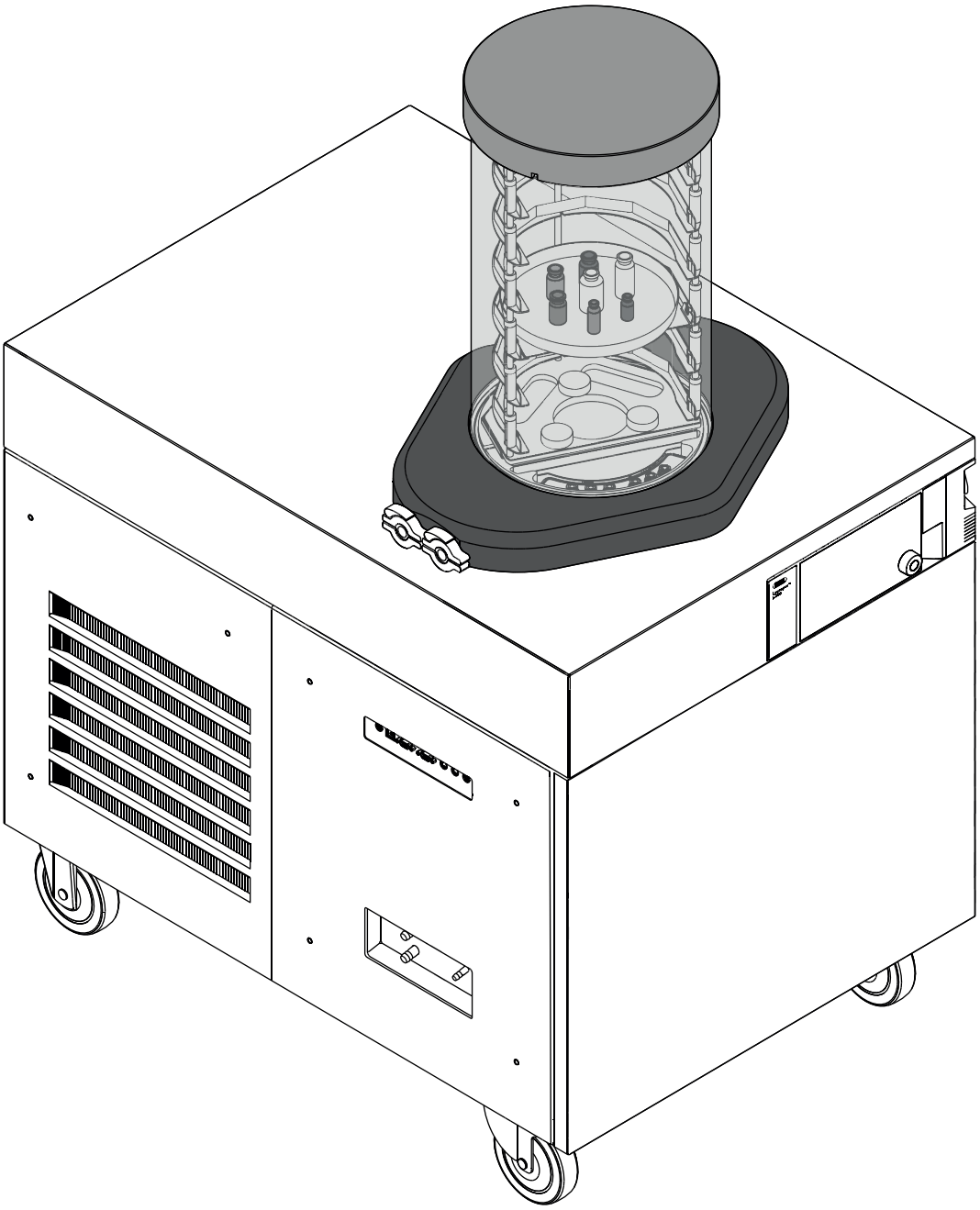
Lyovapor™ L-300/L-300 Pro
Operation Manual



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BÜCHI Labortechnik AG
Meierseggstrasse 40
Postfach
CH-9230 Flawil 1
E-Mail: quality@buchi.com

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1 About this document

This operation manual is applicable for all variants of the instrument.
Read this operation manual before operating the instrument and follow the instructions to ensure safe and trouble-free operation.
Keep this operation manual for later use and pass it on to any subsequent user or owner.
BÜCHI Labortechnik AG accepts no liability for damage, faults and malfunctions resulting from not following this operation manual.
If you have any questions after reading this operation manual:

▶ Contact BÜCHI Labortechnik AG Customer Service.

https://www.buchi.com/contact

1.1 Connected devices

In addition to these operating instructions, follow the instructions and specifications in the documentation for the connected devices.

1.2 Warning notices in this document

Warning notices warn you of dangers that can occur when handling the device.
There are four danger levels, each identifiable by the signal word used.

Signal word	Meaning
DANGER	Indicates a danger with a high level of risk which could result in death or serious injury if not prevented.
WARNING	Indicates a danger with a medium level of risk which could result in death or serious injury if not prevented.
CAUTION	Indicates a danger with a low level of risk which could result in minor or medium-severity injury if not prevented.
NOTICE	Indicates a danger that could result in damage to property.

1.3 Symbols

The following symbols are displayed in this operation manual or on the device:

1.3.1 Warning symbols

Symbol	Meaning
	General warning
	Breakable items
	Hand injuries

Symbol	Meaning
	Hot surface
	Explosive substances
	Dangerous electrical voltage
	Flammable substances
	Instrument damage

1.3.2 Mark-ups and symbols

NOTE

This symbol draws attention to useful and important information.

☑ This character draws attention to a requirement that must be met before the instructions below are carried out.

▶ This character indicates an instruction that must be carried out by the user.

⇨ This character indicates the result of a correctly carried out instruction.

Mark-up	Explanation
Window	Software Windows are marked-up like this.
Tab	Tabs are marked-up like this.
Dialog	Dialogs are marked-up like this.
[Button]	Buttons are marked-up like this.
[Field names]	Field names are marked-up like this.
[Menu / Menu item]	Menus or menu items are marked-up like this.
Status	Status is marked-up like this.
Signal	Signals are marked-up like this.

1.4 Trademarks

Product names and registered or unregistered trademarks that are used in this document are used only for identification and remain the property of the owner in each case.

2 Safety

2.1 Proper use

The Lyovapor™ L-300 is used for freeze-drying solid materials in ampoules, vials, trays, round-neck or wide-neck flasks and is exclusively intended for that purpose.
The Lyovapor™ L-300 can be used in laboratories for the following tasks:

- Sublimating and condensing water-based samples
- Sublimating and condensing samples containing solvents

2.2 Use other than that intended

Use of any other kind than that described in the section Chapter 2.1 "Proper use", page 9 and any application that does not comply with the technical specifications (see Chapter 3.6 "Technical data", page 21) constitutes use other than that intended.
In particular, the following applications are not permissible:

- Use of the instrument in an environment with a potential risk of explosion or areas which require explosion-safe apparatus.
- Use of the instrument for processing substances outside of research and development.
- Production and processing of substances that can lead to spontaneous reactions, such as explosives, metal hydrides or solvents that can form peroxides.
- Processing with explosive gas mixtures.
- Drying samples with high solvent concentrations without special safety precautions.

Damage or hazards attributable to use of the product other than as intended are entirely at the risk of the operator alone.

2.3 Staff qualification

Unqualified persons are unable to identify risks and are therefore exposed to greater dangers.
The instrument may only be operated by suitably qualified laboratory staff.
These operating instructions are aimed at the following target groups:

Users

Users are persons that meet the following criteria:

- They have been instructed in the use of the instrument.
- They are familiar with the contents of these operating instructions and the applicable safety regulations and apply them.
- They are able on the basis of their training or professional experience to assess the risks associated with the use of the instrument.

Operator

The operator (generally the laboratory manager) is responsible for the following aspects:

- The instrument must be correctly installed, commissioned, operated and serviced.
- Only suitably qualified staff may be assigned the task of performing the operations described in these operating instructions.
- The staff must comply with the local applicable requirements and regulations for safe and hazard-conscious working practices.
- Safety-related incidents that occur while using the instrument should be reported to the manufacturer (quality@buchi.com).

BUCHI service technicians

Service technicians authorized by BUCHI have attended special training courses and are authorized by BÜCHI Labortechnik AG to carry out special servicing and repair measures.

2.4 Location of warning signs on the product

2.4.1 Location of warning signs on the product (front view)

The following warning symbols are present on the instrument.

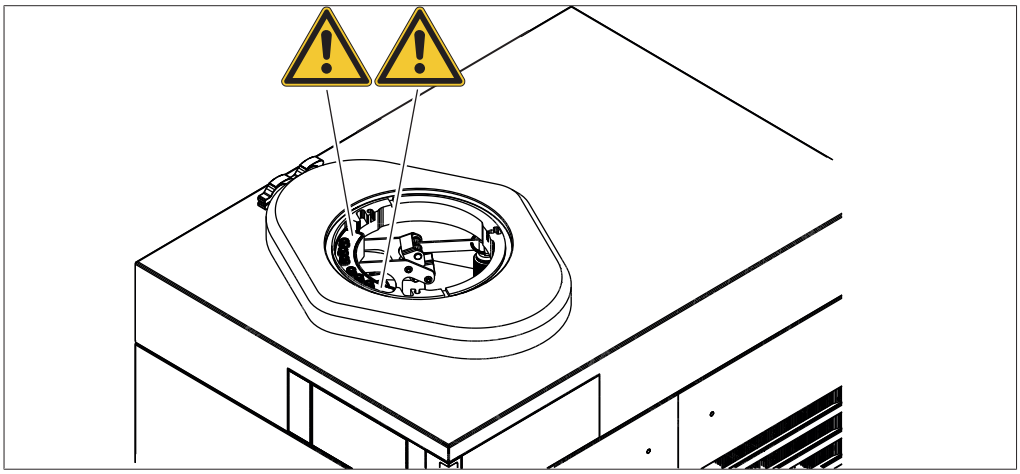


Fig. 1: Location of warning signs on the product

⚠ General warning

2.4.2 Location of warning signs on the product (rear view)

The following warning symbols are present on the instrument.

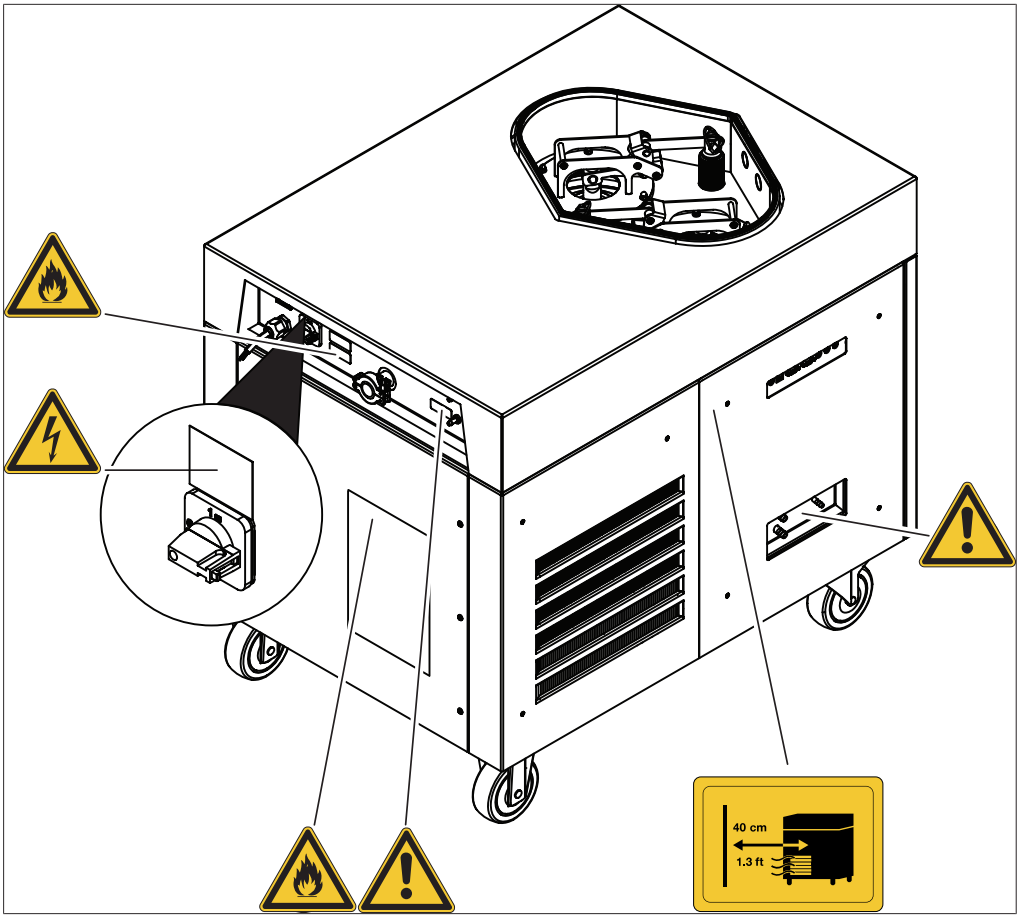


Fig. 2: Location of warning signs on the product

- General warning
- Flammable substances
- Dangerous electrical voltage
- Keep at least 40 cm clearance to prevent overheating

2.4.3 Location of warning signs on the ice condenser

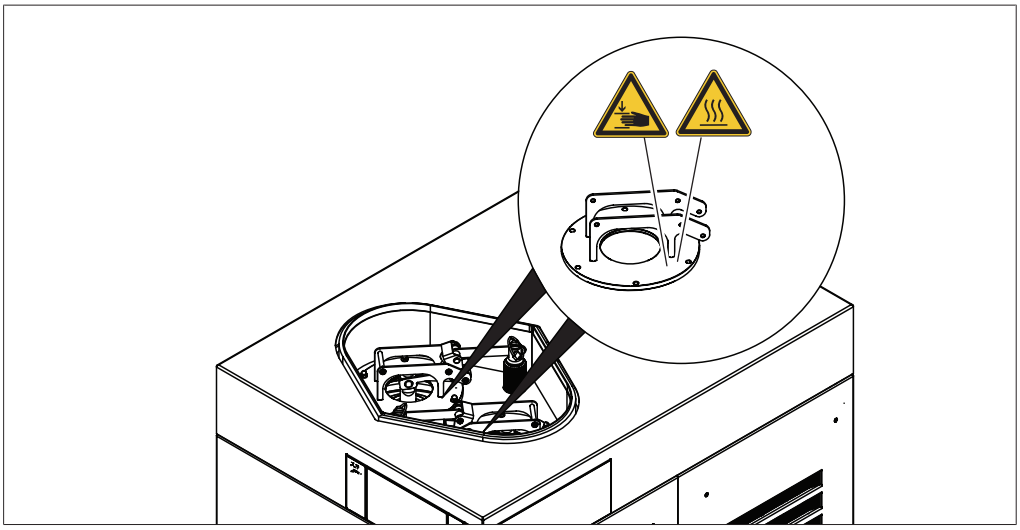


Fig. 3: Location of warning signs on the product

- Hand injuries
- Hot surface

2.5 Residual risks

The device has been developed and manufactured using the latest technological advances. Nevertheless, risks to persons, property or the environment can arise if the device is used incorrectly.
Appropriate warnings in this manual serve to alert the user to these residual dangers.

2.5.1 Faults during operation

If a device is damaged, sharp edges or exposed electrical wires can cause injuries.

- ▶ Regularly check device for visible damage.
- ▶ If faults occur, switch off the device immediately, unplug the power cord and inform the operator.
- ▶ Do not continue to use devices that are damaged.

2.5.2 Glass and acrylic breakage

Broken glass and acrylic can cause severe cuts.
Damaged glass and acrylic components may implode if subjected to a vacuum.
Minor damage to the ground joints impairs the sealing effect and may therefore diminish sublimination capacity.

- ▶ Handle the flask and other glass and acrylic components carefully and do not drop them.
- ▶ Always place the flasks in a suitable holder when they are not mounted on the Lyovapor™.
- ▶ Always visually inspect glass and acrylic components for damage every time they are to be used.
- ▶ Do not continue to use glass and acrylic components that are damaged.
- ▶ Always wear protective gloves when disposing of broken glass and acrylic.

2.5.3 Low internal pressure

Evacuating the system reduces the pressure in the drying chamber. This reduced pressure can cause glass and acrylic components to implode.

- ▶ Make sure that all glass and acrylic components are free of damage.

2.5.4 Cold and hot surfaces

The condenser coil and probes can be extremely cold. Heatable shelf areas can be extremely hot. If touched, hot and cold surfaces can cause skin burns.

- ▶ Do not touch cold or hot surfaces or liquids and/or wear suitable protective gloves.

2.6 Personal protective equipment

Depending on the application, hazards due to heat and/or corrosive chemicals may arise.

- ▶ Always wear appropriate personal protective equipment such as safety goggles, protective clothing and gloves.
- ▶ Make sure that the personal protective equipment meets the requirements of the safety data sheets for all chemicals used.

2.7 Modifications

Unauthorized modifications can affect safety and lead to accidents.

- Use only genuine BUCHI accessories, spare parts and consumables.
- Carry out technical changes only with prior written approval from BUCHI.
- Only allow changes to be made by BUCHI service technicians.

BUCHI accepts no liability for damage, faults and malfunctions resulting from unauthorized modifications.

3 Product description

3.1 Description of function

The Lyovapor™ is a freeze-dryer in which frozen samples can be gently dried.
The basis of freeze-drying is sublimation. Sublimation refers to the process whereby a substance transforms directly from the solid to the gaseous state.
The physical process of sublimation can be explained using the solvent water as an example.

- The water is frozen.
- The frozen water is transformed into the gaseous state under vacuum at a pressure below the triple point.

Thus, freeze-drying takes place in three phases:

1. **Freezing phase:** the sample is frozen at atmospheric pressure.
2. **Main drying phase:** heat is applied to the frozen sample under a vacuum. The frozen water is removed by sublimation.
3. **Secondary drying phase (only possible with heatable shelves):** the trace levels of water remaining are removed by heating.

The Lyovapor™ consists of an ice condenser and various top-mount drying racks. The top-mount drying racks can be chosen to suit the availability of the sample being dried and the requirements of the end product.
The following top-mount drying racks can be used:

- Non-heatable and heatable shelves in rack
- Trays in rack
- Top-mount rack with manifold valves

3.1.1 Freezing phase

In the freezing phase, the liquid sample is transformed to a solid state. Freezing takes place under atmospheric pressure using a separate freezer, a liquid nitrogen bath, or a mixture of dry ice and alcohol.
The end of the freezing phase is reached as soon as the water or solvent contained in the sample has fully crystallized and the entire sample is solidified.

3.1.2 Main drying phase

In the main drying phase, the ice crystals are removed from the sample by sublimation. Sublimation in the Lyovapor™ takes place under a vacuum with the addition of thermal energy.
The vacuum pressure is lowered to the level required for sublimation.
For water that is: less than 6.11mbar.
As the ice condenser is colder than the sample being dried, the vapour pressure in the area of the ice condenser is lower than in the area of the sample. The water vapour escaping from the sample therefore flows towards the ice condenser. The water or solvent vapour condenses on the coil of the ice condenser.
If drying chamber without heating is used, heat transfer takes place by convection and radiation from the surroundings. Control of the thermal energy transferred is then difficult.

If a drying chamber with heating is used, heat transfer takes place additionally by direct contact. The temperature of the heatable shelves is controllable. Control of the thermal energy transferred is then possible.
Controlling the heat transfer prevents the following critical temperatures for amorphous and crystalline materials in the solidified sample being reached:

- the glass transition temperature T_g' of the frozen sample.
- the collapse temperature T_c.
- the eutectic temperature T_{eu}.

Above the glass transition temperature and the collapse temperature, the viscosity of the frozen sample decreases. The reduced viscosity leads to the collapse of the sample's matrix structure.
Above the eutectic temperature, the sample melts.
During the main drying phase, the product temperature must remain below the collapse temperature for amorphous materials in the sample.
Sublimation of the ice crystals progresses downwards from the surface of the product. Above the sublimation boundary, the product is dry ("freeze-dried cake"), while further inside the product is still frozen.
The end of the main drying phase is reached when all ice crystals have been removed from the sample.
After the main drying phase, the remaining fluid content in the sample can still be between 5 to 10%.

3.1.3 Secondary-drying phase

In the secondary drying phase, the unfrozen water is removed from the sample by desorption. The secondary drying function is performed by the heatable shelves in the drying chamber of the Lyovapor™.
In the secondary drying phase, the temperature of the heatable shelves is raised and held for several hours.
The end of the secondary drying phase is reached when the residual moisture in the sample is between 1% and 5% or the end point determination is succeeded.

