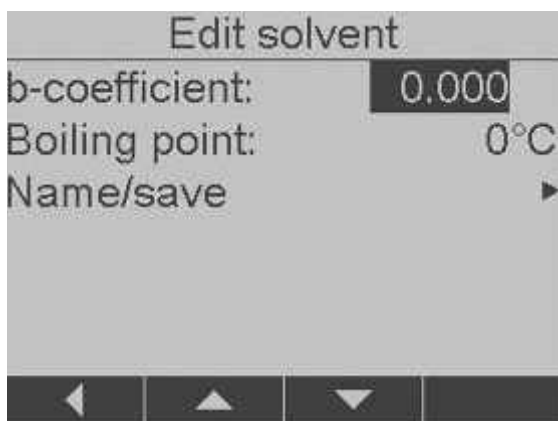


Fig. 6.17: Edit solvent - 2

Use the selection knob of the vacuum controller to define the b-coefficient and the boiling point of the new or modified solvent. Turn the knob to the right to increase the value or to the left to diminish the value and confirm your settings both times with **OK**.

The b-coefficient is used to calculate the desired boiling point T_p at a given pressure p :

$$T_p = \frac{T_s}{(3.006 - \log p) b + 1}$$

where:

T_s = boiling point (°K) at a pressure of 1013 mbar (normal pressure)

T_p = boiling point (°K) at pressure p (mbar)

You can now save the new or modified solvent under a certain name. When you press the Forward button, the following screen appears:



Fig. 6.18: Name of solvent

Use the selection knob at the vacuum controller to move the “cursor” from one character to the other and press **Enter** each time you want to take a character over into the field at the top. Press **Save** to save the solvent under the entered name.

6.8 Calibrating the pressure sensor

In the Extra menu, select **Calibr. pressure sensor**. Now press the Forward button, the following screen appears:

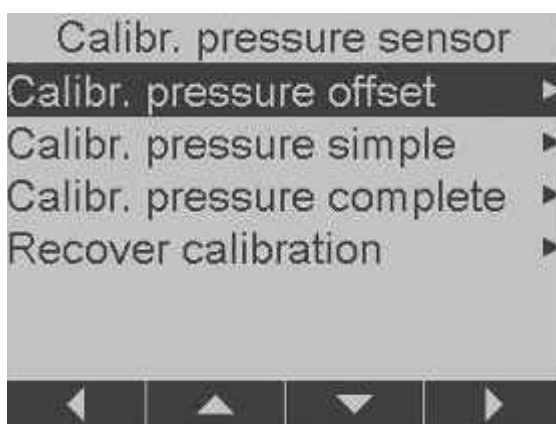


Fig. 6.19: Calibr. pressure sensor

You can now calibrate the pressure sensor:

NOTE

The pressure sensor is precalibrated by the manufacturer before the system is shipped to the customer. You can adapt this calibration to your working conditions by means of a reference measuring device.

6.8.1 Offset calibration

An offset calibration has to be carried out when the pressure value indicated by the Controller does not correspond to your reference pressure measuring device but is shifted up or down by a certain value, the offset.

To carry out an offset calibration of the pressure sensor, select Calibr. pressure offset. The following screen appears:

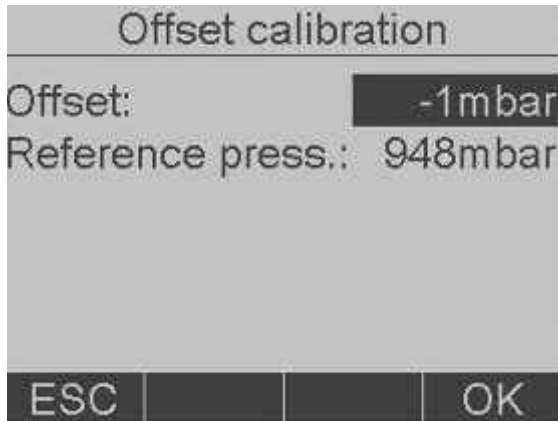


Fig. 6.20: Offset calibration

Use the selection knob of the vacuum controller to define the offset and the reference pressure for the offset calibration. Turn the knob to the right to increase the value or to the left to diminish the value and confirm your settings with **OK**. You will get back to the main screen.