3.2 Configuration

3.2.1 Front View

NOTE

For technical specifications of connections, see Chapter 3.6 "Technical data", page 21

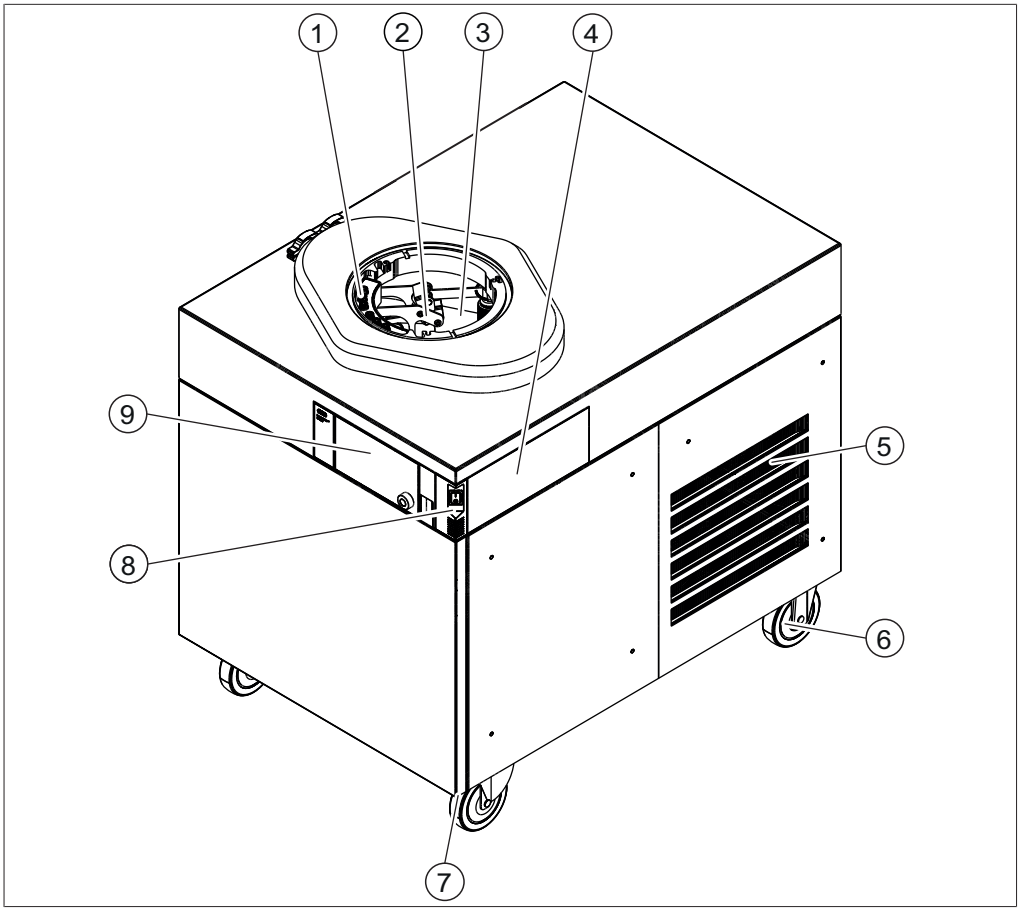


Fig. 4: Front View

1	Connections for heated shelf (Lyovapor™ L-300 Pro only)	2	Intermediate valve
3	Ice condenser	4	Optional mounting position for control panel
5	Ventilation slots	6	Castors
7	Castor brake	8	On/Off master switch
9	User interface		

3.2.2 Rear view

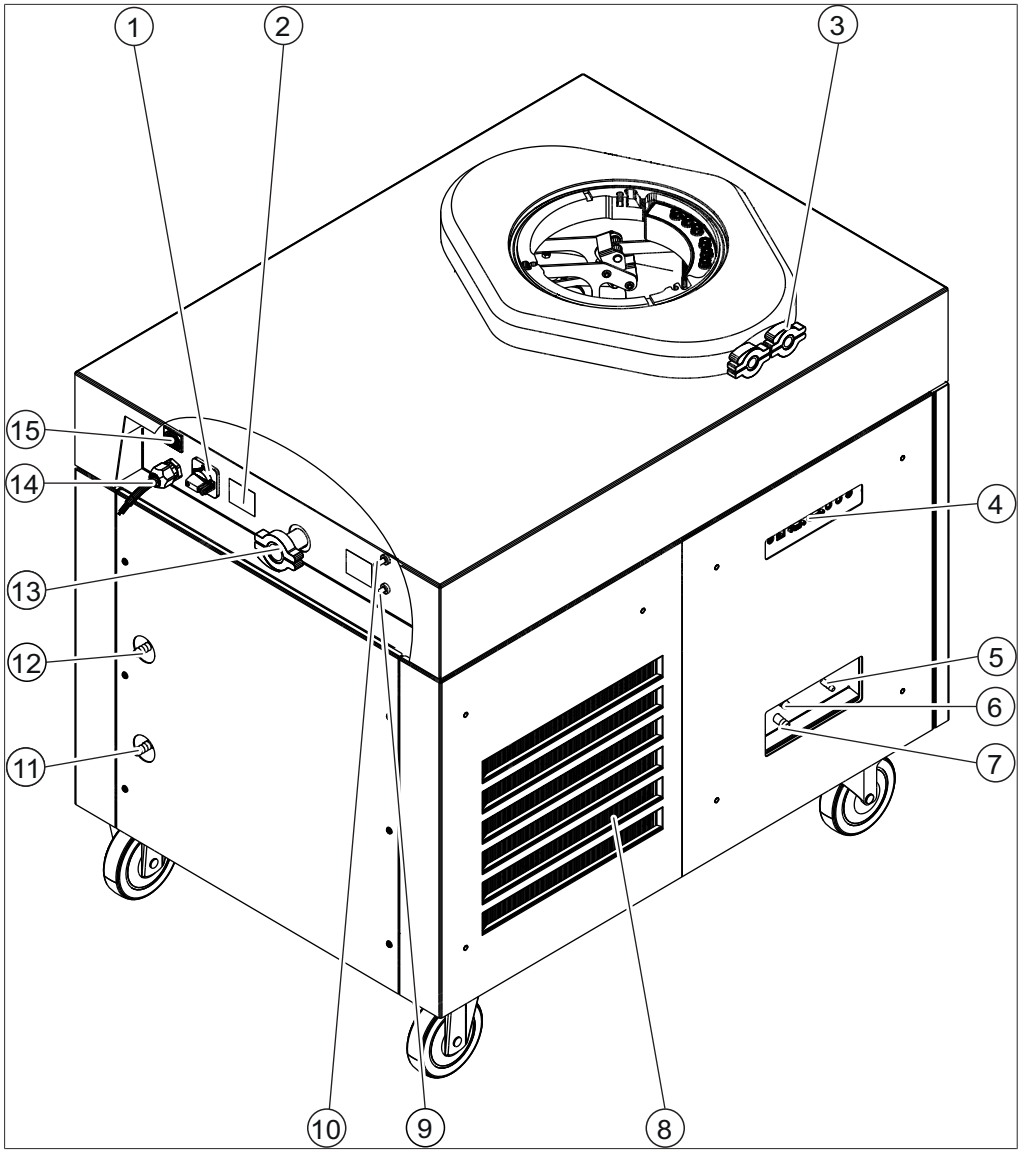


Fig. 5: Rear view

1	Power isolating switch	2	Type plate/Refrigerant specifications
3	Connections for pressure sensors (option)	4	Side connections
5	Connection for fresh water	6	Connection for condensate drain hose I
7	Connection for condensate drain hose II	8	Ventilation slots
9	Gas connection for venting valve	10	Gas connection for pressure regulating valve
11	Coolant outlet connection	12	Coolant inlet connection
13	Vacuum connection	14	Power cord
15	Vacuum pump connection		

3.2.3 Side connections

NOTE

For technical specifications of connections, see Chapter 3.6 "Technical data", page 21

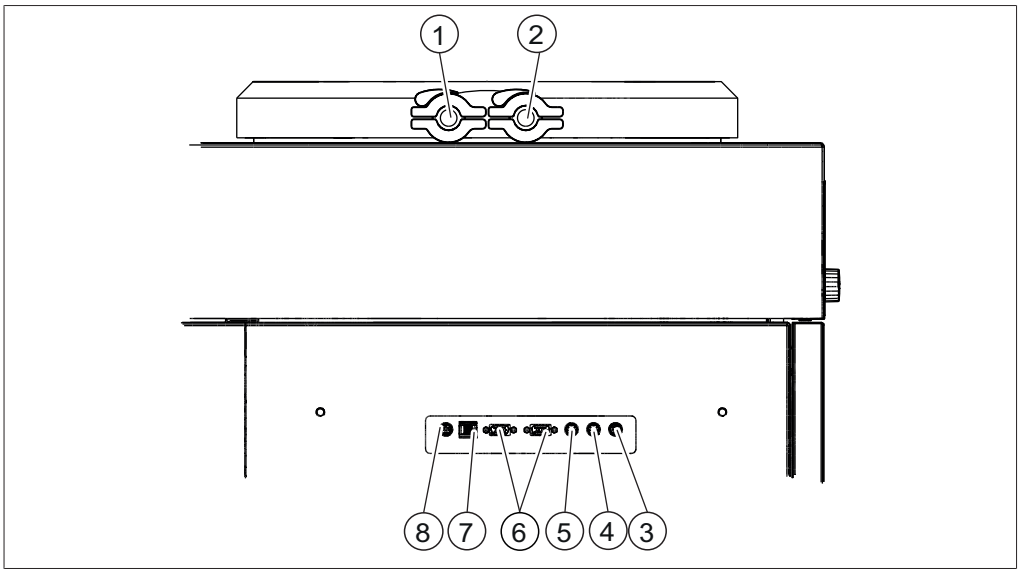


Fig. 6: Side connections

1	Connection for pressure sensor (option)	2	Connection for pressure sensor (option)
3	Automatic stoppering connection	4	Connection for fresh water sensor
5	Connection for receiving vessel sensor	6	Connection for external pressure sensors (optional)
7	LAN port	8	Standard BUCHI communication port (COM)

3.2.4 Control panel

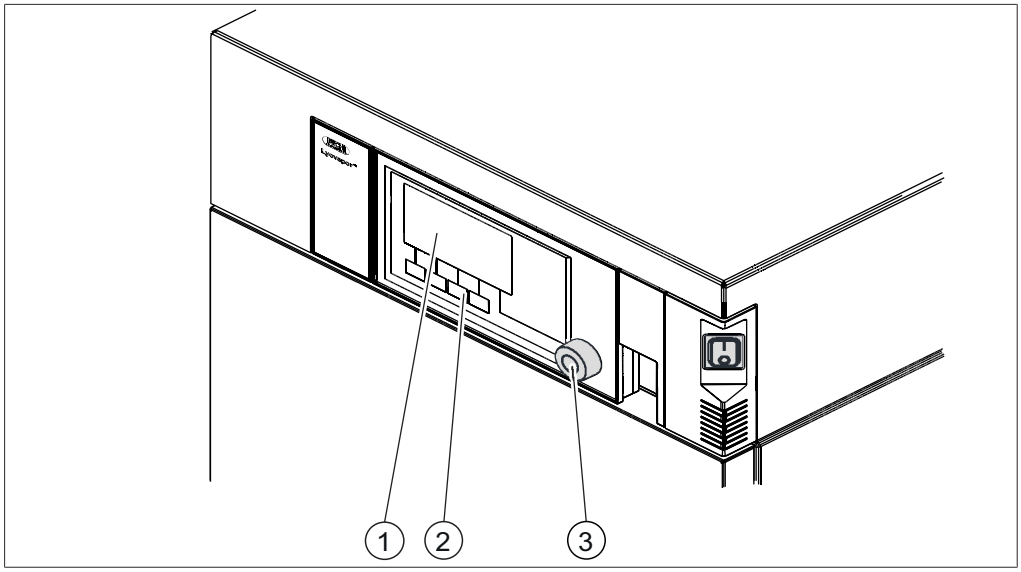


Fig. 7: Control panel

1 View
2 Function buttons
3 Navigation control

3.2.5 Pro control panel

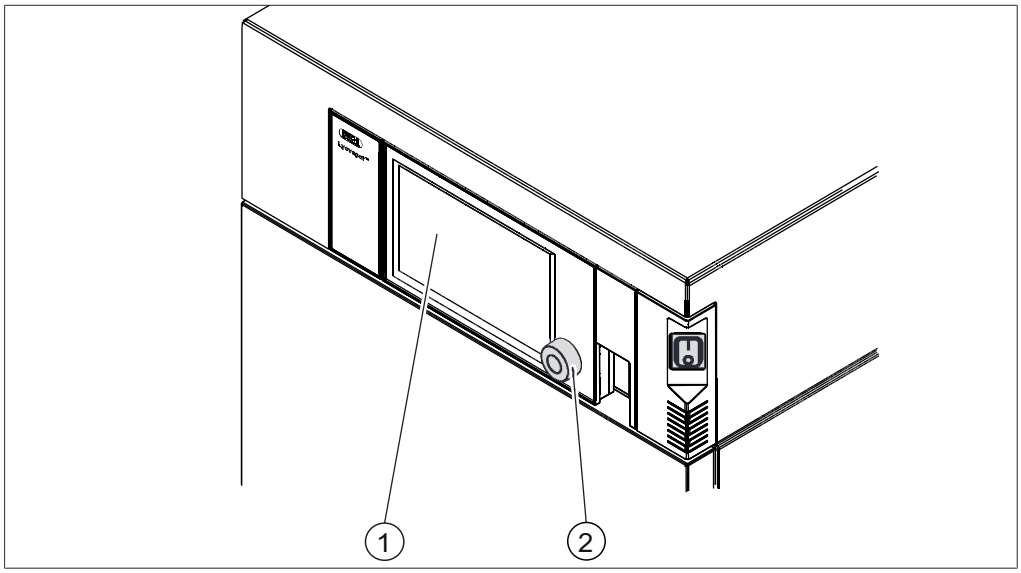


Fig. 8: Pro control panel

1 Touch-screen display
2 Navigation control

3.3 Type plate

The type plate identifies the instrument. The type plate is located at the rear of the instrument.

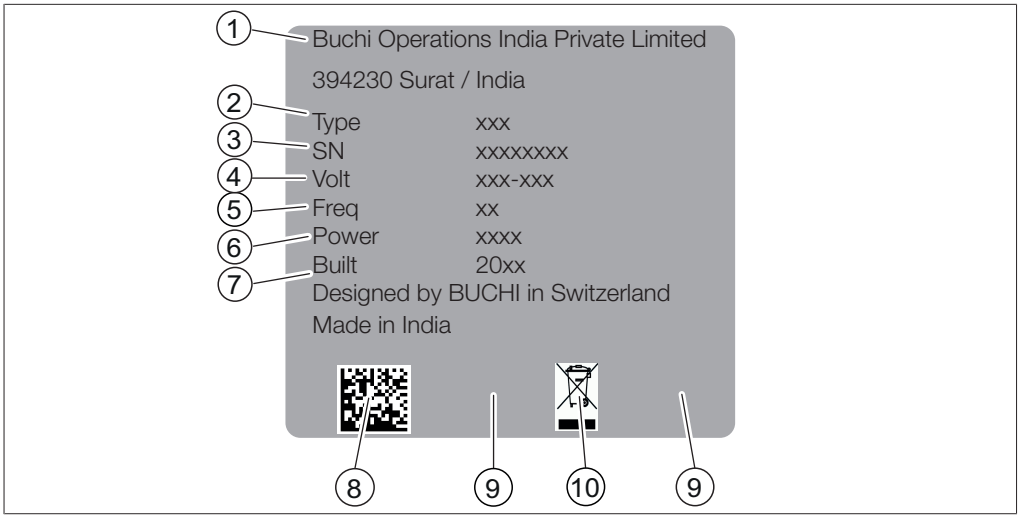


Fig. 9: Type Plate

1	Company name and address	2	Instrument name
3	Serial number	4	Input voltage range
5	Frequency	6	Power consumption maximum
7	Year of manufacture	8	Product code
9	Approvals	10	Symbol for "Do not dispose of as household waste"

3.4 Scope of delivery

NOTE

The scope of delivery depends of the configuration of the purchase order.

Accessories are delivered as per the purchase order, order confirmation, and delivery note.

3.5 Refrigerant Specification

The instrument uses 2 type of compressors to maintain the ice condenser temperature. For details see Chapter 3.6.1 "Lyovapor™ L-300", page 21.

3.5.1 Refrigerant Specification (Low temperature)

The refrigerant details are shown on the back of the instrument.

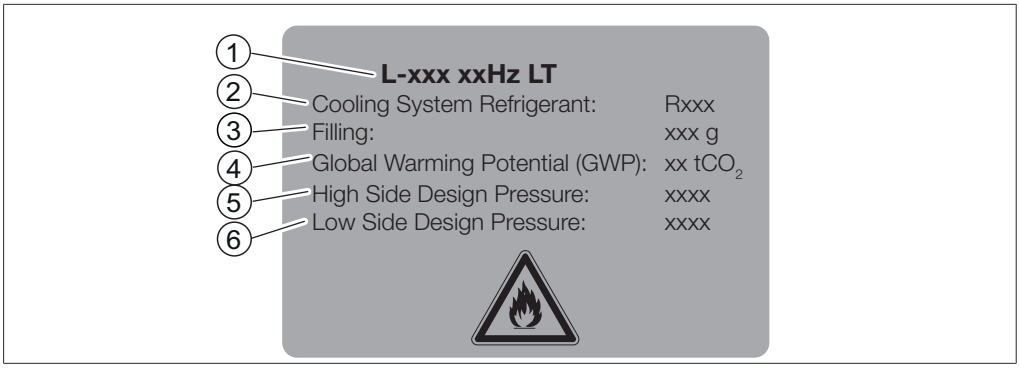


Fig. 10: Refrigerant details

1	Instrument name	2	Refrigerant details
3	Filling capacity	4	Global warming potential
5	High-pressure system design pressure	6	Low-pressure system design pressure

3.5.2 Refrigerant Specification (High temperature)

The refrigerant details are shown on the back of the instrument.

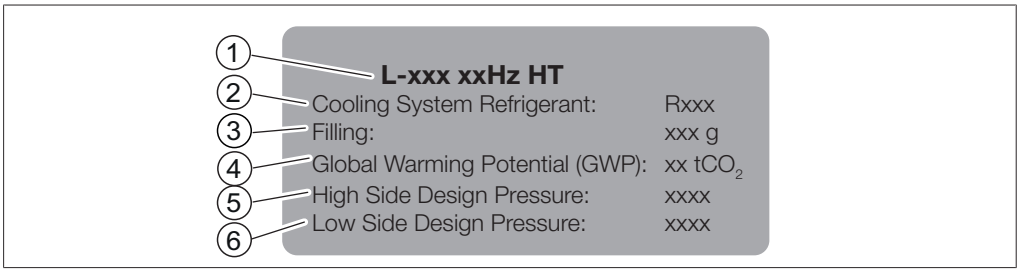


Fig. 11: Refrigerant details

1	Instrument name	2	Refrigerant details
3	Filling capacity	4	Global warming potential
5	High-pressure system design pressure	6	Low-pressure system design pressure

3.6 Technical data

3.6.1 Lyovapor™ L-300

Specification	L-300 for 50Hz	L-300 for 60Hz
Dimensions without drying attachments (W x D x H)	710 x 1000 x 900 mm	710 x 1000 x 900 mm
Weight	272 kg	272 kg
Minimum clearance on all sides	400 mm	400 mm
Power supply	380 – 400 V 3N~	208 – 220 V 3~
Power consumption (maximum)	6000 VA	5000 VA
Lug	16 A	16 A
Frequency	50 Hz	60 Hz

Specification	L-300 for 50Hz	L-300 for 60Hz
Electrical connector (Specified according to UK standard)	CEE 400 V 16 A (IEC 60309),3P+N+PE , 6h, red	NEMA L21-20, 4-pole/5-wire, 20 A, 3Ø 208 V
Max. current for all connections	0.5 A	0.5 A
Voltage per connection	24 V	24 V
Connection voltage for each heatable shelf (Lyovapor™ L-300 Pro only)	48 V	48 V
Max. current for each connection heatable shelf (Lyovapor™ L-300 Pro only)	max. 3 A	max. 3 A
Overvoltage category	II	II
Protection rating	IP20	IP20
Pollution degree	2	2
Condensing capacity at 25 °C ambient temperature	≤ 12 kg/24 h	≤ 12 kg/24 h
Lowest condenser temperature (without samples)	-105 °C	-105 °C
Temperature divergence	± 3.0 °C	± 3.0 °C
Condenser capacity	Unlimited (2 x ≤ 1 kg)	Unlimited (2 x ≤ 1 kg)
Condenser surface area	2 x 1280 cm^2	2 x 1280 cm^2
Number of compressors	2	2
Refrigerant 1	R507 CFC-free	R507 CFC-free
Refrigerant 1 quantity	790 g	790 g
Refrigerant 2	Ethylene CFC-free	Ethylene CFC-free
Refrigerant quantity 2	98 g	98 g
Drying shelf temperature regulation	to 60 °C	to 60 °C
Drying shelf temperature tolerance	± 1.0 °C	± 1.0 °C
Inert gas pressure (relative pressure)	max. 0.5 bar	max. 0.5 bar
EMC to EN 61326	Class B	Class B
Coolant pressure (relative pressure)	< 4 bar	< 4 bar
Coolant connection	DN10 mm	DN10 mm
Inlet water temperature	15 - 25°C	15 - 25°C
Cooling capacity of condenser for water cooling	Min. 350 W	Min. 350 W
Vacuum generation time to 0.1 mbar*	Typically ≤ 15 min	Typically ≤ 15 min

Specification	L-300 for 50Hz	L-300 for 60Hz
Volume-based leakage rate*	Typically ≤ 0.001 mbar x L/sec	Typically ≤ 0.001 mbar x L/sec
Minimum system vacuum (with default vacuum pump / without samples)	Typically ≤ 30 mTorr	Typically ≤ 30 mTorr
Vacuum control range (with default vacuum pump / without samples)	50 to 750 mTorr	50 to 750 mTorr
Noise emission to DIN 45635 (without vacuum pump)	Typically < 68 dB(A)	Typically < 68 dB(A)
Certificates	CE / CSA	CE / CSA

3.6.2 Ambient conditions

For indoor use only.

Max. altitude above sea level	2000 m
Ambient temperature	15 - 30°C
Maximum relative humidity	80 % for temperatures up to 30°C
Storage temperature	max. 45°C

3.6.3 Materials

NOTICE

Use of organic solvents, acids and base.

Can lead to wearout of sealings.

NOTE

Further information on chemical resistance. See *"List of chemical resistances Lyovapor™"*

Component	Materials of construction
Lyovapor™ housing	Steel 1.4301/304 with powder coating
Vacuum chamber and components	Steel 1.4301/304
Main connector	PMMA GS
Drying chamber tube and cover	PMMA GS
Seals	FKM
Manifold drying rack	Steel 1.4301/304
Manifold valves	EPDM, Silicone
Refrigerant circuit	Copper for freezing applications EN 12735-1 Steel 1.4301/304
Vacuum clips	Aluminium

Component	Materials of construction
Condensate drain valve	Steel 1.4301/304 with EPDM sealings Silicon drain tubing
Venting valve	Brass with FKM seal
Regulating valve	EN 1.4301 PBT Silicone
Steam generation	EN 1.4301 EPDM seal Silicone

4 Transport and storage

4.1 Transport

NOTICE

Risk of breakage due to incorrect transportation

Make sure that the instrument is fully dismantled.

Pack every instrument components properly to prevent breakage. Use the original packaging whenever possible.

Avoid sharp movements during transit.

- ▶ After transporting, check the instrument and all glass components for damage.
- ▶ Damage that has occurred in transit should be reported to the carrier.
- ▶ Keep packaging for future transportation.

4.2 Storage

- ▶ Make sure that the ambient conditions are complied with (see Chapter 3.6 "Technical data", page 21).
- ▶ Wherever possible, store the device in its original packaging.
- ▶ After storage, check the device, all glass components, seals and tubing for damage and replace if necessary.

5 Installation

5.1 Installation site

The installation site must meet the following requirements:

⚠ DANGER

Risk of explosion from flammable gas-and-air mixtures

The potential consequences are death or extremely serious injury.

- ▶ Do not damage the refrigerant circuit piping.
- ▶ Store and operate the instrument in a room with a volume of at least 16.6 m^3 so that an ignitable gas-and-air mixture cannot develop.

NOTICE

Instrument damaged if switched on too early.

After transporting, wait twelve hours before switching on the instrument. The fluid in the cooling system requires twelve hours to collect in the refrigerant compressor.

- Firm, level surface
- Minimum space requirements: 810 mm x 1000 mm x 1000 mm (W x D x H).
- Take into account the maximum product dimensions and weight.
- Take into account the 1100 mm operating height of the drying attachments.
- The clearance from the air inlets and outlets to the wall should be at least 40 cm. The clearance ensures air circulation and prevents the instrument from overheating.
- Do not place loose papers or cloths below or to the sides of the instrument, as these could impede the air circulation if drawn in.
- Operate the instrument at an ambient temperature of +15°C to +30°C.
- Make sure that the temperature of the cooling air drawn in is between +15 °C and +30 °C.
- Do not expose the instrument to any external thermal loads, such as direct solar radiation.
- At ambient temperatures upwards of 25°C use water cooling.
- Make sure the castor brakes are locked or make sure the castor brakes are on.

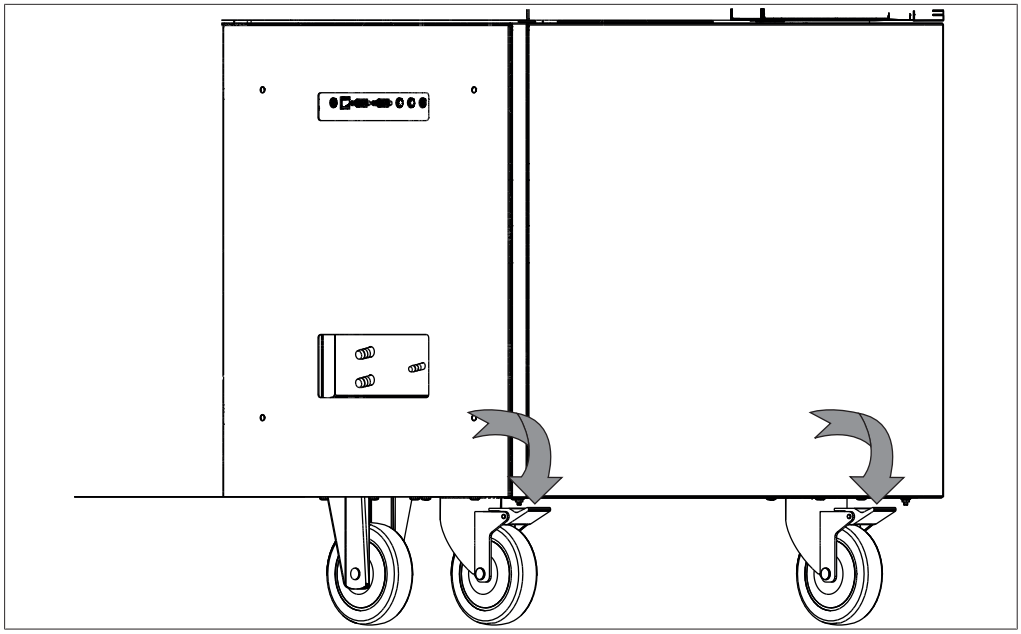


Fig. 12: Castor brake

NOTE

Make sure that the power supply can be disconnected at any time in an emergency.

NOTE

Depending on the ambient conditions, condensation may form on any cold surface on the unit.

5.2 Putting the instrument in operation

NOTICE

Instrument damaged if restarted too early

Wait ten minutes before restarting the instrument. The oil in the refrigerant compressor requires ten minutes to return to the collection tank.

5.2.1 Preparing the instrument

- ▶ Clean the instrument with a damp cloth before commissioning.
- ▶ Check all sealing surfaces for scratches, dust, and cleanliness.

5.2.2 Establishing electrical connections

NOTE

Observe the regulatory provisions when connecting the Lyovapor™ to the power supply.

- ▶ Use additional electrical safety features (e.g., residual-current circuit breakers) to comply with local laws and regulations.

The power supply must fulfil the following conditions:

1. Provide the mains voltage and frequency specified on the type plate of the instrument.

2. Be designed for the load imposed by the instruments connected.
3. Be equipped with suitable fuses and electrical safety features.
4. Be equipped with a proper earthing.

- ▶ Make sure that all connected devices are earthed.
- ▶ Make sure that the power plug is freely accessible at all times.
- ▶ Insert the power plug into the power socket.

5.2.3 Fitting the fresh water connections

NOTICE

Risk of instrument damage from scale formation

- ▶ Use distilled water.
- ▶ Do not connect to mains water supply.

NOTE

- ▶ Use only the containers supplied.
- ▶ Place container at the same level as the instrument.

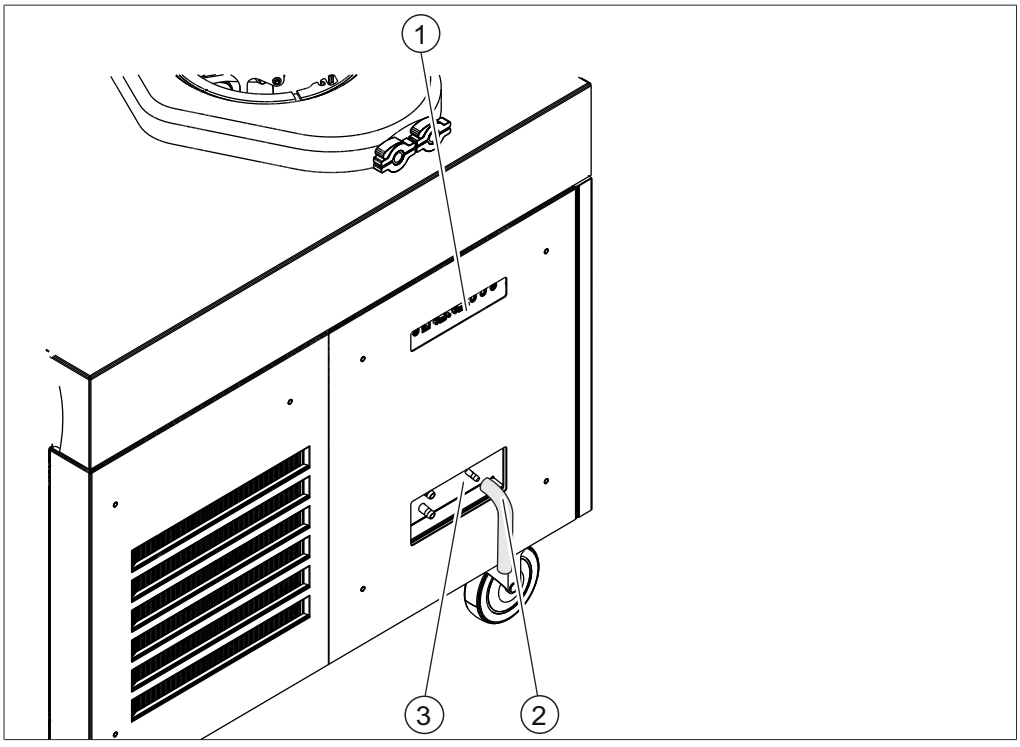


Fig. 13: Fitting the fresh water connections

1	Side connections See Chapter 3.2.3 "Side connections", page 18	2	Tube for fresh water
3	Connection for fresh water		

Precondition:

☑ The coolant connection complies with the specified parameters. See Chapter 3.6 "Technical data", page 21

☑ Depending on the volume of the sample and the environmental conditions 3 L to 8.5 L water in 24 h is necessary.

- ▶ Switch the On/Off master switch to Off.
- ▶ Fit the inlet tube (4) onto the connection marked **Fresh Water** (5).
- ▶ Fit the fresh water level sensor (optional). See Chapter 5.2.4 "Fitting fill-level sensor in water tank (optional)", page 29

5.2.4 Fitting fill-level sensor in water tank (optional)

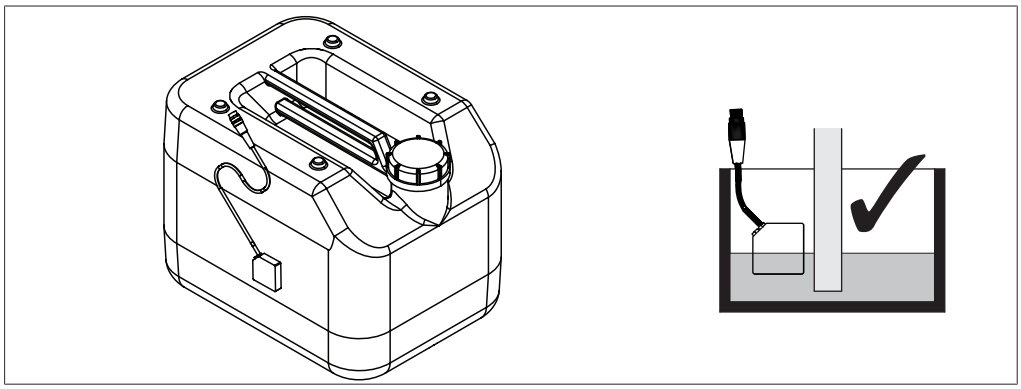


Fig. 14: Fitting the fresh water level sensor

- ▶ Switch the On/Off master switch to Off.
- ▶ Fit the sensor on the fresh water container above the inlet tube.
- ▶ Plug the fresh water sensor electrical connection into the socket marked **Defrost Water**.

5.2.5 Fitting the drain tubes

⚠ CAUTION

Risk of scalding by hot water

- ▶ Make sure the condensate drain hose is not loose.

NOTE

- ▶ Use only the containers supplied.
- ▶ Place container at the same level as the instrument.

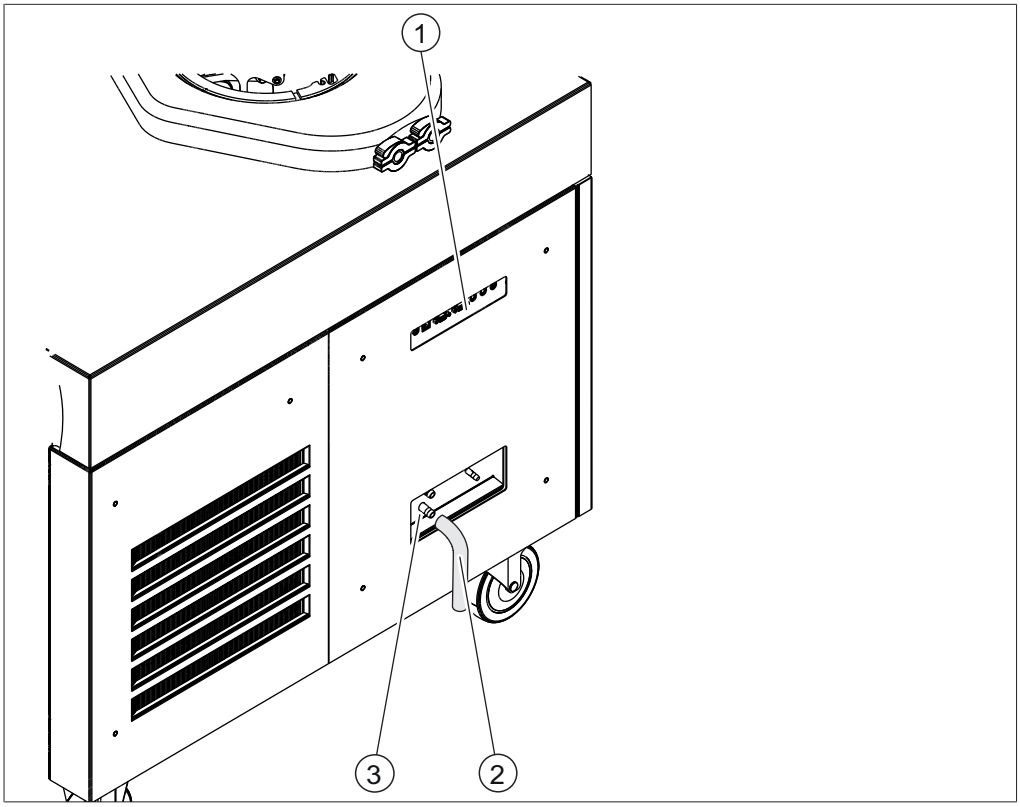


Fig. 15: Fitting the drain tube

1 Side connections
See Chapter 3.2.3 "Side connections", page 18

2 Drain tube

3 Connection for condensate drain tube

- ▶ Switch the On/Off master switch to Off.
- ▶ Fit the drain tube (4) onto the connection marked **Drain 1** (5).
- ▶ Fix the drain tube in place with a hose clip.
- ▶ Fit another drain tube onto the connection marked **Drain 2**.

5.2.6 Fitting the fill-level sensor on the receiving vessel (optional)

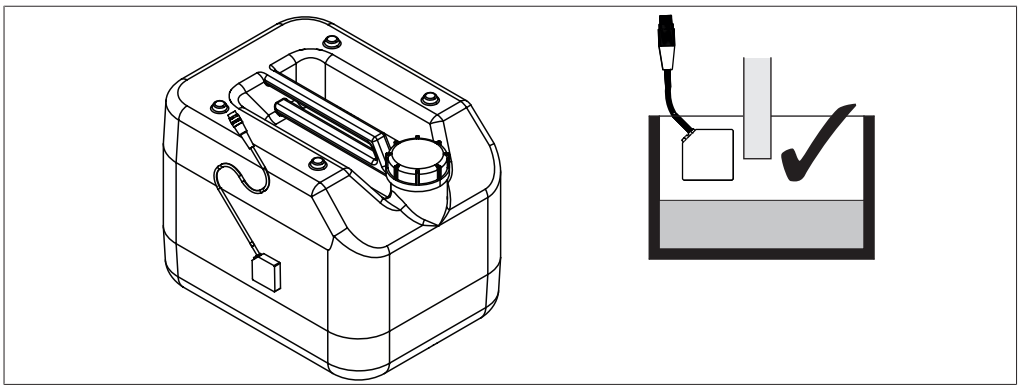


Fig. 16: Position of fill-level sensor in receiving vessel

- ▶ Fix the sensor on the receiving vessel below the condensate drain tube.

- Plug the receiving vessel sensor electrical connection into the socket marked **Waste Water**.

5.2.7 Connecting the coolant

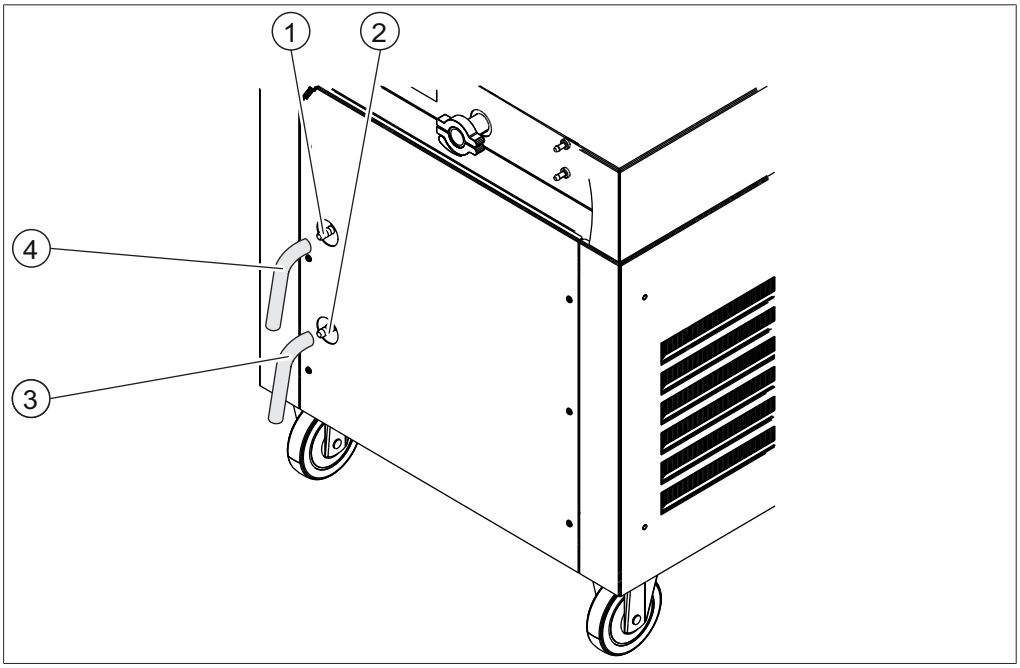


Fig. 17: Connecting the coolant

1	Coolant inlet connection	2	Coolant outlet connection
3	Drain tube	4	Inlet tube

Precondition:

☑ The coolant connection complies with the specified parameters. See Chapter 3.6 "Technical data", page 21

- Make sure that the instrument is not connected to the power supply.
- Fit the inlet tube (4) onto the coolant inlet connection (1).
- Fix the inlet tube (4) in place with a hose clip.
- Fit the drain tube (3) onto the coolant drain connection (2).
- Fix the drain tube (3) in place with a hose clip.

5.2.8 Fitting pressure sensors (option)

The pressure sensors measure the pressure in the top-mount drying rack.

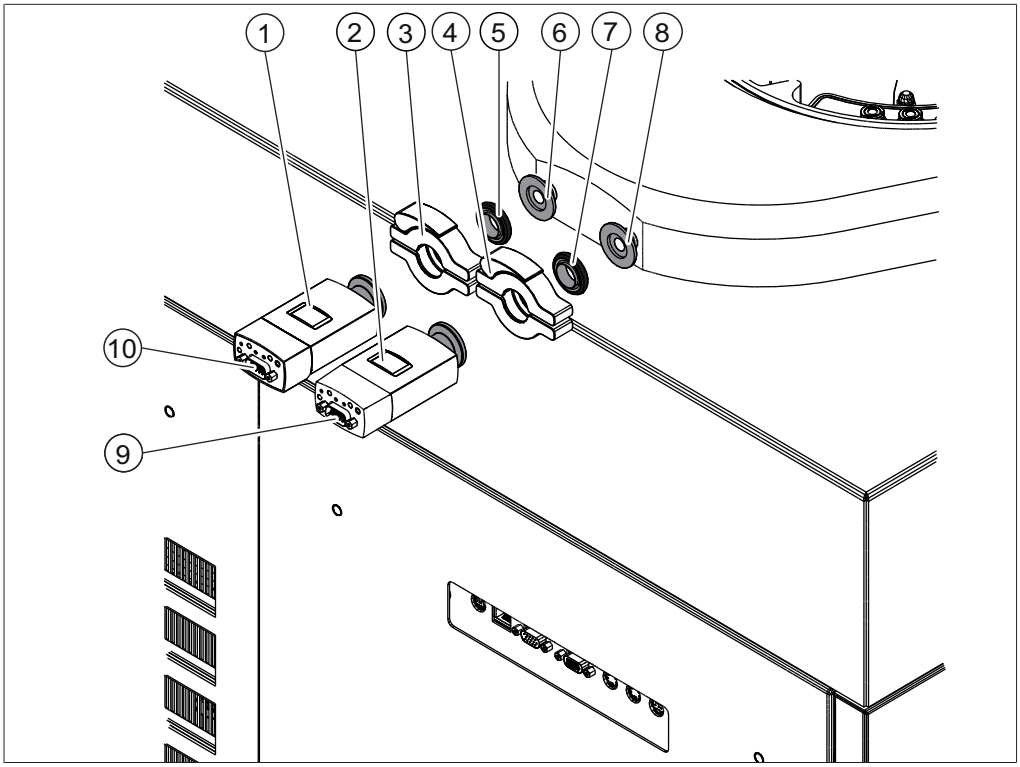


Fig. 18: Fitting the pressure sensors

1	Pressure sensor	2	Pressure sensor
3	Clamp, ISO-KF 16	4	Clamp, ISO-KF 16
5	Seal, ISO-KF 16	6	Connection for pressure sensor
7	Seal, ISO-KF 16	8	Connection for pressure sensor
9	Connection	10	Connection

Fitting pressure sensor one

- ▶ Switch the On/Off master switch to Off.
- ▶ Remove the shipping cap from the pressure sensor connection (6).
- ▶ Fit the pressure sensor (1) and seal (5) to the pressure sensor connection (6) and fix with the clamp (3).
- ▶ Plug the connecting lead connection into the socket (10) on the pressure sensor (1).
- ▶ Plug the connecting lead connection into the socket marked **Vacuum Sensor 1**.
- ▶ Select the sensor from the submenu *[Settings]* on the control panel.

Fitting pressure sensor two

- ▶ Switch the On/Off master switch to Off.
- ▶ Remove the blanking cap from the pressure sensor connection (8).
- ▶ Fit the pressure sensor (2) and seal (7) to the pressure sensor connection (8) and fix with the clamp (4).
- ▶ Plug the connecting lead connection into the socket (9) on the pressure sensor (2).
- ▶ Plug the connecting lead connection into the socket marked **Vacuum Sensor 2**.
- ▶ Select the sensor from the submenu *[Settings]* on the control panel.

5.2.9 Connecting inert gas (option)

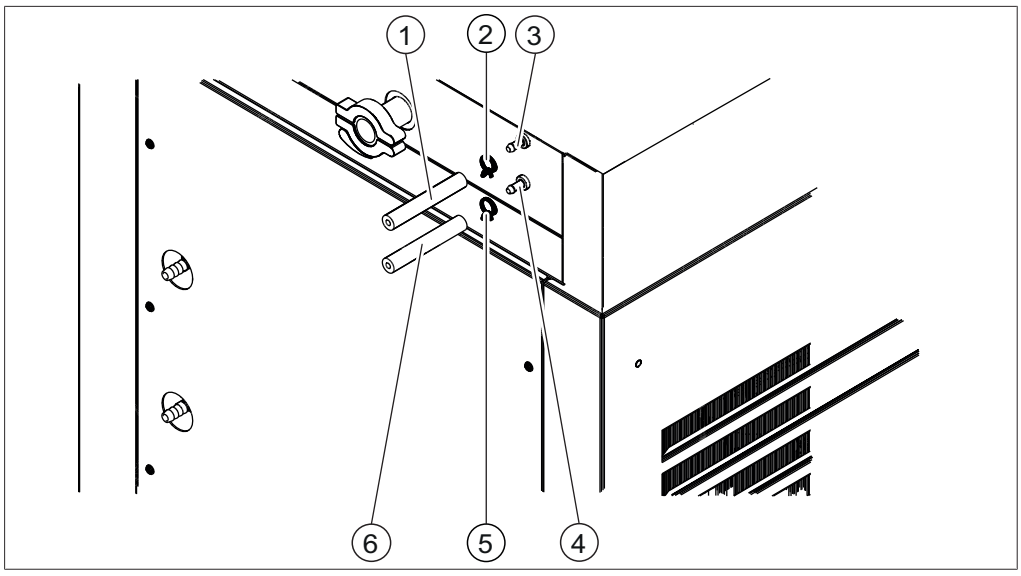


Fig. 19: Connecting inert gas

1	Inert gas tube	2	Tube clip
3	Gas connection for pressure regulating valve	4	Gas connection for venting valve
5	Tube clip	6	Inert gas tube

Connecting the inert gas to the pressure regulating valve

Precondition:

☑ The gas connection complies with the specified parameters. See Chapter 3.6 "Technical data", page 21

- ▶ Switch the On/Off master switch to Off.
- ▶ Fit the inert gas tube (1) onto the gas connection for the pressure regulating valve (3).
- ▶ Fix the inert gas tube (1) with the tube clip (2).

Connecting the inert gas to the venting valve

Precondition:

☑ The gas connection complies with the specified parameters. See Chapter 3.6 "Technical data", page 21

- ▶ Switch the On/Off master switch to Off.
- ▶ Fit the inert gas tube (6) onto the gas connection for the venting valve (4).
- ▶ Fix the inert gas tube (6) with the tube clip (5).