6.8.2 Simple calibration (without temperature compensation)

NOTE

This calibration should only be carried out by authorized service personnel.

The calibration on working temperature serves to adjust the linearity of the pressure sensor at certain predetermined pressure levels.

During the calibration on working temperature, the pressure sensor is calibrated for normal pressure and a pressure of 800, 600, 400, 200, 10 mbar in 6 steps at room temperature.

NOTE

During the calibration procedure the system carries out a plausibility check on the measured values and displays an error message when the confirmed values are implausible.

To carry out the calibration, proceed as follows:

- Connect a reference pressure measuring device to the vacuum system your pump and controller are part of.
- Select Calibr. pressure simple. The following screen appears:

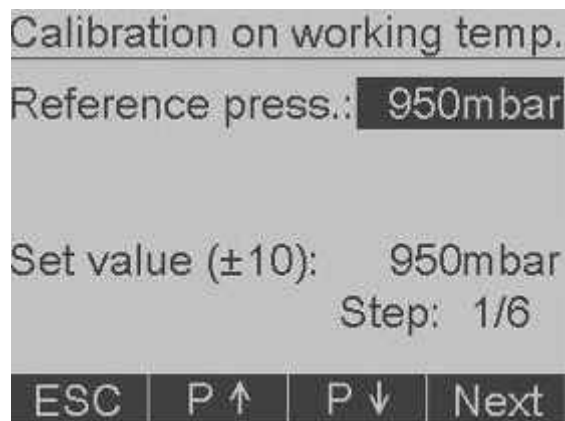


Fig. 6.21: Calibration on working temperature

- Press the START button at the vacuum controller to start the pump.
- Observe the display of the reference pressure measuring device and use the buttons **P↑** and **P↓** to increase or to diminish the pressure in the vacuum system until the displayed value is at least 10 mbar from the set value.
- Use the selection knob of the vacuum controller to adjust the reference pressure value to the one indicated on the display of the reference measuring device. Turn the knob to the right to increase the value or to the left to diminish the value.
- Press **OK** to confirm the value.
- Press **Next** to continue with the next step and proceed as described for the step before. When the last step is finished, you are asked whether you want to save the calibration.
- Press **OK** to confirm. The calibration is saved and you get back to the main screen.

6.8.3 Complete calibration with temperature compensation

NOTE

This calibration should only be carried out by authorized service personnel.

The manual calibration serves to adjust the linearity of the pressure sensor at certain predetermined pressure levels.

During the manual calibration, the pressure sensor is calibrated for normal pressure and a pressure of 800, 600, 400, 200, 10 mbar in 6 steps at room temperature and at a temperature of 55 °C.

WARNING

Hot surfaces when the instrument comes out of the laboratory kiln.



- Always be aware of the burn hazard.
- Always wear personal protective equipment such as protective gloves when getting the instrument out of the laboratory kiln.

NOTE

During the calibration procedure the system carries out a plausibility check on the measured values and displays an error message when the confirmed values are implausible.

To carry out the calibration, proceed as follows:

- Connect a reference pressure measuring device to the vacuum system your pump and controller are part of.
- Select Calibr. pressure complete. The following screen appears:

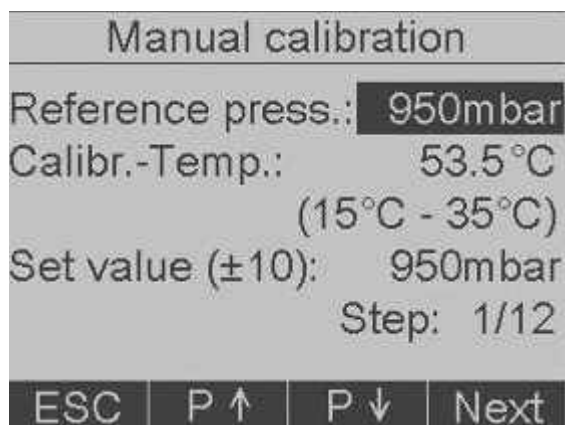


Fig. 6.22: Manual calibration

- Press the START button at the vacuum controller to start the pump.
- Observe the display of the reference pressure measuring device and use the buttons **P↑** and **P↓** to increase or to diminish the pressure in the vacuum system until the displayed value is at least 10 mbar from the set value.
- Use the selection knob of the vacuum controller to adjust the reference pressure value to the one indicated on the display of the reference measuring device. Turn the knob to the right to increase the value or to the left to diminish the value.
- Press **OK** to confirm the value.
- Press **Next** to continue with the next step and proceed as described for the step before.
- When the calibration at room temperature is finished, put the instrument into the laboratory oven and heat it up to 55 °C (this will take approx. 1.5 h).
- Repeat the calibration steps described above.
- When the last step is finished, you are asked whether you want to save the calibration.
- Press **OK** to confirm. The calibration is saved and you get back to the main screen.

Recover calibration:

To delete the current calibration and get back to the factory calibration, i.e. the delivery condition, select Recover calibration. You are asked whether you want to recover the calibration or not. Press **Yes** to confirm or **No** to maintain the current calibration.



ATTENTION

Consider that „Recover calibration“ deletes any existing calibration carried out by the customer.

6.9 Tips and tricks for a distillation

6.9.1 What to do when the solvent starts foaming?

- Press the button **P↑**. The current system pressure is frozen and the aeration valve is opened. The system is aerated and changes into the Hold mode, i.e. the **H Off** button becomes active.
- When the foam is gone or has sufficiently degenerated, press the **H Off** button to continue with the distillation process.
- In case the solvent starts foaming again, repeat the measures described above.

6.9.2 How to find out the distillation conditions for a solvent?

The solvent library integrated into the vacuum controller software provides you with information on a number of different solvents.

To use the library, proceed as follows:

- Press the Library button. The Solvent library screen opens.
- Select the solvent you are operating with by means of the selection knob at the vacuum controller and press **OK**.
- Now define the bath temperature you want to operate with by means of the selection knob at the vacuum controller and press **Accept**. The setting is saved and the value for pressure is adapted accordingly.

NOTE

The values indicated for boiling point and cooling H_2O max only serve for information purposes.

6.9.3 How to start a distillation without determining a pressure setpoint?

Preconditions:

- In the submenu **Remote control Evaporator**, the options **Rotation start** and **Jack down** have to be set to **Off**.

For a distillation quick start, proceed as follows:

- On the main screen press the **Cont.** button. The distillation starts.
- Now press the **Man.** button to enter the Manual mode.

7 Maintenance

This chapter gives instructions on all maintenance work to be performed in order to keep the instrument in good working condition. In addition to this, adjustment jobs the operator can carry out by himself/herself are explained.



WARNING

All maintenance and repair work requiring the opening or removal of instrument covers may only be carried out by trained personnel and with the tools provided for this purpose.



WARNING

Electrical hazard:

- *Prior to all maintenance work on the instrument switch off the power supply and remove all sources of flammable vapor.*



ATTENTION

Use only genuine consumables and genuine spare parts for maintenance and repair to assure good system performance and reliability. Any modifications to the spare parts used are only allowed with the prior written permission of the manufacturer.

7.1 Housing

Immediate maintenance

The housing is made of plastic. Remove any acid drops immediately from the housing with a moist cloth.

General maintenance

Check the housing for defects (controls, plugs) and clean it regularly with a moist cloth.



ATTENTION

Never use organic solutions (except for ethanol) as cleaning agents as these might damage the instrument.

7.2 Functional test

Test the following functions in regular intervals:

- Switch on the instrument. The display shows the basic state of the last distillation. When the connected instrument is aerated, the current atmospheric pressure is displayed.
- Press RUN. The aeration valve turns on, making an audible sound, the pump starts, the vacuum valve opens, and the display indicates the RUN mode.
- Press STOP. The aeration valve switches, making an audible sound, the pump stops, the vacuum valve closes and the display changes to the basic mode.

NOTE

When Aeration Off is configured, the valve only switches when you press the STOP button a second time.

8 Troubleshooting

This chapter helps to resume operation after a minor problem has occurred with the instrument. It lists possible occurrences, their probable cause and suggests how to remedy the problem.

The troubleshooting table below lists possible malfunctions and errors of the instrument. The operator is enabled to correct some of those problems or errors by him/herself. For this, appropriate corrective measures are listed in the column "Corrective measure".