5.2.10 Fitting an air filter (option)

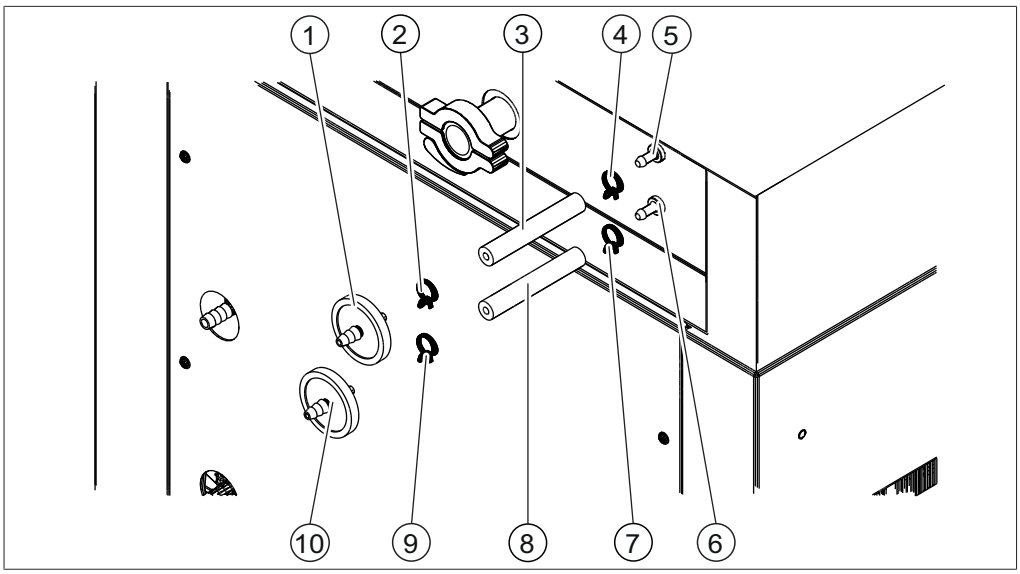


Fig. 20: Fitting an air filter

1	Air filter	2	Tube clip
3	Tubing	4	Tube clip
5	Gas connection for pressure regulating valve	6	Gas connection for venting valve
7	Tube clip	8	Tubing
9	Tube clip	10	Air filter

Fitting an air filter for the pressure regulating valve

Precondition:

☑ The gas connection complies with the specified parameters. See Chapter 3.6 "Technical data", page 21

- ▶ Switch the On/Off master switch to Off.
- ▶ Fit the tube (3) onto the gas connection for the pressure regulating valve (5).
- ▶ Fix the tube (3) with the tube clip (4).
- ▶ Fit the air filter (1) onto the tube (3).
- ▶ Fix the air filter (1) with the tube clip (2).

Fitting an air filter for the venting valve

Precondition:

☑ The gas connection complies with the specified parameters. See Chapter 3.6 "Technical data", page 21

- ▶ Switch the On/Off master switch to Off.
- ▶ Fit the tube (8) onto the gas connection for the venting valve (6).
- ▶ Fix the tube (8) with the tube clip (7).
- ▶ Fit the air filter (10) onto the tube (8).
- ▶ Fix the air filter (10) with the tube clip (9).

5.3 Commissioning the vacuum pump

The vacuum pump evacuates the top-mount drying rack during the freeze-drying process.

NOTICE

Open gas ballast valve.

A closed gas ballast valve when using solvents can cause damage to the instrument.

▶ Open the gas ballast valve.

NOTE

To increase the service life of the vacuum pump, operate the vacuum pump with an open gas ballast valve.

NOTE

Prepare the vacuum pump according to the manufacturer's instructions. See relevant documentation.

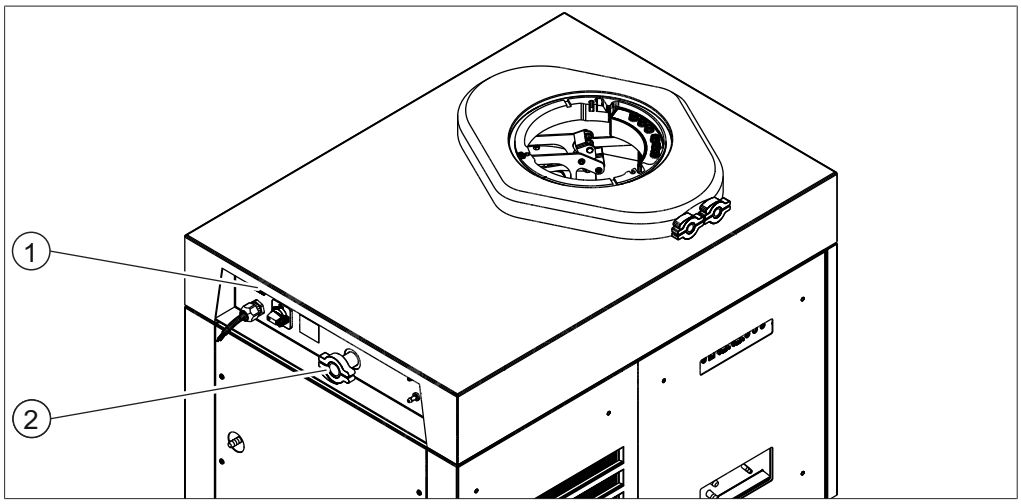


Fig. 21: Connections for vacuum pump

1	Vacuum pump power connection	2	Vacuum tube connection, ISO-KF 25

▶ Switch the On/Off master switch to Off.
▶ Connect the vacuum pump vacuum tube to the vacuum tube connection (2).
▶ Plug the vacuum pump electrical connection into the socket marked **Vacuum Pump**.

5.4 Establishing LAN connection

5.4.1 Requirements for local network settings

▶ The following port has to be enabled in the firewall settings on the internet gateway:

- TCP (HTTPS) traffics through remote port 443

- In order to use the BUCHI Cloud a DNS server must be configured on the instrument.

NOTE

If there is no DNS server available enter the IP address for the BUCHI Cloud connection manually.

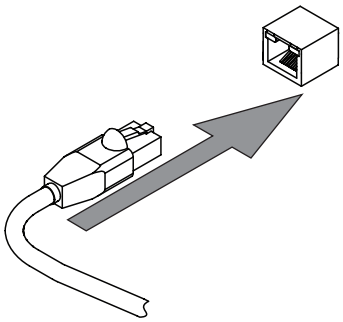
NOTE

If there is no DHCP server available enter the IP address, gateway subnet mask and DNS server manually.

5.4.2 Preparing the instrument for app using

NOTICE! Do not unplug the LAN cable while the unit is connected to the BUCHI Cloud Services.

- Connect the unit to the LAN (local area network).
- Restart the unit.



Navigation path
➔ ⚙ ➔ *[Settings]* ➔ *[Network]*

- Navigate to *[Network]*.
- Activate the function *[DHCP]*.

⇨ The unit is now ready.

5.4.3 Enabling BUCHI Cloud access

Enable access to BUCHI Cloud in order to use the BUCHI Monitor App and BUCHI Lyovapor software.

Navigation path
➔ ⚙ ➔ Settings ➔ Network ➔ BUCHI Cloud

- Navigate to the action *[BUCHI Cloud]* via the navigation path.
- Select the option *[Yes]*.

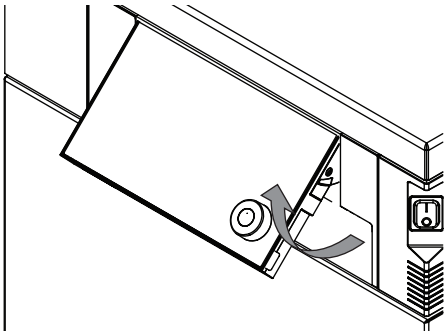
⇨ The instrument is connected to the BUCHI Cloud.

5.5 Insert SD card (Pro control panel only)

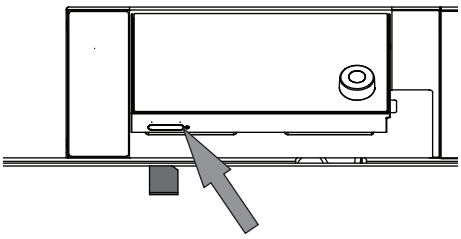
NOTE

Only insert or remove the SD card in Standby mode.

▶ Fold the control panel forward.



▶ Insert the SD card on the underside.



▶ Switch on the instrument.

⇨ The status bar shows the SD card symbol.

The following data is stored on the SD card:

- Numbering
- Date
- Time
- Set pressure
- Current pressure in the ice condenser
- Inlet temperature of the ice condensers
- Set drying shelf temperature
- Current temperature of the drying shelves
- Current sample temperatures

6 Operating the control panel

This section describes the operation of the instrument using the control panel.

⚠ CAUTION

Risk of injury from glass splinters

Sharp objects can damage the display.

▶ Keep sharp objects away from the display.

NOTICE

Unnecessary operation hours can affect the lifetime of the instrument.

Turn off the instrument if no samples are proceeded for several days.

6.1 Layout of the control panel

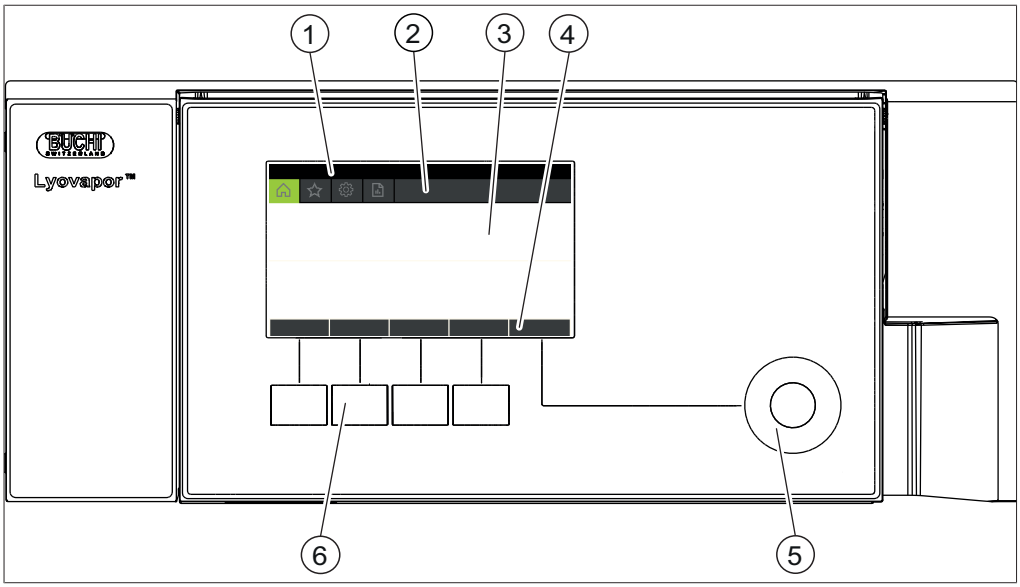


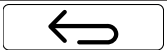
Fig. 22: Layout of the control panel

No.	Description	Function
1	Status bar	Shows the current status of the instrument.
2	Menu bar	Shows symbols representing the menus.
3	Content area	Shows current settings, submenus or actions depending on current operation.
4	Function bar	Shows functions that can be performed according to the current operation.
5	Navigation control	Used for navigating the user interface. Pressing the control performs the assigned function on the function bar.
6	Function buttons	Pressing a function button performs the assigned function on the function bar.

6.2 Function bar

The function bar shows available functions according to the current operation.
The functions on the function bar are executed by tapping the relevant function buttons or pressing the navigation control.

General function buttons

Symbol	Description	Meaning
	*[Back]*	The display reverts to the previous view.
ESC	*[Cancel]*	Cancels an operation.
	*[Add to favourites]*	Adds the selected item to the *[[Favourites]]* menu.
OK	*[Confirm]*	Confirms an entry.
EDIT	*[Edit]*	Allows the selected item to be edited.
MENU	*[Menu]*	Allows selection of a menu from the menu bar using the navigation control.
SAVE	*[Save]*	Saves the setting.

Process control function buttons

Symbol	Description	Meaning
	*[Defrost]*	Defrosts the ice condenser.
AERATE	*[Aerate]*	Vents the system.
	*[Shut down]*	The instrument shuts down.
START	*[[Start]]*	Starts the freeze-drying process.
	*[Start conditioning]*	Starts the conditioning phase.
SKIP	*[Skip]*	Skips the current process.
OPEN	*[Open]*	Opens the selected valve.
CLOSE	*[Close]*	Closes the selected valve.

6.3 Menu bar

The menus are represented by symbols on the menu bar. Navigation through the menus is by input controls.
The following menus are available:

Menu symbol	Meaning	Submenu/Action
	*[Start]* menu	• Process control parameters
	*[Favourites]* menu	• Bookmarks for individual entry points
	*[Configuration]* menu	• Process settings • Settings • Servicing • Service • System information
	*[Messages]* menu	• Notifications • Journal

6.3.1 Start menu

On the *[Start]* menu, parameters can be set manually.

Changing parameters

▶ Select a parameter by turning the navigation control.

⇨ The control panel highlights the selected parameter in green.

▶ Tap the function *[Edit]* on the function bar.

⇨ The control panel highlights the selected parameter in black.

▶ To increase or decrease the figure, turn the navigation control clockwise or anti-clockwise.

▶ Tap the function *[Save]* on the function bar.

⇨ The setting is saved.

6.3.2 Favourites menu

The *[Favourites]* menu allows you to define submenus and actions as bookmarks.

Adding a favourite

▶ Navigate to a submenu or action.

▶ Tap the function *[Add to favourites]* on the function bar.

⇨ The user interface switches to the *[Delete]* menu and displays the favourite created.

Removing a favourite

▶ On the *[Favourites]* menu, navigate to the favourite you wish to remove.

▶ Tap the function *[Delete]* on the function bar.

⇨ The favourite is removed.

6.3.3 Configuration menu

On the *[Configuration]* menu, you can enter a variety of settings and retrieve information.

Process settings submenu

The submenu *[Process settings]* contains functions for automatic process control.

Action	Option	Explanation
[Vacuum test after conditioning]	Off/On	Automatic vacuum test after the conditioning phase.
[Leak test after conditioning]	Off/On	Automatic leak test after the conditioning phase.
[Defrost Mode]	Choice of which ice condenser chamber is defrosted.	The action is only available if the status bar shows the status **Standby**. Defrosting in the recent ice condenser will be performed after each aeration of the instrument. The following options are available: None/Currently active chamber/Both chambers.

Settings submenu

The submenu *[Settings]* contains system settings for the instrument.

Action	Option	Explanation
[Mobile connection password]	View	The control panel shows a password for entry in the BUCHI Monitor app.
[Mobile connection QR code]	View	The control unit shows a QR code for reading by the BUCHI Monitor app.
[Language]	Choice of display language on the control panel	The following languages are available: English/German/French/Italian/ Spanish/Russian/Portuguese/Japanese/Chinese/Indonesian/Korean
[Temperature unit]	Choice of unit for indication of temperatures	The following units are available: °C (Celsius)/°F (Fahrenheit)/K (Kelvin)
[Pressure unit]	Choice of unit for indication of the vacuum	The following units are available: HPa (hectopascals), mbar (millibars), torr (= torr), mTorr (= millitorr), mmHg (millimetres of mercury)
[Date]	Date input	Enter in sequence: Day, month, year. Apply the settings by pressing *[Save]*.
[Time]	Time input	Enter in sequence: Minutes, hours. Apply the settings by pressing *[Save]*.
[Vacuum Sensor 1]	Pressure sensor selection	The following pressure sensors are available: None, Inficon Porter CDG020D, Inficon PSG 550

Action	Option	Explanation
[Vacuum Sensor 2]	Pressure sensor selection	The following pressure sensors are available: None, Inficon Porter CDG020D, Inficon PSG 550
[Vacuum pump oil exchange]	Enter value	Enter the oil change interval recommended by the manufacturer.
[Key sound]	Off/On	Setting for audible signal in response to input controls.
[Display brightness]	Enter setting	Display illumination level in %: 0 - 100
[Network]	Enter value	The following parameters can be edited: Device name/MAC address/DHCP/ System IP address/Subnet mask/ Gateway/DNS server/BUCHI Cloud/ Server IP address
[Delete app connection]	Confirmation question	Resets external connections to the instrument.

Submenu Maintenance

The submenu *[Maintenance]* contains tests for maintaining the instrument.

Action	Option	Explanation
[Leak test]	Perform leak test	See section Chapter 9.3 "Performing a leak test", page 99
[Vacuum test]	Perform vacuum test	See Chapter 9.2 "Performing a vacuum test", page 98

Submenu Service

NOTE

While freeze-drying is in progress, no settings can be changed on the Service submenu.

Action	Option	Explanation
[Refrigerant circuit]	View	The following information on the refrigerant circuit is available: • Operating hours • Compressor high temperature • Compressor low temperature • Inlet temperature, ice condenser 1 • Outlet temperature, ice condenser 1 • Inlet temperature, ice condenser 2 • Outlet temperature, ice condenser 2 • Expansion valve 1 • Expansion valve 2 • Bypass valve • Safety switch for low pressure/low temp • Safety switch for high pressure/ low temp • Intermediate heat exchanger temperature • Safety switch for low pressure/ high temp • Safety switch for high pressure/ high temp • Ambient temperature • Evaporation pressure, low temperature • Evaporation pressure, high temperature • Condensation pressure, low temperature • Condensation pressure, high temperature • Suction line temperature, low temperature • Discharge line temperature, low temperature • Discharge line temperature, high temperature • EEV bypass, low temperature • EEV, high temperature

Action	Option	Explanation
[Vacuum system]	View	The following information on the vacuum system is available: • Operating hours pump • Pump oil hours of duty • Pressure, ice condenser 1 • Pressure, ice condenser 2 • Main valve 1 • Main valve 2 • Vacuum Pump • Venting valve 1 • Venting valve 2 • Regulating valve 1 • Vacuum regulation 1 • Vacuum regulation 2 • Regulating valve 2 • Vacuum sensor 1 • Vacuum sensor 2
[[Ice condenser]]	View	The following information on the ice condenser is available: • Steam generator valve • Defrost valve, ice condenser 1 • Defrost valve, ice condenser 2 • Intermediate valve 1 • Intermediate valve 2 • Active ice condenser

Action	Option	Explanation
[Defrosting system]	View	The following information on the defrosting system is available: • Duty hours • Steam generator • Water pump • Drain valve 1 • Drain valve 2 • Protection valve, vacuum sensor 1 • Protection valve, vacuum sensor 2 • Steam generator over pressure • Steam generator over temperature • Steam generator water level OK • Water tank fill level low • Waste tank full • Water pump
[Stoppering System]	View	The following information on the stoppering system is available: • Number of uses • Start • Up • Down • Oil pressure

Submenu System Information

The submenu *[[System information]]* contains details of the connected components and information on network connection diagnosis.

Action	Option	Explanation
[Control panel]	View	The following information on the control panel is available: • Serial number • Firmware version • Operating hours • Status • Board Temperature • 24V power supply • 5V power supply

Action	Option	Explanation
[Instrument]	View	The following information is available: • Serial number • Firmware version • Hours of duty • Status • Board Temperature • 48V power supply • 24V power supply • 5V power supply • 3.3V power supply
[Network diagnostics]	View/Enter settings	The following network diagnosis information is available: • MAC address • Network interruptions • Event list

6.3.4 Messages menu

The *[Messages]* menu shows the current instrument messages and the instrument's message history.
The following message types are possible:

- I = Information: No immediate actions by customer are needed.
- W = Warning: Minor failures during operation. Customer action is required.
- E = Error: Major failures during operation due to defective system component. Usually service support is needed.

Submenu Notifications

The submenu *[Notifications]* shows a list of unacknowledged and unresolved notifications together with date and time in each case.

Submenu Logbook

The submenu *[Logbook]* shows the instrument's message history.
Logbook:

- List of the last 100 messages.
- Every occurrence is shown with date and time.

The following status types are possible:

Symbol	Description	Meaning
x	Acknowledged	The message has been be processed and acknowledged.
<	Sent	The message initiator is no longer present.

Symbol	Description	Meaning
>	Received	The display shows a message.

6.4 Status bar

The status bar shows the status of the instrument.
The following statuses are possible:

Indication on status bar

View	Status
Unload / Load	Conditioning is completed. Before the freeze-drying process: Load the top-mount drying rack with a frozen sample.
	After the freeze-drying process: Remove the dried sample from the top-mount drying rack.
Aerating	The system is venting.
Shutting down	As the instrument is shutting down the refrigerant and vacuum circuits are switching off. • The status bar shows the remaining time.
Defrosting	The instrument is defrosting. • The status bar shows the remaining time.
Standby	Shutting down is completed.
Conditioning	The instrument is starting up including starting refrigerant compressors and vacuum pump.
Reconditioning	The instrument is restarting after a temporary power failure (< 15 min).
Warming up pump	The vacuum pump is being brought up to operating temperature.
Vacuum Test	The instrument is performing a vacuum test.
Leak Test	The instrument is performing a leak test.
Manual Drying	The instrument is in the course of a manual freeze-drying process.
Recovering	The system is in the process of recovering from a power failure (> 15 min). The current parameters of the freeze-drying process are being re-established.

Symbols on the status bar

Symbol	Status
	The instrument is connected to the BUCHI Cloud.
	The instrument is defrosting.

Symbol	Status
	The instrument is starting up.
	The instrument is in energy-saving mode.
	Before the freeze-drying process: Load the top-mount drying rack with a frozen sample.
	After the freeze-drying process: Remove the dried sample from the top-mount drying rack.
	The system evacuates to the set pressure.
	The instrument is performing a vacuum test or a leak test.
	The ice condenser is white: • Attach the sample.
	The ice condenser is yellow: • The ice condenser is preparing for switch over. • Sample attachment is possible as long p and T settings are stable.
	The ice condenser is red: • The ice condenser preparation is final stage. • Do not attach a sample.

6.5 Carrying out freeze-drying

6.5.1 Preparing the instrument

NOTICE

Several conditioning of instrument in a day is damaging for cooling circuit.

If it is necessary, wait 2 hours between each conditioning.

Time required:	approx. 30min

Navigation path

➔ Start

Precondition:

☑ All commissioning operations have been completed. See Chapter 5.2 "Putting the instrument in operation", page 27

▶ Navigate to the *[Start]* menu via the navigation path.

▶ Tap the function *[[Start conditioning]]* on the function bar.

⇨ The temperature in the ice condenser cools down to operating temperature.

⇨ The vacuum pump is being brought up to operating temperature.

⇨ After completion of the conditioning phase, the status bar shows the status **Unload / Load**.

6.5.2 Starting freeze-drying

⚠ CAUTION

Risk of skin burns from touching parts of the ice condenser after completion of conditioning.

▶ Wear protective gloves when working on the instrument after the conditioning phase.

Navigation path

➔ Start

Precondition:

☑ The instrument has been prepared.

▶ Fit a top-mount drying rack. See Chapter 8 "Operating top-mount drying racks", page 81.

▶ Load the top-mount drying rack with frozen samples.

▶ Navigate to the *[Start]* menu via the navigation path.

▶ Enter the required settings for the process parameters.

▶ Tap the function *[Start]* on the function bar.

⇨ The freeze-drying process starts.

⇨ The control panel shows the *Start* menu with a black background.

⇨ The status bar shows a clock counting up and the status **Manual Drying**.

⇨ The system evacuates to the set pressure.

6.5.3 Editing parameters while the process is running

Navigation path

➔ Start

Precondition:

☑ The freeze-drying process has been started.

▶ Navigate to the *[Start]* menu via the navigation path.

▶ Navigate to the desired parameter using the navigation control.

▶ Tap the function *[Edit]* on the function bar.

⇨ The control panel highlights the selected parameter in white.

▶ Turn the navigation control to increase or decrease the parameter setting.

▶ Tap the function *[Save]* on the function bar.

⇨ The setting is saved.

6.5.4 Ending freeze-drying

Navigation path

➔ Start

Precondition:
☑ The sample is dry.

- ▶ Navigate to the *[Start]* menu via the navigation path.
- ▶ Tap the function *[Aerate]* on the function bar.
- ▶ Answer **YES** to the confirmation question.

⇨ The system is vented.

⇨ The status bar shows the status **Aerating**.

- ▶ As soon as the status bar shows the status **Unload / Load**, remove the dried sample from the drying rack.

6.5.5 Shutting down the instrument

NOTICE

Not completed shut down of the instrument.

An interruption while shutting down the instrument can damage the instrument.

- ▶ Shut down the instrument completely.
- ▶ If the shutdown was interrupted, tap the function *[Defrost]* on the function bar.

NOTICE

Do not use force to remove the ice from the ice condenser.

Time required: 40 min

Navigation path

➔ Start

Precondition:
☑ The freeze-drying process has ended.
☑ The gas ballast on the vacuum pump is open.
☑ Make sure that there is sufficient distilled water available.

- ▶ Navigate to the *[Start]* menu via the navigation path.
- ▶ Tap the function *[Shut down]* on the function bar.

⇨ The instrument is shutting down.

⇨ The status bar shows the remaining time and the status **Shutting down**.

⇨ After the instrument has shut down, the status bar shows the remaining time and the status **Defrosting**.

⇨ After defrosting, the status bar shows the status **Stand by**.

6.5.6 Switching off the instrument

Precondition:

☑ The instrument has been shut down. See Chapter 6.5.5 "Shutting down the instrument", page 50

▶ Switch the On/Off master switch to Off.

7 Operating Pro control panel

This section describes the operation of the instrument using the Pro control panel.

⚠ CAUTION

Risk of injury from glass splinters

Sharp objects can damage the display.

▶ Keep sharp objects away from the display.

NOTICE

Unnecessary operation hours can affect the lifetime of the instrument.

Turn off the instrument if no samples are proceeded for several days.

7.1 Layout of Pro control panel

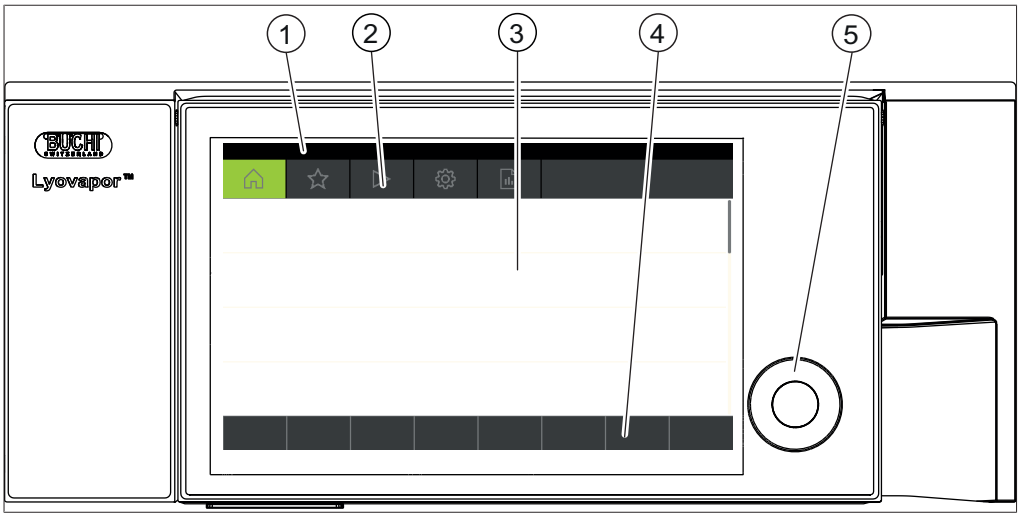


Fig. 23: Layout of Pro control panel

No.	Description	Function
1	Status bar	Shows the current status of the instrument.
2	Menu bar	Shows symbols representing the menus.
3	Content area	Shows current settings, submenus or actions depending on the current operation.
4	Function bar	Shows functions that can be performed according to the current operation
5	Navigation control	Used for navigating the user interface. Pressing the control performs the assigned function on the function bar.

7.2 Function bar

The function bar shows functions that can be performed according to the current operation.

The functions on the function bar are executed by tapping the relevant function buttons or pressing the navigation control.

General function buttons

Symbol	Description	Meaning
	*[Back]*	The display reverts to the previous view.
ESC	*[Cancel]*	Cancels an operation.
	*[Add to favourites]*	Adds the selected item to the *[[Favourites]]* menu.
OK	*[Confirm]*	Confirms an entry.
EDIT	*[Edit]*	Allows the selected item to be edited.
MENU	*[Menu]*	Allows selection of a menu from the menu bar using the navigation control.
SAVE	*[Save]*	Saves the setting.

Process control function buttons

Symbol	Description	Meaning
	*[Defrost]*	Defrosts the ice condenser.
AERATE	*[Aerate]*	Vents the system.
	*[Shut down]*	The instrument shuts down.
START	*[[Start]]*	Starts the freeze-drying process.
	*[Start conditioning]*	Starts the conditioning phase.
MANUAL	*[Manual]*	Switches to manual freeze-drying.
METHOD	*[Method]*	Switches to freeze-drying with programmable parameters.
NEW	*[New]*	Creates a new method
	*[Right]*	Moves the selection to the right.
	*[Left]*	Moves the selection to the left.
	*[Progression]*	Graphical display of method progression showing pressure and temperature details.
ACTIVATE	*[Activate]*	Confirms selection of a method.
DELETE	*[Delete]*	Deletes the selected entry.
SKIP	*[Skip]*	Skips the current process.

Symbol	Description	Meaning
UNPROT	*[[Deactivate sample protection]]*	Manually deactivates sample protection.
COPY	*[Copy]*	Copies the selected method.
OPEN	*[Open]*	Opens the selected valve.
CLOSE	*[Close]*	Closes the selected valve.

7.3 Other symbols on the control panel

Symbol	Description	Meaning
	*[Closed]*	The assigned method is active and cannot be changed.

7.4 Menu bar

The menus are represented by symbols on the menu bar. Navigation through the menus is by the input controls.
The following menus are available:

Menu symbol	Meaning	Submenu/Action
	Start menu	• Process control parameters
	Favourites menu	• Bookmarks for individual entry points
	Method menu	• For saving freeze-drying methods • Editing and activating freeze-drying method
	Configuration menu	• Process settings • Settings • End point determination • Maintenance • Service • System information
	Messages menu	• Notifications • Journal

7.4.1 Start menu

On the *[Start]* menu, parameters can be set manually.

Setting parameters using the navigation control

▶ Select a parameter by turning the navigation control.
⇨ The control panel highlights the selected parameter in green.

▶ Tap the function *[Edit]* on the function bar.

⇨ The control panel highlights the selected parameter in black.

▶ To increase or decrease the figure, use the dialog box with a numeric input.

▶ Press the navigation control.

⇨ The setting is saved.

⇨ The control panel highlights the new setting in green.

Setting parameters using the touch-screen

▶ Select the parameter by tapping the control panel screen.

⇨ The control panel shows a dialog box with a numeric input box.

⇨ The control panel highlights the selected parameter in black.

▶ Enter the value in the numeric input box.

▶ Tap the function *[Save]* on the function bar.

⇨ The setting is saved.

⇨ The dialog box closes.

⇨ The control panel highlights the new setting in green.

7.4.2 Favourites menu

The *[Favourites]* menu allows you to define submenus and actions as favourites.

Adding a favourite

▶ Navigate to a submenu or action.

▶ Tap the function *[Add to favourites]* on the function bar.

⇨ The user interface switches to the *[Favourites]* menu and displays the favourite created.

Removing a favourite

▶ On the *[Favourites]* menu, navigate to the favourite you wish to remove.

▶ Tap the function *[Delete]* on the function bar.

⇨ The favourite is removed.

7.4.3 Method menu

The *[Method]* menu allows freeze-drying processes with multiple phases and steps to be saved. See Chapter 7.6 "Editing a method", page 64

7.4.4 Configuration menu

On the *[Configuration]* menu, you can enter a variety of settings and retrieve information.

Process settings submenu

The submenu *[Process settings]* contains actions for automatic process control.

Action	Option	Explanation
[Vacuum test after conditioning]	Off/On	Automatic vacuum test after the conditioning phase.
[Leak test after conditioning]	Off/On	Automatic leak test after the conditioning phase.

Action	Option	Explanation
[Defrost Mode]	Choice of which ice condenser chamber is defrosted.	The action is only available if the status bar shows the status **Standby**. Defrosting in the recent ice condenser will be performed after each aeration of the instrument. The following options are available: None/Currently active chamber/Both chambers.

Settings submenu

The submenu *[[Settings]]* contains system settings for the instrument.

Action	Option	Explanation
[Mobile connection password]	View	The control panel shows a password for entry in the BUCHI Monitor app.
[Mobile connection QR code]	View	The control unit shows a QR code for reading by the BUCHI Monitor app.
[Language]	Choice of display language on the control panel	The following languages are available: English/German/French/Italian/Spanish/Russian/Portuguese/Japanese/Chinese/Indonesian/Korean
[Temperature unit]	Choice of unit for indication of temperatures	The following units are available: °C (Celsius)/°F (Fahrenheit)/K (Kelvin)
[Pressure unit]	Choice of unit for indication of the vacuum	The following units are available: HPa (hectopascals), mbar (millibars), torr (= torr), mTorr (= millitorr), mmHg (millimetres of mercury)
[Vacuum Sensor 1]	Pressure sensor selection	The following pressure sensors are available: None, Inficon Porter CDG020D, Inficon PSG 550
[Vacuum Sensor 2]	Pressure sensor selection	The following pressure sensors are available: None, Inficon Porter CDG020D, Inficon PSG 550
[Vacuum pump oil exchange]	Enter value	Enter the oil change interval recommended by the manufacturer.
[Date]	Date input	Enter in sequence: Day, month, year. Apply the settings by pressing *[Save]*.
[Time]	Time input	Enter in sequence: Minutes, hours. Apply the settings by pressing *[Save]*.

Action	Option	Explanation
[Key sound]	Off/On	Setting for audible signal in response to input controls.
[Display brightness]	Enter setting	Display illumination level in %: 0 - 100
[Network]	Enter value	The following parameters can be edited: Device name/MAC address/DHCP/ System IP address/Subnet mask/ Gateway/DNS server/BUCHI Cloud/ Server IP address
[Delete app connection]	Confirmation question	Resets external connections to the instrument.

Submenu End point determination

Action	Option	Explanation
[Pressure rise test]	View	Shows the current settings for the pressure rise test.
[Pressure difference test]	View	• Actual and specified settings • Result
[Temperature difference test]	View	• Actual and specified settings • Result

Submenu Maintenance

The submenu *[Maintenance]* contains tests for maintaining the instrument.

Action	Option	Explanation
[Leak test]	Perform leak test	See section Chapter 9.3 "Performing a leak test", page 99
[Vacuum test]	Perform vacuum test	See Chapter 9.2 "Performing a vacuum test", page 98

Submenu Service

NOTE

While freeze-drying is in progress, no settings can be changed on the Service submenu.

Action	Option	Explanation
[Refrigerant circuit]	View	The following information on the refrigerant circuit is available: • Operating hours • Compressor high temperature • Compressor low temperature • Inlet temperature, ice condenser 1 • Outlet temperature, ice condenser 1 • Inlet temperature, ice condenser 2 • Outlet temperature, ice condenser 2 • Expansion valve 1 • Expansion valve 2 • Bypass valve • Safety switch for low pressure/low temp • Safety switch for high pressure/ low temp • Intermediate heat exchanger temperature • Safety switch for low pressure/ high temp • Safety switch for high pressure/ high temp • Ambient temperature • Evaporation pressure, low temperature • Evaporation pressure, high temperature • Condensation pressure, low temperature • Condensation pressure, high temperature • Suction line temperature, low temperature • Discharge line temperature, low temperature • Discharge line temperature, high temperature • EEV bypass, low temperature • EEV, high temperature

Action	Option	Explanation
[Vacuum system]	View	The following information on the vacuum system is available: • Operating hours pump • Pump oil hours of duty • Pressure, ice condenser 1 • Pressure, ice condenser 2 • Main valve 1 • Main valve 2 • Vacuum Pump • Venting valve 1 • Venting valve 2 • Regulating valve 1 • Vacuum regulation 1 • Vacuum regulation 2 • Regulating valve 2 • Vacuum sensor 1 • Vacuum sensor 2
[[Ice condenser]]	View	The following information on the ice condenser is available: • Steam generator valve • Defrost valve, ice condenser 1 • Defrost valve, ice condenser 2 • Intermediate valve 1 • Intermediate valve 2 • Active ice condenser

Action	Option	Explanation
[Defrosting system]	View	The following information on the defrosting system is available: • Duty hours • Steam generator • Water pump • Drain valve 1 • Drain valve 2 • Protection valve, vacuum sensor 1 • Protection valve, vacuum sensor 2 • Steam generator over pressure • Steam generator over temperature • Steam generator water level OK • Water tank fill level low • Waste tank full • Water pump
[Stoppering System]	View	The following information on the stoppering system is available: • Number of uses • Start • Up • Down • Oil pressure
[Drying shelves]	View	Switches heating for the individual shelves on and off (where available).

Submenu System Information

The submenu *[System information]* contains details of the connected devices and information on network connection diagnosis.

Action	Option	Explanation
[Control panel]	View	The following information on the control panel is available: • Serial number • Firmware version • Operating hours • Status • Board Temperature • 24V power supply • 5V power supply

Action	Option	Explanation
[Instrument]	View	The following information is available: • Serial number • Firmware version • Hours of duty • Status • Board Temperature • 48V power supply • 24V power supply • 5V power supply • 3.3V power supply
[Network diagnostics]	View/Enter settings	The following network diagnosis information is available: • MAC address • Network interruptions • Event list

7.4.5 Messages menu

The *[Messages]* menu shows the current instrument messages and the instrument's message history.
The following message types are possible:

- I = Information: No immediate actions by customer are needed.
- W = Warning: Minor failures during operation. Customer action is required.
- E = Error: Major failures during operation due to defective system component. Usually service support is needed.

Submenu Notifications

The submenu *[Notifications]* shows a list of unacknowledged and unresolved notifications together with date and time in each case.

Submenu Logbook

The submenu *[Logbook]* shows the instrument's message history.
Logbook:

- List of the last 100 messages.
- Every occurrence is shown with date and time.

The following status types are possible:

Symbol	Description	Meaning
x	Acknowledged	The message has been be processed and acknowledged.
<	Sent	The message initiator is no longer present.

Symbol	Description	Meaning
>	Received	The display shows a message.

7.5 Status bar

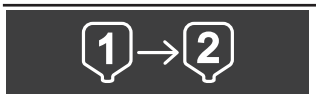
The status bar shows the status of the instrument.
The following statuses are possible:

Indication on status bar

View	Status
Unload / Load	Conditioning is completed. Before the freeze-drying process: Load the top-mount drying rack with a frozen sample.
	After the freeze-drying process: Remove the dried sample from the top-mount drying rack.
Aerating	The system is venting.
Shutting down	As the instrument is shutting down the refrigerant and vacuum circuits are switching off. • The status bar shows the remaining time.
Defrosting	The instrument is defrosting. • The status bar shows the remaining time.
Standby	Shutting down is completed.
Conditioning	The instrument is starting up including starting refrigerant compressors and vacuum pump.
Reconditioning	The instrument is restarting after a temporary power failure (< 15 min).
Warming up pump	The vacuum pump is being brought up to operating temperature.
Vacuum Test	The instrument is performing a vacuum test.
Leak Test	The instrument is performing a leak test.
Manual Drying	The instrument is in the course of a manual freeze-drying process.
Recovering	The system is in the process of recovering from a power failure (> 15 min). The current parameters of the freeze-drying process are being re-established.
Hold	The instrument is in the holding phase.
Primary drying	The instrument is in the primary drying phase.
Secondary drying	The instrument is in the secondary drying phase.
Tempering shelves	The instrument is modulating the heatable shelves to the set temperature.

Symbols on the status bar

Symbol	Status
	The instrument is defrosting.
	The instrument is in energy-saving mode.
	The instrument is in the course of a freeze-drying process using a method.
	The instrument is starting up.
	The instrument is in the course of a manual freeze-drying process.
	The instrument is connected to the BUCHI Cloud.
	Sample protection is active. Reason: the pressure is outside the pressure limits.
	Sample protection is active. Reason: the temperature is outside the safe temperature range.
	Sample protection is active. Reason: the pressure is outside the pressure limits. the temperature is outside the safe temperature range.
	Before the freeze-drying process: Load the top-mount drying rack with a frozen sample.
	After the freeze-drying process: Remove the dried sample from the top-mount drying rack.
	The system evacuates to the set pressure.
	The instrument is performing a vacuum test or a leak test.
	The memory card has been inserted.

Symbol	Status
	The ice condenser is white: • Attach the sample.
	The ice condenser is yellow: • The ice condenser is preparing for switch over. • Sample attachment is possible as long p and T settings are stable.
	The ice condenser is red: • The ice condenser preparation is final stage. • Do not attach a sample.

7.6 Editing a method

The Pro control panel can save up to 35 methods. The methods enable the freeze-drying process to be automated.

7.6.1 Creating a new method

There are two possible ways of creating a new method:

Creating a new method

Navigation path
➔ Method

▶ Navigate to the *[Method]* menu via the navigation path.
▶ Tap the function *[New]* on the function bar.
⇨ The new method is created.

Creating a new method by copying an existing method

Navigation path
➔ Method

▶ Navigate to the *[Method]* menu via the navigation path.
▶ Tap the name of the method that you wish to copy.
▶ Tap the function *[Copy]* on the function bar.
⇨ The new method is created.

7.6.2 Changing the name of a method

Navigation path
➔ Method

▶ Navigate to the *[Method]* menu via the navigation path.
▶ Tap the name of the method that you wish to edit.
⇨ The control panel highlights the selected method in green.
▶ Tap the action *[Information]*.
⇨ The control panel shows the action Information.

▶ Tap the setting *[Name]*.
⇨ The control panel shows a blank box with an alphanumeric input box.
▶ Enter a name for the method.
▶ Tap the function *[Save]* on the function bar.
⇨ The new name is saved.
⇨ The dialog box closes.

7.6.3 Setting the sample collapse temperature

Navigation path

➔ Method

▶ Navigate to the *[Method]* menu via the navigation path.
▶ Tap the name of the method that you wish to edit.
⇨ The control panel highlights the selected method in green.
▶ Tap the action *[General]*.
⇨ The control panel shows the action *[General]*.
▶ Tap the setting *[Sample collapse temperature]*.
⇨ The control panel shows a dialog box with a numeric input box.
▶ Enter the value in the numeric input box.
▶ Tap the function *[Save]* on the function bar.
⇨ The setting is saved.
⇨ The dialog box closes.

7.6.4 Setting the gas type

Navigation path

➔ Method

▶ Navigate to the *[Method]* menu via the navigation path.
▶ Tap the name of the method that you wish to edit.
⇨ The control panel highlights the selected method in green.
▶ Tap the action *[General]*.
⇨ The control panel shows the action *[General]*.
▶ Tap the setting *[Gas type]*.
⇨ The control panel shows a dialog box with an alphanumeric input box.
▶ Enter the gas type.
▶ Tap the function *[Save]* on the function bar.
⇨ The setting is saved.
⇨ The dialog box closes.

7.6.5 Setting the shelf loading temperature

Navigation path

➔ Method

▶ Navigate to the *[Method]* menu via the navigation path.

▶ Tap the name of the method that you wish to edit.
⇨ The control panel highlights the selected method in green.
▶ Tap the action *[General]*.
⇨ The control panel shows the action *[General]*.
▶ Tap the action *[Shelf load temp.]*
⇨ The control panel shows a dialog box with a numeric input box.
▶ Enter the value in the numeric input box.
▶ Tap the function *[Save]* on the function bar.
⇨ The setting is saved.
⇨ The dialog box closes.

7.6.6 Setting the steps of a method

The Pro control panel can save up to 30 steps for each method.

NOTE

The maximum heating rate is 3 °C/min.

NOTE

The settings for the action Steps affect a single step in each case.

Navigation path

➔ Method

▶ Navigate to the *[Method]* menu via the navigation path.
▶ Tap the name of the method that you wish to edit.
⇨ The control panel highlights the selected method in green.
▶ Tap the action *[Steps]*.
⇨ The control panel shows the action Steps.

The following settings are available for each step:

Setting	Option	Meaning
[Step phase]	Primary drying/Secondary drying	Sets the type of step phase.
[Term]	Enter value	Sets the duration of the step in minutes.
[Shelf temperature]	Enter value	Set the temperature of the heatable shelves in one step.
[Pressure zone]	Regulated/Minimum	Regulated: the settings for pressure and pressure limits are applied.
		Minimum: The maximum vacuum is applied to reach the lowest possible pressure.
[Pressure]	Enter value	Sets a target value for the regulated pressure.

Setting	Option	Meaning
[Pressure limit]	Enter value	Absolute value for divergence from the set pressure before the sample protection function is activated.
[Pressure duration]	Enter value	Sets the period of time that the pressure is allowed to exceed the pressure limit before the sample protection function is activated.

Editing a step

- ▶ Use the function *[Right]* or *[Left]* on the function bar to navigate to the step that you wish to edit.
- ▶ Using the navigation control, navigate to the setting that you wish to change.
- ▶ Tap the function *[Edit]* on the function bar.
- ▶ Edit the setting as required.
- ▶ Tap the function *[Save]* on the function bar.

⇨ The setting is changed.

Add step

- ▶ Use the function *[Right]* or *[Left]* on the function bar to navigate to the position at which you wish to add a step.
- ▶ Tap the function *[New]* on the function bar.

⇨ The new step is created.

Delete step

- ▶ Use the function *[Right]* or *[Left]* on the function bar to navigate to the step that you wish to delete.
- ▶ Tap the function *[Delete]* on the function bar.
- ▶ When asked to confirm, press *[OK]*.

⇨ The step is deleted.

7.6.7 Setting the phases of a method

NOTE

The settings in the Phase view affect all steps of a phase.

Navigation path
➔ Method

- ▶ Navigate to the *[Method]* menu via the navigation path.
- ▶ Tap the name of the method that you wish to edit.

⇨ The control panel highlights the selected method in green.

- ▶ Tap the action *[[Phase]]*.

⇨ The control panel shows the Phase view.