The elimination of more complicated malfunctions or errors is usually performed by a Buchi technical engineer who has access to the official service manuals. In this case, please refer to your local Buchi customer service agent.

8.1 Malfunctions and their remedy

Table 8-1: Malfunction and their remedy

Malfunction	Possible cause	Corrective measure
No display	Instrument has no current	Switch instrument on, check mains connectins
Frequent switching of valve or pump	System is leaky Hysteresis is too small	Control all sealing points (tubes and their connections) Choose a larger hysteresis (if the end-vacuum is higher than 700 mbar, set the instrument to auto-matic hysteresis)
Valve does not switch	Valve does not close	Valve coil is dirty Valve cable is not plugged in Valve is not adjusted, contact the Buchi customer service for assistance
No vacuum	Tubing or cabling incorrect	Correct the tubing or cabling by referring to the corresponding chapters
Vacuum is not reached	Back evaporation at the Rotavapor Water pressure to water jet pump is too low	Empty the receiving flask and completely open the water tap Dry the pump diaphragm
Auto distillation has "abated"	Manually decrease the pressure until the distillation starts again, then return to the automatic function, if desired	
EasyVac distillation "abated"	Manually decrease the pressure until the distillation starts. The distillation stops automatically	
Distillation ended although not dried out completely	<ul style="list-style-type: none"> - Back evaporation from the receiving flask is too strong (especially for solvent mixtures), drain receiving flask and restart the distillation - Malfunction in distillation process is not exactly defined (e.g., sudden cooling, heat flow is too low, etc. Decrease the pressure manually until the distillation starts again, then return to the automatic function, if desired 	
Too much remaining liquid after auto distillation	Manually decrease the product pressure to distill the remaining liquid	

Table 8-2: Error messages

Error message	Remedy
The pressure sensor is not working	Contact the Buchi customer service.
The pressure sensor is not calibrated	Calibrate the pressure sensor as described in chapter 6.8. We recommend to have the simple and the complete calibration be carried out by the Buchi customer service.
Data transfer error on the RS-485	Check whether the RS-485 cable is at the right place and that only one vacuum controller is connected to it.
The AutoDest probe is not connected	Install the AutoDest probe as described in chapter 5.3.
Because of a leak the distillation process was cancelled	Retighten all connections and check all seals.
Excess pressure in the system	Let the pump run continuously until it has reduced the system pressure.
There was a read/write memory error	Contact the Buchi customer service.

8.2 Customer service

Only authorised service personnel are allowed to perform repair work on the instrument. These persons have a comprehensive technical training and knowledge of possible dangers which might arise from the instrument.

Addresses of official Buchi customer service offices are given on the Buchi website under: www.buchi.com. If malfunctions occur on your instrument or you have technical questions or application problems, contact one of these offices.

The customer service offers the following:

- Spare part delivery
- Repairs
- Technical advice

9 Shutdown, storage, transport and disposal

This chapter instructs how to shut down the instrument, how to pack it for storage or transport, and specifies the storage and shipping conditions.

9.1 Storage and transport

Store and transport the instrument in its original packaging.

9.2 Disposal

To dispose of the instrument in an environmentally friendly manner, a list of materials is given in chapter 3. This helps to ensure that the components are separated and recycled correctly.

Please follow valid regional and local laws concerning disposal.

NOTE

When you send the instrument back to the manufacturer for repair work, please copy the health and safety clearance form on the following page, fill it in and enclose it in the instrument package.

9.3 Health and safety clearance form

Declaration concerning safety, potential hazards and safe disposal of waste, e.g. used oil.

Safety and health of our staff, laws and regulations regarding the handling of dangerous goods, occupational health and safety regulations, safety at work laws and regulations regarding safe disposal of waste, e.g. waste oil, require that for all Rotavapors and other products this form must be sent to our office duly completed and signed before any equipment is repaired or dispatched to our premises.

Products will not be accepted for any procedure and handling and repair / DKD calibration will not start before we have received this declaration.