The following phases of a method are available:

Phase	Setting	Option	Meaning
[Primary drying]	*[Pressure action]*	None/Sample protection/ Message	None: no action is carried out.
			Sample protection: if the pressure is too high, heating of the shelves is paused.
			Message: if the pressure is too high, the control panel displays a message.
	[Temp. action]	None/Sample protection/ Message	None: no action is carried out.
			Sample protection: if the temperature is too high, heating of the shelves is paused.
			Message: if the temperature is too high, the control panel displays a message.
	[Safety temperature]	Enter value	Maximum divergence below the set sample collapse temperature before the sample protection function is activated.
	[Safety temp time]	Enter value	Time as of which sample protection in inactive. The value relates to the time before completion of primary drying.
	[End point definition]	More settings	See Setting end point definitions
[Secondary drying]	*[Pressure action]*	None/Sample protection/ Message	None: no action is carried out.
			Sample protection: if the pressure is too high, heating of the shelves is paused.
			Message: if the pressure is too high, the control panel displays a message.
	[Temp. action]	None/Sample protection/ Message	None: no action is carried out.
			Sample protection: if the temperature is too high, heating of the shelves is paused.
			Message: if the temperature is too high, the control panel displays a message.
	[Safety temperature]	Enter value	Maximum lower divergence from the set shelf temperature before the sample protection function is activated.
	[End point definition]	More settings	See Setting end point definitions

Phase	Setting	Option	Meaning
[Stoppering]	*[Pressure range]*	Regulated/Minimum	Regulated: the settings for pressure and pressure limits are applied.
			Minimum: the lowest possible vacuum pressure is applied.
	[Pressure]	Enter value	Sets a target value for the regulated pressure.
	[Mode]	None/Manual	None: no action is carried out.
			Manual: sealing is performed manually.
[Hold]	*[Pressure range]*	Regulated/Minimum	Regulated: the settings for pressure are applied.
			Minimum: the lowest possible vacuum pressure is applied.
	[Pressure]	Enter value	Sets a level for the regulated pressure.
	[Drying shelf temperature]	Enter value	Specifies a temperature for the drying shelves.

Editing the settings for a phase

- ▶ Tap the phase that you wish to edit.
- ⇨ The control panel highlights the selected phase in green.
- ▶ Tap the setting that you wish to edit.
- ▶ Edit the setting as required.
- ▶ Tap the function *[Save]* on the function bar.
- ⇨ The setting is changed.

7.7 Deleting a method

Navigation path
➔ Method

- ▶ Navigate to the *[Method]* menu via the navigation path.
- ▶ Tap the name of the method that you wish to edit.
- ⇨ The control panel highlights the selected method in green.
- ▶ Tap the function *[Delete]* on the function bar.
- ▶ Select *[Confirm]* to confirm the action in response to the confirmation question.
- ⇨ The method is deleted.

7.8 Setting end point definitions

The end of a phase can be defined by setting the end point definition.
The end point can be defined by means of the following test:

- Temperature difference test
- Pressure difference test
- Pressure rise test

It is possible to use a single test or combine these tests.
It is possible to use the tests for automatic transition to the next phase.
Settings:

[Continue] action setting	Explanation
Yes	The test is used for automatic transition.
No	The test is not used for automatic transition. Automatic transition relies on other tests.

7.8.1 Pressure difference test

The pressure difference test establishes the difference between the readings from two pressure sensors in the drying chamber. If the difference between the two sensor readings is below a threshold, the freeze-drying phase can be ended.

Navigation path
➔ Method

Precondition:
☑ A capacitive pressure sensor (Inficon Porter CDG020D) is connected to the connection **Vacuum Sensor 1**. See Chapter 5.2.8 "Fitting pressure sensors (option)", page 31
☑ A Pirani pressure sensor (Inficon PSG55x) is connected to the connection **Vacuum Sensor 2**. See Chapter 5.2.8 "Fitting pressure sensors (option)", page 31

▶ Perform vacuum test. See Chapter 9.2 "Performing a vacuum test", page 98
▶ Navigate to the *[Method]* menu via the navigation path.
▶ Tap the name of the method that you wish to edit.
⇨ The control panel highlights the selected method in green.
▶ Tap the action *[[Phase]]*.
⇨ The control panel shows the action Phase.
▶ Tap the setting *[[End point definition]]*.
⇨ The control panel shows the setting End point definition.
▶ Tap *[[Pressure difference test]]*.
⇨ The control panel shows the pressure difference test.

The following settings are available:

Setting	Option	Explanation
[[Pressure difference test]]	Yes/No	Switches the pressure difference test on or off.
[[Start time]]	Enter value	Sets the time from which the pressure difference test is to be performed. The value relates to the time before completion of the primary drying phase or the secondary drying phase.

Setting	Option	Explanation
[[Pressure difference limit]]	Enter value	Specifies the difference between the two sensor readings below which the end point is reached.
[[Duration]]	Enter value	The period of time during which the difference is not to be exceeded. If the threshold is not exceeded for the full period of time, the pressure difference test is passed.
[[Continue]]	Yes/No	Yes : the method switches to the next phase.
		No: the phase is ended when the set levels are reached.
[[Message]]	Yes/No	The control panel shows or does not show a message as soon as the pressure difference test is passed.

7.8.2 Temperature difference test

NOTE

The temperature test is successfully completed if all drying shelves are below the threshold.

The samples on a drying shelf have different drying times. Take account of the different drying times in the *[Duration]* setting.

The temperature difference test establishes the difference between the readings from the temperature sensor for the heatable shelf and the temperature sensor in the sample. If the difference between the two sensor readings is below a threshold, the freeze-drying phase can be ended.

Navigation path

➔ Method

Precondition:

☑ The heatable shelves are fitted in the rack. See Chapter 8 "Operating top-mount drying racks", page 81

☑ The optional temperature sensor has been installed. See Chapter 8 "Operating top-mount drying racks", page 81

▶ Place the optional temperature sensor in the sample.

▶ Navigate to the *[Method]* menu via the navigation path.

▶ Tap the name of the method that you wish to edit.

⇨ The control panel highlights the selected method in green.

▶ Tap the action *[Phase]*.

⇨ The control panel shows the action Phase.

▶ Tap the setting *[End point definition]*.

⇨ The control panel shows the setting End point definition.

▶ Tap *[Temperature difference test]*.

⇨ The control panel shows the temperature difference test.

The following settings are available:

Setting	Option	Explanation
[Temperature difference test]	Yes/No	Switches the temperature difference test on or off.
[Start time]	Enter value	Sets the time from which the temperature difference test is to be performed. The value relates to the time before completion of the primary drying phase.
[Temperature difference limit]	Enter value	Specifies the difference between the two sensor readings below which the end point is reached.
[Term]	Enter value	The period of time during which the difference is not to be exceeded. If the threshold is not exceeded for the full period of time, the temperature difference test is passed.
[Continue]	Yes/No	Yes : the method switches to the next phase.
		No: the phase is ended when the set levels are reached.
[Message]	Yes/No	The control panel shows or does not show a message as soon as the temperature difference test is passed.

7.8.3 Pressure rise test

NOTE

Take account of the result of the leak test in settings for *[Pressure limit]* and *[Duration]*.

Navigation path
➔ Method

Precondition:

☑ A pressure sensor is fitted. See Chapter 5.2.8 "Fitting pressure sensors (option)", page 31

☑ A leak test has been successfully completed before the pressure rise test. See Chapter 9.3 "Performing a leak test", page 99.

▶ Navigate to the *[Method]* menu via the navigation path.
▶ Tap the name of the method that you wish to edit.
⇨ The control panel highlights the selected method in green.
▶ Tap the action *[Phase]*.
⇨ The control panel shows the action Phase.
▶ Tap the setting *[End point definition]*.
⇨ The control panel shows the setting End point definition.
▶ Tap *[Pressure rise test]*.
⇨ The control panel shows the pressure rise test.

The following settings are available:

Setting	Option	Explanation
[Pressure rise test]	Yes/No	Switches the pressure rise test on or off.
[Duration]	Enter value	Specifies the length of time for which the pressure rise test is to be carried out.
[Start time]	Enter value	Sets the time from which the pressure difference test is to be performed. The value relates to the time before completion of the primary drying phase or the secondary drying phase.
[Pressure limit]	Enter value	Pressure (delta p, measured by sensor in the drying rack) increase within the running test.
[Interval]	Enter value	Time between repetitions of the test.
[Start condition]	Time/Pressure difference test/ Temp difference test/Both	Time: The pressure rise test is carried out when the specified time has elapsed.
		Pressure difference test: The pressure rise test is only carried out if a pressure difference test is passed.
		Temperature difference test: The pressure rise test is only carried out if a temperature difference test is passed.
		Both: The pressure rise test is only carried out if the temperature difference test and the pressure difference test are both passed.

Setting	Option	Explanation
[Continue]	Yes/No	Yes : the method switches to the next phase.
		No: the phase is ended when the set levels are reached.
[Message]	Yes/No	The control panel shows or does not show a message as soon as the temperature difference test is passed.

7.9 Performing freeze-drying using a method [Pro control panel]

7.9.1 Preparing the instrument

NOTICE

Several conditioning of instrument in a day is damaging for cooling circuit.

If it is necessary, wait 2 hours between each conditioning.

Time required:	approx. 30min

Navigation path

➔ Start

Precondition:

☑ All commissioning operations have been completed. See Chapter 5.2 "Putting the instrument in operation", page 27

▶ Navigate to the *[Start]* menu via the navigation path.

▶ Tap the function *[[Start conditioning]]* on the function bar.

⇨ The temperature in the ice condenser cools down to operating temperature.

⇨ The vacuum pump is being brought up to operating temperature.

⇨ After completion of the conditioning phase, the status bar shows the status **Unload / Load**.

7.9.2 Selecting a method

Navigation path

➔ Method

▶ Navigate to the *[Method]* menu via the navigation path.

▶ Tap the function *[Method]* on the function bar.

▶ Tap the method that you wish to use.

▶ Tap the function *[Activate]* on the function bar.

⇨ The status bar shows the method activated.

7.9.3 Starting freeze-drying

⚠ CAUTION

Risk of skin burns from touching parts of the ice condenser after completion of conditioning.

- ▶ Wear protective gloves when working on the instrument after the conditioning phase.

NOTE

The freeze-drying process can be cancelled by tapping the functions *[Manual]* and *[Aerate]* on the *[Start]* menu.

Navigation path

➔ Start

If a gas is being used

Precondition:

☑ The instrument has been prepared.

☑ A method is selected.

- ▶ Fit a top-mount drying rack. See Chapter 8 "Operating top-mount drying racks", page 81.
- ▶ Load the top-mount drying rack with frozen samples.
- ▶ Navigate to the *[Start]* menu via the navigation path.
- ▶ Tap the function *[Start]* on the function bar.
- ▶ Make sure that the specified gas is being used.
- ▶ Answer **YES** to the confirmation question.

⇨ The freeze-drying process starts.

⇨ The control panel shows the *Start* menu with a black background.

⇨ The system carries out the selected method.

If a gas is not being used

Precondition:

☑ The instrument has been prepared.

☑ A method is selected.

- ▶ Fit a top-mount drying rack. See Chapter 8 "Operating top-mount drying racks", page 81.
- ▶ Load the top-mount drying rack with frozen samples.
- ▶ Navigate to the *[Start]* menu via the navigation path.
- ▶ Tap the function *[Start]* on the function bar.

⇨ The freeze-drying process starts.

⇨ The control panel shows the *Start* menu with a black background.

⇨ The system carries out the selected method.

7.9.4 Changing parameters while the process is running

NOTE

Coming step can be deleted.

- ▶ Select the step you wish to delete.
- ▶ Tap the *[Delete]* button on the function bar.

7.9.5 Ending freeze-drying

Navigation path

➔ Start

Precondition:

☑ The status bar is showing the status **Hold**.

- ▶ Navigate to the *[Start]* menu via the navigation path.
- ▶ Tap the function *[Aerate]* on the function bar.
- ▶ Answer **YES** to the confirmation question.

⇨ The system is vented.

⇨ The status bar shows the status **Aerating**.

- ▶ Wait until the status bar shows the status **Unload / Load**.
- ▶ Remove the dried preparation from the top-mount drying rack.

7.9.6 Shutting down the instrument

NOTICE

Not completed shut down of the instrument.

An interruption while shutting down the instrument can damage the instrument.

- ▶ Shut down the instrument completely.
- ▶ If the shutdown was interrupted, tap the function *[Defrost]* on the function bar.

NOTICE

Do not use force to remove the ice from the ice condenser.

Time re-quired: 40 min

Navigation path

➔ Start

Precondition:

☑ The freeze-drying process has ended.

☑ The gas ballast on the vacuum pump is open.

☑ Make sure that there is sufficient distilled water available.

- ▶ Navigate to the *[Start]* menu via the navigation path.

▶ Tap the function *[Shut down]* on the function bar.

⇨ The instrument is shutting down.

⇨ The status bar shows the remaining time and the status **Shutting down**.

⇨ After the instrument has shut down, the status bar shows the remaining time and the status **Defrosting**.

⇨ After defrosting, the status bar shows the status **Stand by**.

7.9.7 Switching off the instrument

Precondition:

☑ The instrument has been shut down. See Chapter 7.9.6 "Shutting down the instrument", page 76

▶ Switch the On/Off master switch to Off.

7.10 Performing freeze-drying manually [Pro control panel]

7.10.1 Preparing the instrument

NOTICE

Several conditioning of instrument in a day is damaging for cooling circuit.

If it is necessary, wait 2 hours between each conditioning.

Time required:	approx. 30min

Navigation path

➔ Start

Precondition:

☑ All commissioning operations have been completed. See Chapter 5.2 "Putting the instrument in operation", page 27

▶ Navigate to the *[Start]* menu via the navigation path.

▶ Tap the function *[[Start conditioning]]* on the function bar.

⇨ The temperature in the ice condenser cools down to operating temperature.

⇨ The vacuum pump is being brought up to operating temperature.

⇨ After completion of the conditioning phase, the status bar shows the status **Unload / Load**.

7.10.2 Starting freeze-drying

⚠ CAUTION

Risk of skin burns from touching parts of the ice condenser after completion of conditioning.

▶ Wear protective gloves when working on the instrument after the conditioning phase.

Navigation path

➔ Start

Precondition:
☑ The instrument has been prepared.

- ▶ Fit a top-mount drying rack. See Chapter 8 "Operating top-mount drying racks", page 81.
- ▶ Load the top-mount drying rack with frozen samples.
- ▶ Navigate to the *[Start]* menu via the navigation path.
- ▶ Tap the function *[Manual]* on the function bar.
- ▶ Enter the required settings for the process parameters.
- ▶ Tap the function *[Start]* on the function bar.

⇨ The freeze-drying process starts.

⇨ The background color of the *Start* menu changes from white to black.

⇨ The status bar shows a clock counting up and the status **Manual Drying**.

⇨ The system evacuates to the set pressure.

Shutting down	The instrument is shutting down. • The aeration valve and the drain valve are closed. • The status bar shows the remaining time.

7.10.3 Editing parameters while the process is running

Navigation path

➔ Start

Precondition:
☑ The process has been started.

- ▶ Navigate to the *[Start]* menu via the navigation path.
- ▶ Using the navigation control, navigate to the parameter that you wish to change.
- ▶ Tap the function *[Edit]* on the function bar.

⇨ The control panel shows a dialog box with a numeric input box.

⇨ The control panel highlights the selected parameter in white.

- ▶ Enter the value in the numeric input box.
- ▶ Tap the function *[Save]* on the function bar.

⇨ The setting is saved.

⇨ The dialog box closes.

7.10.4 End point definition

NOTE
Take account of the result of the leak test in settings for *[Pressure limit]* and *[Duration]*.

To determine the end point of the freeze-drying process, a pressure rise test can be carried out manually while freeze-drying is in progress.

Navigation path

➔ Configuration ➔ End point determination ➔ Pressure rise test

Precondition:
☑ The process has been started.

- ▶ Navigate to the action *[Pressure rise test]* via the navigation path.
- ▶ On the line *[Pressure limit]* enter the pressure increase (delta p) within the running test.
- ▶ On the line *[Test duration]* set the length of time for which the pressure rise test is to be carried out.
- ▶ Tap the function *[Start]* on the function bar.

⇨ The pressure rise test starts.

⇨ After completion of the pressure rise test, the *[Pressure rise test]* line shows whether the pressure rise test has been passed or not.

7.10.5 Ending freeze-drying

Navigation path

➔ Start

Precondition:
☑ The sample is dry.

- ▶ Navigate to the *[Start]* menu via the navigation path.
- ▶ Tap the function *[Aerate]* on the function bar.
- ▶ Answer **YES** to the confirmation question.

⇨ The system is vented.

⇨ The status bar shows the status **Aerating**.

- ▶ As soon as the status bar shows the status **Unload / Load**, remove the dried sample from the drying rack.

7.10.6 Shutting down the instrument

NOTICE

Not completed shut down of the instrument.

An interruption while shutting down the instrument can damage the instrument.

- ▶ Shut down the instrument completely.
- ▶ If the shutdown was interrupted, tap the function *[Defrost]* on the function bar.

NOTICE

Do not use force to remove the ice from the ice condenser.

Time re-quired:	40 min

Navigation path

➔ Start

Precondition:

☑ The freeze-drying process has ended.

☑ The gas ballast on the vacuum pump is open.

☑ Make sure that there is sufficient distilled water available.

▶ Navigate to the *[Start]* menu via the navigation path.

▶ Tap the function *[Shut down]* on the function bar.

⇨ The instrument is shutting down.

⇨ The status bar shows the remaining time and the status **Shutting down**.

⇨ After the instrument has shut down, the status bar shows the remaining time and the status **Defrosting**.

⇨ After defrosting, the status bar shows the status **Stand by**.

7.10.7 Switching off the instrument

Precondition:

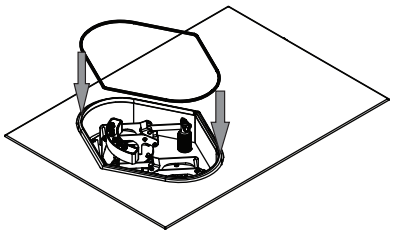
☑ The instrument has been shut down. See Chapter 7.10.6 "Shutting down the instrument", page 79

▶ Switch the On/Off master switch to Off.

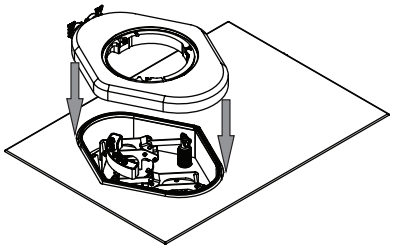
8 Operating top-mount drying racks

8.1 Operating stoppering acrylic drying chamber

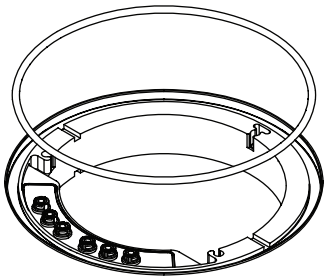
- ▶ Make sure that the groove above the ice condenser is clean, free of dust and not scratched.
- ▶ Check the O-ring for damage.
- ▶ Place the O-ring into the groove on the ice condenser.



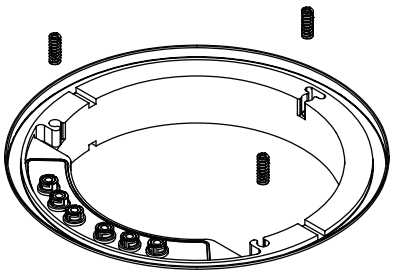
- ▶ Place the main plate on the ice condenser.



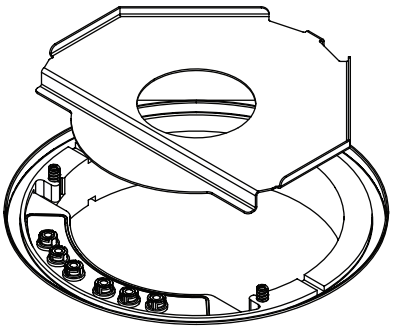
- ▶ Make sure that the groove on the ice condenser is clean, free of dust and not scratched.
- ▶ Check the 300 mm dia. O-ring for damage.
- ▶ Place the 300mm dia. O-ring in the groove in the main plate.



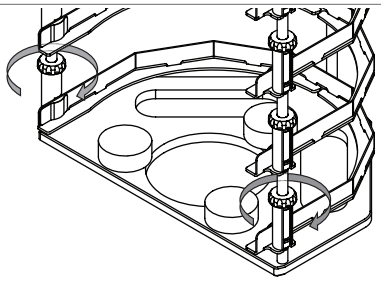
- ▶ Locate the springs in the holes on the main plate.



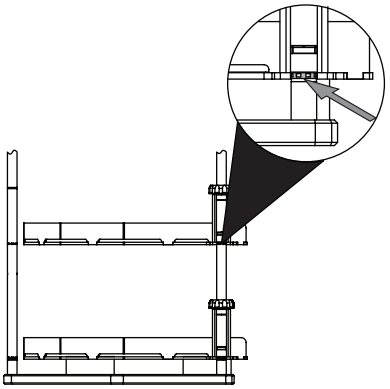
▶ Place the intermediate plate on the main plate.



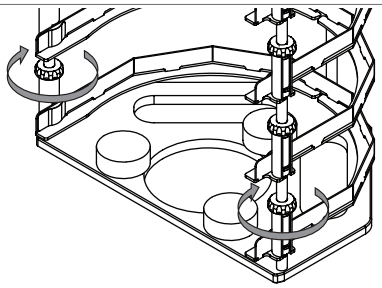
▶ Loosen all fixing screws.



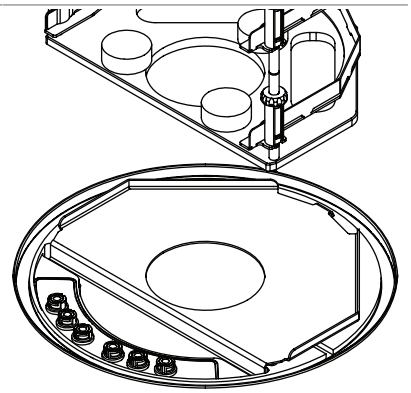
▶ Align the slots for the shelves.



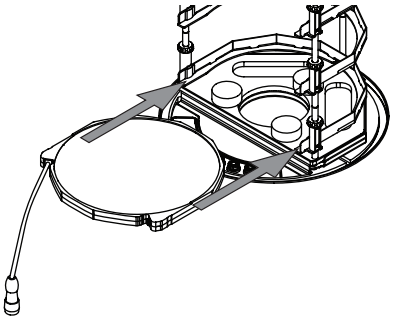
▶ Tighten the fixing screws.



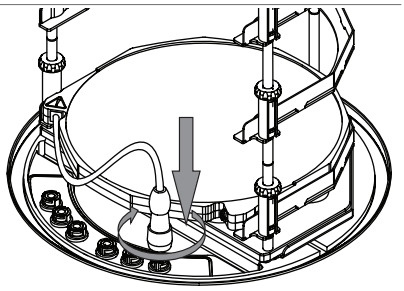
▶ Place the rack on the intermediate plate.



▶ Slide the shelves into the rack.



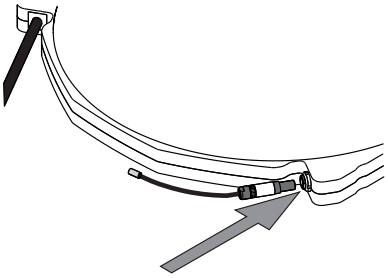
▶ Press the plug onto the shelf connection and turn the ring counterclockwise at the same time.



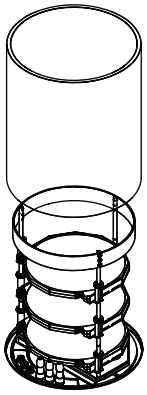
(option)

▶ Turn the temperature sensor electrical connector so that the marks on the connector and the heatable shelf are parallel

▶ Press the temperature sensor electrical connector onto the connection.



▶ Locate the cylinder in the groove above the main plate.

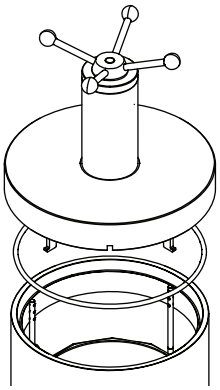


▶ Check the O-ring for damage.

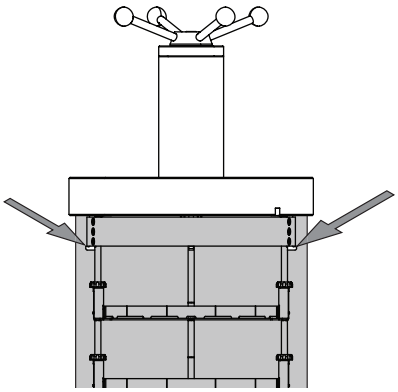
▶ Screw the hand wheel upwards until the plate inside the lid has pressed the hooks all the way in.

▶ Place the O-ring into the groove of the cover.

▶ Place the cover on the cylinder.



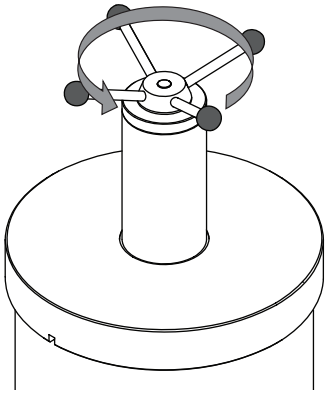
▶ Make sure that the hooks on the rack are engaged.



▶ Carry out freeze-drying.

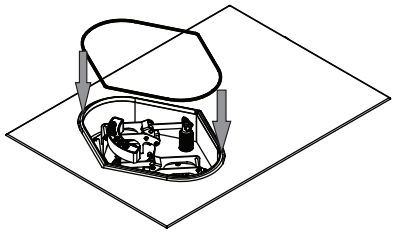
Precondition:
☑ The status bar shows the status **Stoppering**.

▶ Turn the hand wheel, until all samples are sealed.
▶ Confirm the verification question on the control panel.

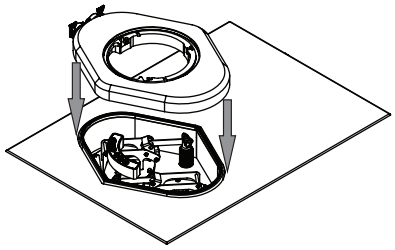


8.2 Operating manifold acrylic drying chamber (heatable shelves)

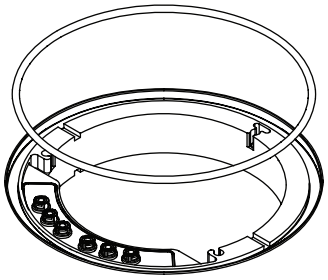
▶ Make sure that the groove above the ice condenser is clean, free of dust and not scratched.
▶ Check the O-ring for damage.
▶ Place the O-ring into the groove on the ice condenser.



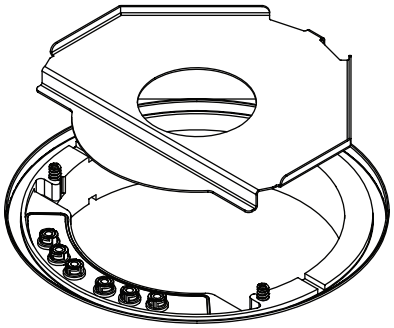
▶ Place the main plate on the ice condenser.



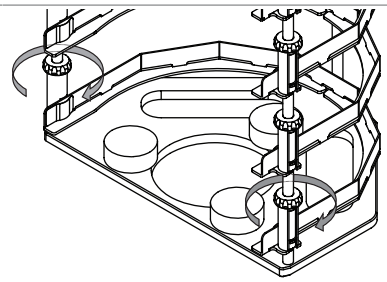
- ▶ Make sure that the groove on the ice condenser is clean, free of dust and not scratched.
- ▶ Check the 300 mm dia. O-ring for damage.
- ▶ Place the 300mm dia. O-ring in the groove in the main plate.



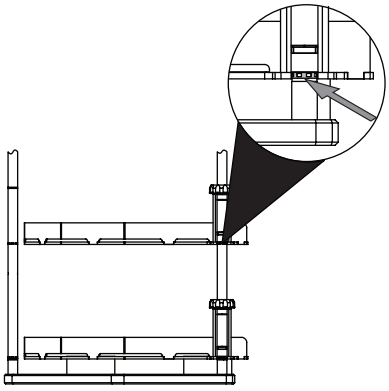
- ▶ Place the intermediate plate on the main plate.



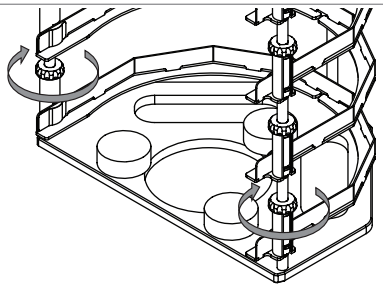
- ▶ Loosen all fixing screws.



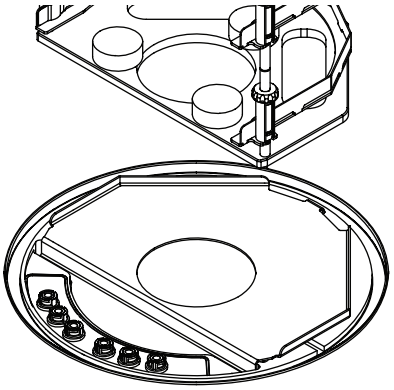
- ▶ Align the slots for the shelves.



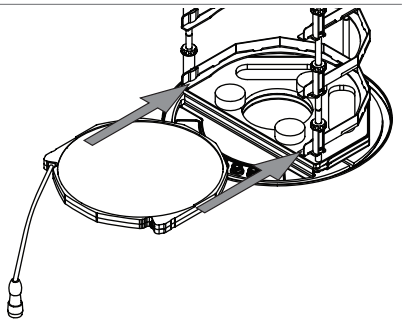
- ▶ Tighten the fixing screws.



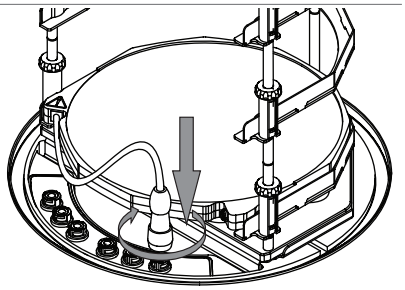
▶ Place the rack on the intermediate plate.



▶ Slide the shelves into the rack.



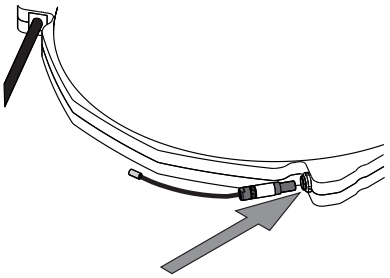
▶ Press the plug onto the shelf connection and turn the ring counterclockwise at the same time.



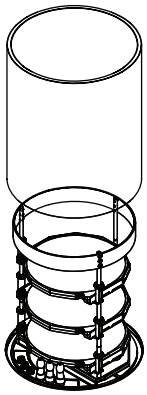
(option)

▶ Turn the temperature sensor electrical connector so that the marks on the connector and the heatable shelf are parallel

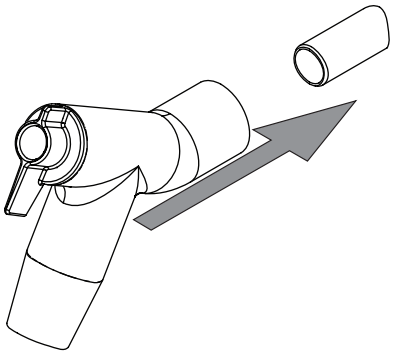
▶ Press the temperature sensor electrical connector onto the connection.



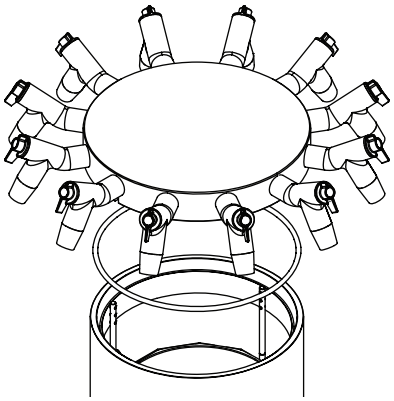
▶ Locate the cylinder in the groove above the main plate.

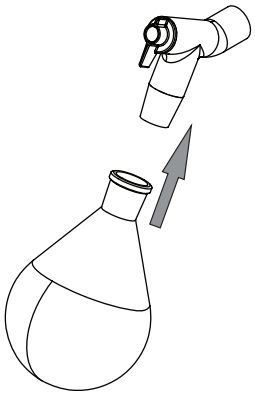


▶ Fit manifold valve onto the connection on the top-mount drying rack.



▶ Check the O-ring for damage.
▶ Place the O-ring into the groove of the cover.
▶ Place the manifold cover on the cylinder.

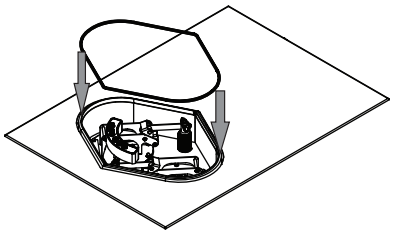




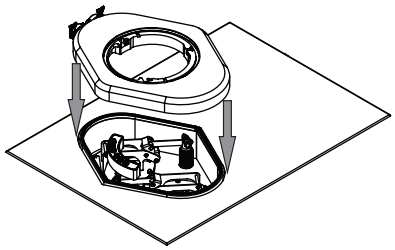
▶ Carry out freeze-drying.

8.3 Operating manifold acrylic drying chamber (non-heatable shelf)

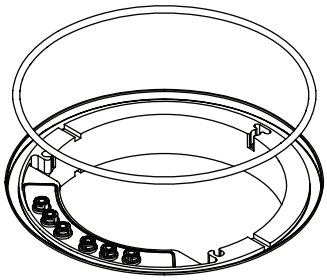
▶ Make sure that the groove above the ice condenser is clean, free of dust and not scratched.
▶ Check the O-ring for damage.
▶ Place the O-ring into the groove on the ice condenser.



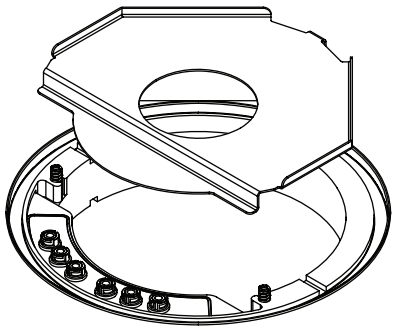
▶ Place the main plate on the ice condenser.



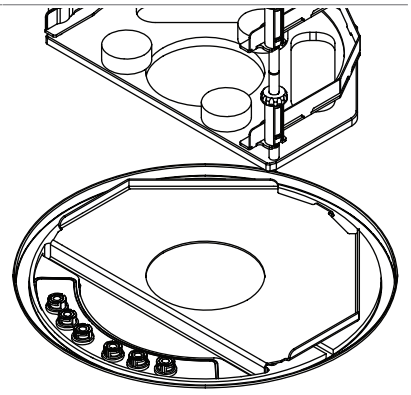
▶ Make sure that the groove on the ice condenser is clean, free of dust and not scratched.
▶ Check the 300 mm dia. O-ring for damage.
▶ Place the 300mm dia. O-ring in the groove in the main plate.



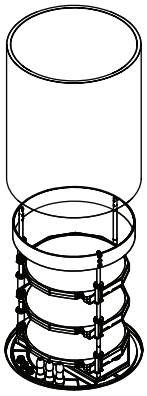
▶ Place the intermediate plate on the main plate.



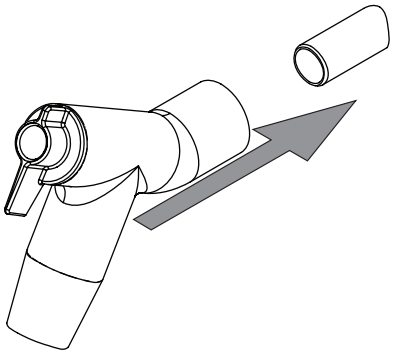
▶ Place the rack on the intermediate plate.



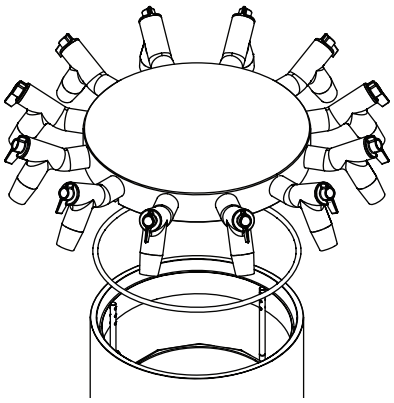
▶ Locate the cylinder in the groove above the main plate.

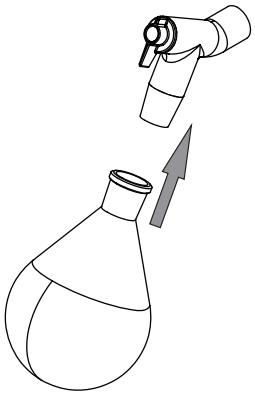


▶ Fit manifold valve onto the connection on the top-mount drying rack.



▶ Check the O-ring for damage.
▶ Place the O-ring into the groove of the cover.
▶ Place the manifold cover on the cylinder.

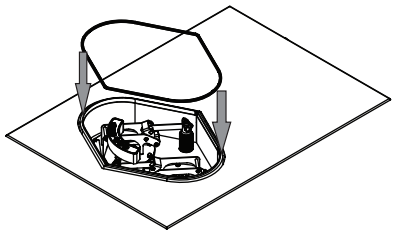




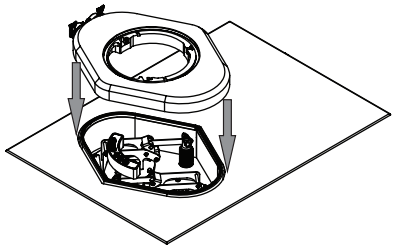
▶ Carry out freeze-drying.

8.4 Operating acrylic drying chamber (heatable shelf)

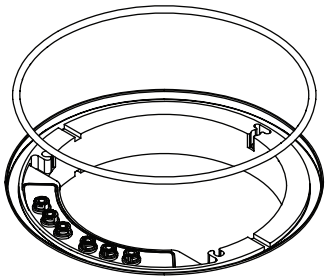
- ▶ Make sure that the groove above the ice condenser is clean, free of dust and not scratched.
- ▶ Check the O-ring for damage.
- ▶ Place the O-ring into the groove on the ice condenser.



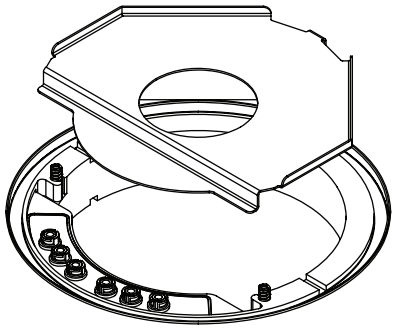
- ▶ Place the main plate on the ice condenser.



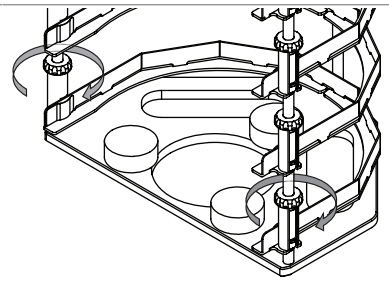
- ▶ Make sure that the groove on the ice condenser is clean, free of dust and not scratched.
- ▶ Check the 300 mm dia. O-ring for damage.
- ▶ Place the 300mm dia. O-ring in the groove in the main plate.



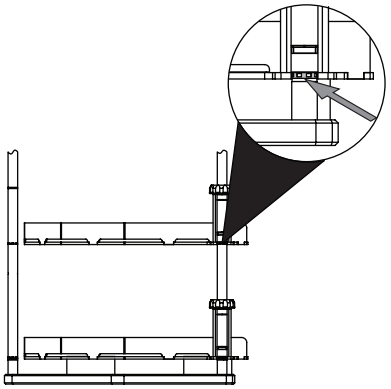
- ▶ Place the intermediate plate on the main plate.



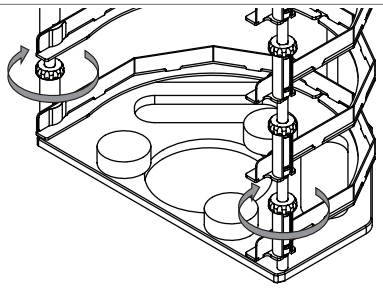
- ▶ Loosen all fixing screws.



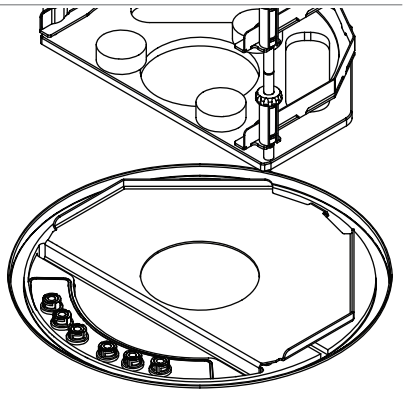
▶ Align the slots for the shelves.



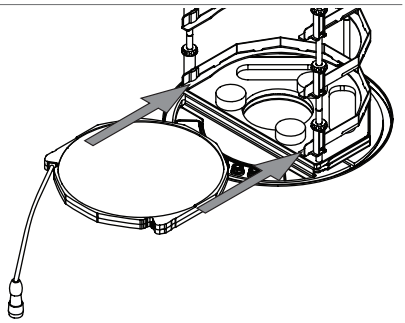
▶ Tighten the fixing screws.



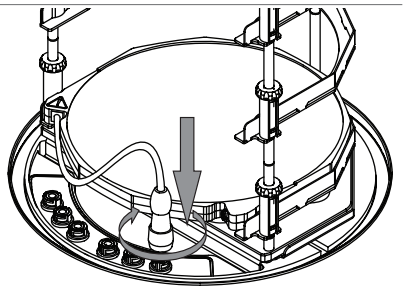
▶ Place the rack on the intermediate plate.



▶ Slide the shelves into the rack.

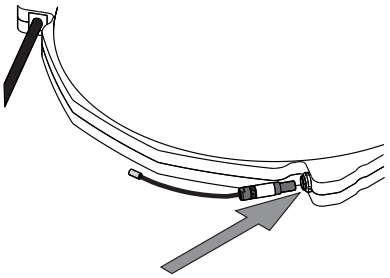


▶ Press the plug onto the shelf connection and turn the ring counterclockwise at the same time.

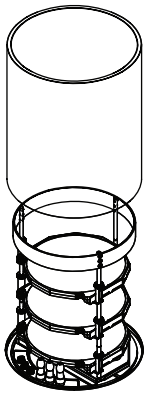


(option)

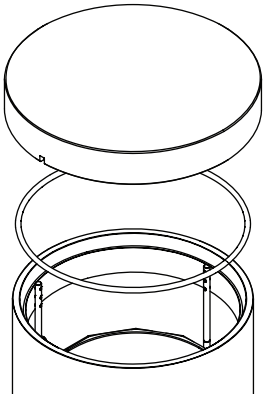
- ▶ Turn the temperature sensor electrical connector so that the marks on the connector and the heatable shelf are parallel
- ▶ Press the temperature sensor electrical connector onto the connection.



- ▶ Locate the cylinder in the groove above the main plate.



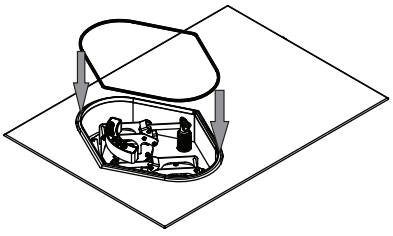
- ▶ Check the O-ring for damage.
- ▶ Place the O-ring into the groove of the cover.
- ▶ Place the cover on the cylinder.



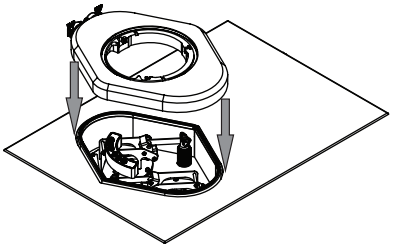
- ▶ Carry out freeze-drying.

8.5 Operating acrylic drying chamber (non-heatable shelf)

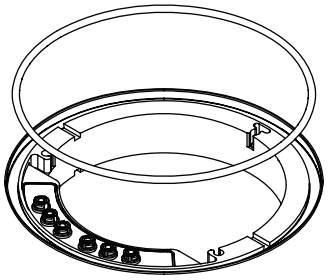
- ▶ Make sure that the groove above the ice condenser is clean, free of dust and not scratched.
- ▶ Check the O-ring for damage.
- ▶ Place the O-ring into the groove on the ice condenser.



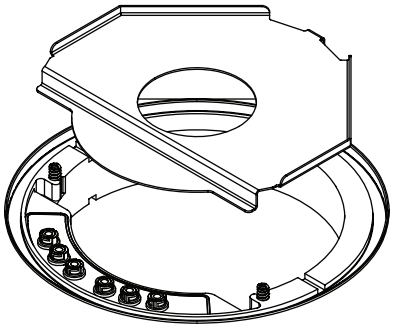
- ▶ Place the main plate on the ice condenser.



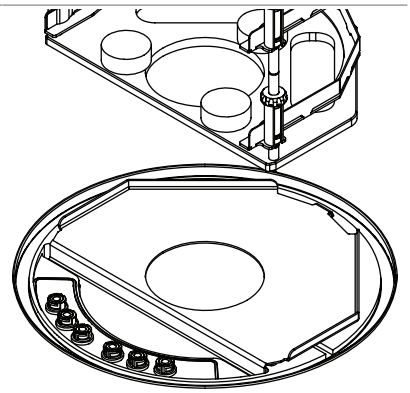
- ▶ Make sure that the groove on the ice condenser is clean, free of dust and not scratched.
- ▶ Check the 300 mm dia. O-ring for damage.
- ▶ Place the 300mm dia. O-ring in the groove in the main plate.



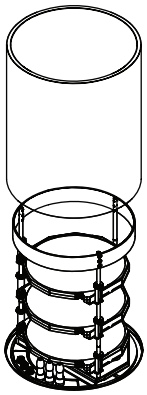
- ▶ Place the intermediate plate on the main plate.



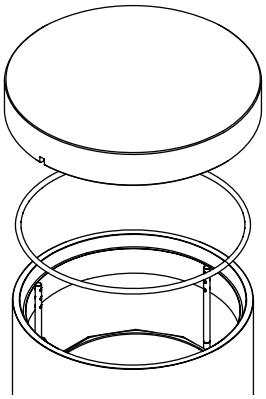
- ▶ Place the rack on the intermediate plate.



- ▶ Locate the cylinder in the groove above the main plate.



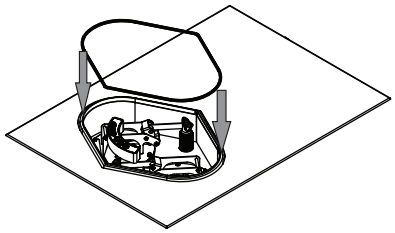
- ▶ Check the O-ring for damage.
- ▶ Place the O-ring into the groove of the cover.
- ▶ Place the cover on the cylinder.