- a) Fax or post a **completed copy of this form** to us in advance. The declaration must arrive before the equipment. **Enclose a second, completed copy with the product.** If the product is contaminated you must notify the carrier (**GGVE, GGVS, RID, ADR**).
- b) Inevitably, the repair process will be delayed considerably, if this information is missing or this procedure is not obeyed. We hope for your understanding for these measures which are beyond our control and that you will assist us in expediting the repair procedure.
- c) **Make sure that you know all about the substances which have been in contact with the equipment and that all questions have been answered correctly and in detail.**

1. Product (Model):

2. Serial No.:

3. List of substances in contact with the equipment or reaction products:

3.1 Chemical/substance name, chemical symbol:

- a)
- b)
- c)
- d)

3.2 Important information and precautions, e.g. danger classification

- a)
- b)
- c)
- d)

4. Declaration (please mark as applicable):

☐ **4.1 for non dangerous goods:**

We assure for the returned product that

- neither toxic, corrosive, biologically active, explosive, radioactive nor contamination dangerous in any way has occurred.
- the product is free of dangerous substances.

The oil or residues of pumped media have been drained.

☐ **4.2 for dangerous goods:**

We assure for the returned product that

- all substances, toxic, corrosive, biologically active, explosive, radioactive or dangerous in any way which have pumped or been in contact with the product are listed in 3.1, that the information is complete and that we have not withheld any information.
- the product, in accordance with regulations, has been

- ☐ cleaned
- ☐ decontaminated
- ☐ sterilized

5. Way of transport / carrier:

Day of dispatch to Büchi Labortechnik AG:

We declare that the following measures - where applicable - have been taken:

- The oil has been drained from the product.

Important: Dispose of according to national regulations.

- The interior of the product has been cleaned.
- All inlet and outlet ports of the product have been sealed.
- The product has been properly packed, if necessary, please order an original packaging (costs will be charged) and marked as appropriate.
- The carrier has been informed about the hazardous nature of goods (if applicable).

Signature:

Name (print):

Job title (print):

Company's seal:

Date:

10 Spare parts

This chapter lists spare parts, accessories, and options including their ordering information.

Order the spare parts from Buchi. Always state the product designation and the part number when ordering spare parts.

Use only genuine Buchi consumables and genuine spare parts for maintenance and repair to assure good system performance and reliability. Any modifications to the spare parts used are only allowed with the prior written permission of the manufacturer.

10.1 Spare parts

Table 10-1: Spare parts

Product	Order number
Set with 5 sieves and 10 seals	15860
Tube connection GL-14, bent, complete, set of 4	37287

11 Declarations and requirements

11.1 FCC requirements (for USA and Canada)

English:

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to both Part 15 of the FCC Rules and the radio interference regulations of the Canadian Department of Communications. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment.

This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

Français:

Cet appareil a été testé et s'est avéré conforme aux limites prévues pour les appareils numériques de classe A et à la partie 15 des réglementations FCC ainsi qu'à la réglementation des interférences radio du Canadian Department of Communications. Ces limites sont destinées à fournir une protection adéquate contre les interférences néfastes lorsque l'appareil est utilisé dans un environnement commercial.

Cet appareil génère, utilise et peut irradier une énergie à fréquence radioélectrique, il est en outre susceptible d'engendrer des interférences avec les communications radio, s'il n'est pas installé et utilisé conformément aux instructions du mode d'emploi. L'utilisation de cet appareil dans les zones résidentielles peut causer des interférences néfastes, auquel cas l'exploitant sera amené à prendre les dispositions utiles pour palier aux interférences à ses propres frais.

11.2 Declaration of conformity

We BÜCHI Labortechnik AG
do hereby declare on our responsibility that the product:

Vacuum Controller V-850/855

which is the object of this certification, is in accordance with the following norms:

EN 61010-1:2001 (~ IEC 61010-1) Safety regulations for electrical measuring, control, regulation, and laboratory devices:
general requirements

EN 61326:2002 (~ IEC 61326) Electrical equipment for measurement, control, and laboratory use
- EMC requirements

EN ISO 12100-1:2003 Safety of Machinery. Basic concepts, general principles for design - part 1
Basic terminology and methodology

EN ISO 12100:2:2003 Safety of Machinery. Basic concepts, general principles for design - part 2
Technical principles

In accordance with the regulations of the EU guidelines

73/23/EEC (electrical operating equipment/low-voltage guidelines)

89/336/EEC (electromagnetic compatibility)

89/392/EEC (machinery directive)

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