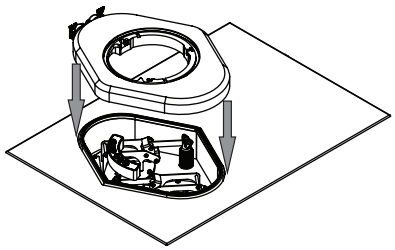
- ▶ Carry out freeze-drying.

8.6 Operating manifold drying rack

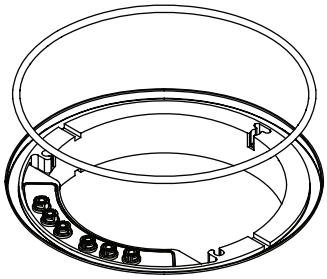
- ▶ Make sure that the groove above the ice condenser is clean, free of dust and not scratched.
- ▶ Check the O-ring for damage.
- ▶ Place the O-ring into the groove on the ice condenser.



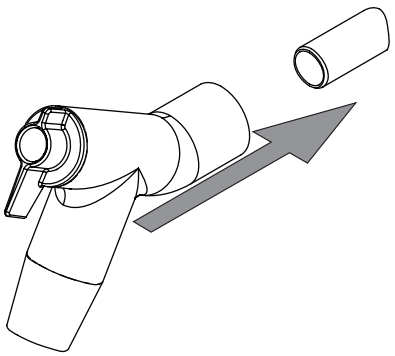
- ▶ Place the main plate on the ice condenser.



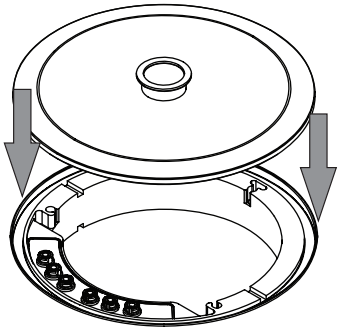
- ▶ Make sure that the groove on the ice condenser is clean, free of dust and not scratched.
- ▶ Check the 300 mm dia. O-ring for damage.
- ▶ Place the 300mm dia. O-ring in the groove in the main plate.



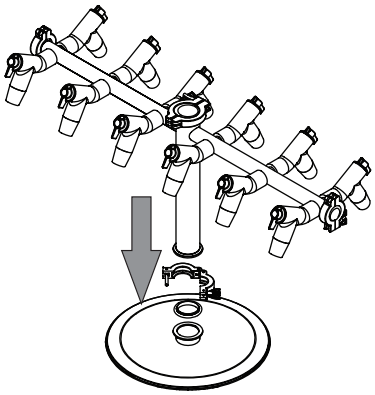
▶ Fit manifold valve onto the connection on the top-mount drying rack.

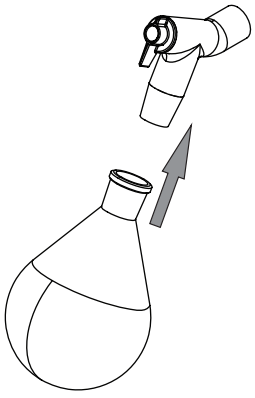


▶ Place the base plate on the main plate.



▶ Place the seal on the connection.
▶ Fit the manifold drying rack onto the seal and fix it with the clamp.





▶ Carry out freeze-drying.

8.7 Determining the number of flasks

NOTE

Do not overfill flasks

Maximum volume of the samples ≤ half of the flask volume

NOTE

The number of flasks used should be determined individually for every process.

The number of flasks used is dependent on the following factors:

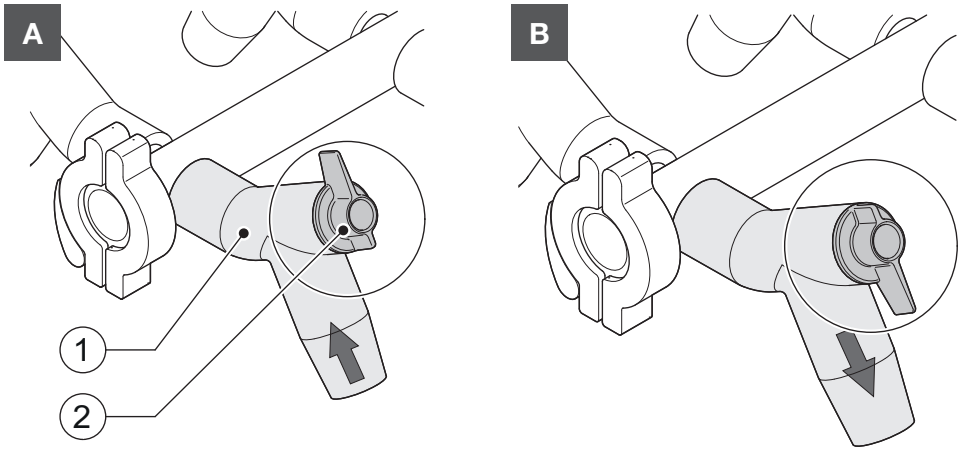
- The volume of the flask
- The method of freezing
- The concentration of the sample
- The composition of the solvent

Number of flasks using water as an example

	Flask volume 1000 mL	Flask volume 500 mL
Rotating freezing	Max. 22 flasks	Max. 22 flasks
Static freezing	Max. 36 flasks	Max. 36 flasks

8.8 Operating manifold valves

The lever on a manifold valve can be set to the following positions:



Position	Function
A: Lever pointing up	The connected vessel is evacuated.
B: Lever pointing down	The connected vessel is vented.

9 Cleaning and servicing

NOTE

Users may only carry out the servicing and cleaning operations described in this section.

Any servicing and repair work which involves opening up the casing may only be carried out by BUCHI service technicians.

9.1 Regular maintenance work

Component	Action	Interval
Vacuum Pump	▶ Carry out maintenance according to the manufacturer's instructions. See relevant documentation.	See manufacturer's instructions
	▶ Clean the outlet filter in an ultrasonic bath.	Monthly
Top-mount drying racks	▶ Wipe down the top-mount drying racks with a damp cloth. ▶ If heavily soiled, use a mild detergent.	Daily
O-ring, dia. 300 mm	▶ Wipe down the 300 mm O-rings with a damp cloth. ▶ Check for scratches and other damage. ▶ Replace the 300 mm O-ring if it is damaged.	Daily
	▶ Replace the 300 mm O-ring.	Annually
Seals ISO-KF 16 Seals ISO-KF 25	▶ Wipe down the seals with a damp cloth. ▶ Check for scratches and other damage. ▶ Replace seals if they are damaged.	Annually
Vacuum tubing	▶ Wipe down the vacuum tube with a damp cloth. ▶ Check for damage. ▶ Replace the vacuum tube if it is damaged.	Annually
Space above ice condensers	▶ Wipe down the space between the ice condensers with a damp cloth. ▶ If heavily soiled, use ethanol or a mild detergent.	Weekly - Monthly
Casing	▶ Wipe down the casing with a damp cloth. ▶ If heavily soiled, use ethanol or a mild detergent.	Weekly
Warning symbols	▶ Check that the warning symbols on the instrument are legible. ▶ If they are dirty, clean them.	Weekly

Component	Action	Interval
Heat exchanger Heater	▶ Remove dust and foreign objects from the ventilation slots using compressed air or a vacuum cleaner.	Monthly
View	▶ Wipe down the display with a damp cloth.	Monthly
Ice condenser	▶ If samples have been proceed for 4 weeks, clean the ice condenser by shutting down the instrument, start defrost and restart at next day. See Chapter 7.9.6 "Shutting down the instrument", page 76.	Monthly
	▶ Clean the ice condenser. See Chapter 9.4 "Cleaning the ice condenser", page 103.	Every 6 months

9.2 Performing a vacuum test

The vacuum test checks the performance capacity of the vacuum system.

Time required: max. 10 min

Navigation path

➜ Configuration ➜ Servicing ➜ Vacuum test

Precondition:

☑ Conditioning of the instrument has been completed.

☑ A top-mount drying rack is fitted.

☑ The top-mount drying rack does not contain sample.

▶ Navigate to the action *[Vacuum Test]* via the navigation path.

▶ Specify a required setting for the vacuum to be achieved.

▶ Specify a required time within which the vacuum is to be reached.

▶ Tap the function *[Start]* on the function bar.

⇨ The vacuum test starts.

⇨ The status bar shows the status **Vacuum Test**.

⇨ If the vacuum pressure is not below 500 mbar after 30 s, the vacuum test automatically aborts.

⇨ After completion of the vacuum test, the *[Vacuum test]* line shows whether the vacuum test has been passed or not.

Troubleshooting after failed vacuum test

Possible cause	Action
Top-mount drying rack not correctly fitted	Fit the top-mount drying rack correctly.

Possible cause	Action
Top-mount drying rack is damaged	Check function of PMMA parts, replace manifold valves, clean drain valve.
O-rings dirty	Wipe down the O-rings with a damp cloth.
O-rings damaged	Check O-rings and replace if necessary.
Groove of O-rings dirty	Wipe groove of O-rings with a damp cloth.
KF clamps not closed	Close the KF clamps.
KF seals dirty	Wipe down the KF seals with a damp cloth.
KF seals damaged	Inspect KF seals and replace as necessary.
The pump connected is not delivering sufficient performance	Carry out vacuum test with a different vacuum pump.

9.3 Performing a leak test

9.3.1 Performing a leak test with a drying chamber

The leak test checks the vacuum system for possible leaks.

Time required:	45 min

NOTE

The leak test can be aborted by tapping *[Stop]* on the function bar.

Navigation path

→ Configuration → Servicing → Leak test

Precondition:

☑ Conditioning of the instrument has been completed.

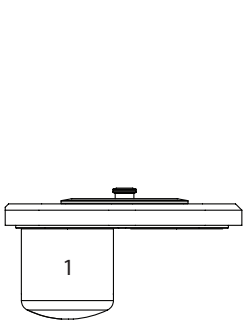
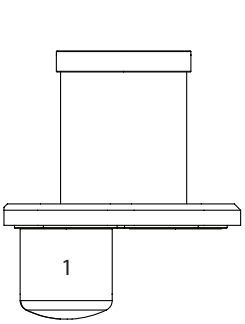
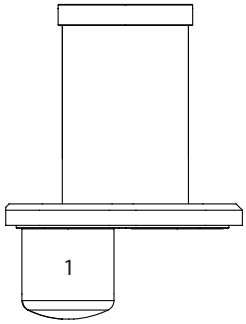
☑ A top-mount drying rack is fitted.

☑ The top-mount drying rack does not contain sample.

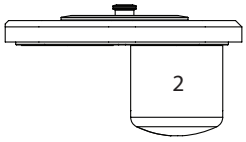
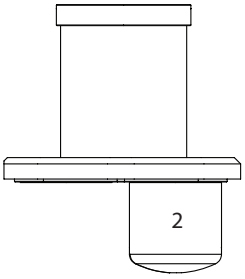
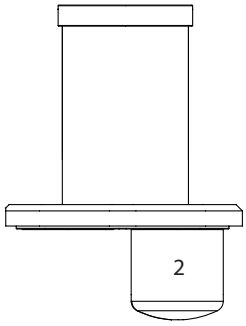
- ▶ Navigate to the action *[Leak test]* via the navigation path.
- ▶ On the *[Ice Condenser]* line, enter a required setting for the vacuum.
- ▶ On the *[Shelf temperature]* line enter the required shelf temperature.
- ▶ On the *[Test scope]* line select the component to be tested.
- ▶ On the *[Drying shelf heating]* line switch the drying shelf heating on or off.
- ▶ On the *[Volume]* line enter the actual volume of the components to be tested.

The following options are available:

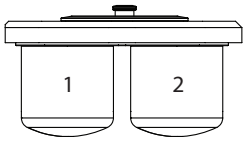
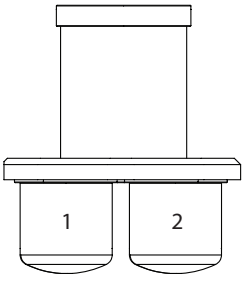
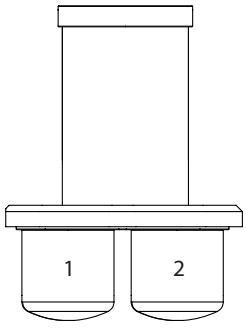
Ice condenser 1

		
24.4L	47.2L Acrylic drying chamber (with 4 drying shelves)	54.1L Acrylic drying chamber (with 6 drying shelves)

Ice condenser 2

		
24.4L	47.2L Acrylic drying chamber (with 4 drying shelves)	54.1L Acrylic drying chamber (with 6 drying shelves)

Both ice condensers

		
33.5L	56.3L Acrylic drying chamber (with 4 drying shelves)	63.2L Acrylic drying chamber (with 6 drying shelves)

▶ Tap the function *[Start]* on the function bar.

⇨ The leak test starts.

⇨ The status bar shows the status **Leak Test**.

⇨ When the leak test is completed, the *[Leak test]* tab indicates whether the leak test was successful.

⇨ The leak test is passed if the measured leakage rate is less than the pre-set rate of 10.10 mbar*L/h.

Troubleshooting after failed leak test

Possible cause	Action
Top-mount drying rack not correctly fitted	Fit the top-mount drying rack correctly.
O-rings dirty	Wipe down the O-ring with a damp cloth.
O-rings damaged	Check O-rings and replace if necessary.
Groove of O-rings dirty	Wipe groove of O-rings with a damp cloth.
KF clamps not closed	Close the KF clamps.
KF seals dirty	Wipe down the KF seals with a damp cloth.
KF seals damaged	Inspect KF seals and replace as necessary.
Pump oil dirty	Service according to manufacturer's instructions.
Leaking manifold valves (manifold acrylic drying chamber only)	Replace leaking manifold valve. Locate leaking manifold valve. See Chapter 10.3 "Locating leaking manifold valve", page 105

9.3.2 Performing leak test with a manifold drying rack

The leak test checks the vacuum system for possible leaks.

Time required:	45 min

NOTE

The leak test can be aborted by tapping *[Stop]* on the function bar.

Navigation path

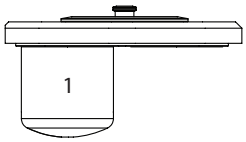
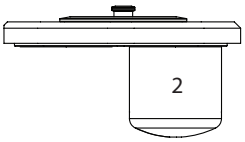
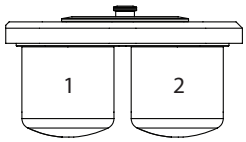
➞ Configuration ➞ Servicing ➞ Leak test

Precondition:

☑ Conditioning of the instrument has been completed.

- ▶ Fit the base plate with a KF 40 blind flange, an ISO-KF 40 seal and an ISO-KF 4 clamp.
- ▶ Navigate to the action *[Leak test]* via the navigation path.
- ▶ On the *[Ice Condenser]* line, enter a required setting for the vacuum.
- ▶ On the *[Shelf temperature]* line enter the required shelf temperature.
- ▶ On the *[Test scope]* line select the component to be tested.
- ▶ On the *[Drying shelf heating]* line switch the drying shelf heating on or off.
- ▶ On the *[Volume]* line enter the actual volume of the components to be tested.

The following options are available:

		
24.4L	24.4L	33.5L

▶ Tap the function *[Start]* on the function bar.

⇨ The leak test starts.

⇨ The status bar shows the status **Leak Test**.

⇨ When the leak test is completed, the *[Leak test]* tab indicates whether the leak test was successful.

⇨ The leak test is passed if the measured leakage rate is less than the pre-set rate of 10.10 mbar*L/h.

NOTE

To test the leak-tightness of the manifold drying rack, carry out another leak test with the manifold drying rack installed.

Troubleshooting after failed leak test

Possible cause	Action
Top-mount drying rack not correctly fitted	Fit the top-mount drying rack correctly.
O-rings dirty	Wipe down the O-ring with a damp cloth.
O-rings damaged	Check O-rings and replace if necessary.
Groove of O-rings dirty	Wipe groove of O-rings with a damp cloth.
KF clamps not closed	Close the KF clamps.
KF seals dirty	Wipe down the KF seals with a damp cloth.
KF seals damaged	Inspect KF seals and replace as necessary.
Pump oil dirty	Service according to manufacturer's instructions.
Leaking manifold valves (only if manifold drying rack installed)	Replace leaking manifold valve. Locate leaking manifold valve. See Chapter 10.3 "Locating leaking manifold valve", page 105

9.4 Cleaning the ice condenser

NOTICE

Do not use force to remove the ice from the ice condenser.

Opening intermediate valve

Navigation path

➔ Configuration ➔ Service ➔ Ice condenser

Precondition:

☑ The instrument is in standby mode. See Chapter 7.9.6 "Shutting down the instrument", page 76

- ▶ Navigate to the *Ice condenser* view via the navigation path.
- ▶ Open the intermediate valve of the ice condensers.

Cleaning the ice condenser

Navigation path

➔ Configuration ➔ Service ➔ Defrosting system

Precondition:

☑ A receiving vessel is installed. See Chapter 5.2.5 "Fitting the drain tubes", page 29

- ▶ Pour approx. 5 L of warm water into the ice condenser through the open intermediate valve.
- ▶ Leave it to take effect for five minutes.
- ▶ Navigate to the *Defrosting system* view via the navigation path.
- ▶ Tap the action *[Drain valve 1]*.

⇨ The control panel shows the drain valve highlighted in green.

- ▶ Tap the function *[Open]* on the function bar.
- ▶ Tap the action *[Drain valve 2]*.

⇨ The control panel shows the drain valve highlighted in green.

- ▶ Tap the function *[Open]* on the function bar.
- ▶ Wait until the water has run off.
- ▶ Tap the action *[Drain valve 1]*.

⇨ The control panel shows the drain valve highlighted in green.

- ▶ Tap the function *[Close]* on the function bar.
- ▶ Tap the action *[Drain valve 2]*.

⇨ The control panel shows the drain valve highlighted in green.

- ▶ Tap the function *[Close]* on the function bar.

10 Help with faults

10.1 Troubleshooting

Problem	Possible cause	Action
Compressor fails to start or switches off	No power supply to compressor	▶ Check the power supply and switch on the device.
	Compressor overheated	▶ Allow the compressor to cool down. ▶ Check ambient conditions.
Cooling temperature is not achieved	Wrong ambient conditions	Adjust ambient conditions. See Installation site
	Too much ice in the ice condenser	▶ Defrost the ice condenser. See Chapter 7.9.6 "Shutting down the instrument", page 76 for automatic defrosting or Chapter 10.4 "Manually defrosting ice condenser", page 105. ▶ Fill up fresh water.

10.2 Faults, possible causes and remedies

Malfunction	Possible cause	Remedy
Instrument does not work	Instrument is not connected to the power supply.	▶ Make sure that the power supply is connected and switched on.
Vacuum is not achieved	Vacuum system is leaking.	▶ Carry out a leak test (see Performing a leak test). ▶ Carry out a vacuum test (see Chapter 9.2 "Performing a vacuum test", page 98). ▶ If necessary, replace tubing and/or seals.
	Vacuum pump is too weak.	▶ Use a vacuum pump with a performance of at least 9 m^3/h. ▶ Carry out maintenance work according to the vacuum pump manufacturer's documentation. ▶ Clean the filter at pump outlet in a an ultrasonic bath.
	Drain valve is leaking.	▶ Check whether closed drain tube contracts. If it does, contact BUCHI Service.

Malfunction	Possible cause	Remedy
Instrument is not vented	The connection for the gas supply is blocked.	▶ Make sure that gas is able to flow into the instrument through the gas supply connection. ▶ Clean the air filter (option).
One of the ice condensers is overfilled with ice	The instrument only uses one ice condenser.	▶ See Chapter 10.4 "Manually defrosting ice condenser", page 105

10.3 Locating leaking manifold valve

Navigation path

➔ Start

Precondition:
☑ The system does not evacuate to less than 0.1 mbar.

- ▶ Navigate to the *Start* view via the navigation path.
- ▶ Set the vacuum to 0.5 mbar.
- ▶ Tap the function *[Start]* on the function bar.
- ▶ Turn each manifold valve individually while checking the display to see if the actual pressure changes.
- ▶ If the vacuum decreases in the case of one of the manifold valves, then that valve is the one that is leaking.
- ▶ Tap the function *[Aerate]* on the function bar.
- ▶ Replace the manifold valve concerned.

10.4 Manually defrosting ice condenser

NOTICE

Do not use force to remove the ice from the ice condenser.

Opening intermediate valve

Navigation path

➔ Configuration ➔ Service ➔ Ice condenser

Precondition:
☑ The instrument is in standby mode. See Chapter 7.9.6 "Shutting down the instrument", page 76

- ▶ Navigate to the *Ice condenser* view via the navigation path.
- ▶ Open the intermediate valve of the ice condenser concerned.

Defrosting the ice condenser

Navigation path
➔ Configuration ➔ Service ➔ Defrosting system

Precondition:

☑ A receiving vessel is installed. See Chapter 5.2.5 "Fitting the drain tubes", page 29

- ▶ Pour approx. 5 L of warm water into the ice condenser through the open intermediate valve.
- ▶ Leave it to take effect for five minutes.
- ▶ Navigate to the *Defrosting system* view via the navigation path.
- ▶ Tap the drain valve that is to be opened.

⇨ The control panel shows the drain valve highlighted in green.

- ▶ Tap the function *[Open]* on the function bar.
- ▶ Wait until the water has run off.
- ▶ Tap the function *[Close]* on the function bar.
- ▶ Repeat the instructions for defrosting the ice condenser until the temperature of the defrosting water matches the ambient temperature.

10.5 Error messages

Error message	Possible cause	Solution
5014	A power failure for 15 min.	▶ Confirm to recover the instrument and continue the process with risk of sample melting.
		▶ Stop the process in standby, release pressure manually by activating the aeration valve in service menu.
5042	Recovery of current drying process.	Recovery of the latest process parameters (p, T) will be started automatically. ▶ Check samples after recovery. ▶ Consider to use an UPS to keep power fail time short.
5040	Only Pro instrument Primary drying: the actual sample temperature exceeded the collapse temperature and safety temperature.	▶ Choose lower shelf set temperature.
	Secondary drying: the actual sample temperature is to close to the set shelf temperature.	

Error message	Possible cause	Solution
5041	Only Pro instrument. The actual pressure in ice condenser is above defined safety pressure during a method run.	▶ Choose lower shelf set temperature. ▶ Resolve any leakages.
5071	Motor driver of intermediate valve or main valve or both valves are not working.	▶ Aerate the drying chamber by manual opening the manifold valve. ▶ Remove the KF sealing at PMMA main plate. ▶ Restart instrument by main switch.
5072	Short circuit at vacuum sensor connection 1-2.	▶ Disconnect vacuum sensor 1-2. ▶ Check connectors and correct wiring assembly.
5170	Low temperature coolant pressure takes more than 10 min to drop below 10.5 Bar.	▶ Start conditioning again. ▶ Reduce ambient temperatures below 25°C and increase instrument clearance.
5241	Final confirmation for the aeration of the drying chamber.	▶ Confirm if aeration should be done.
5242	Vacuum pump oil operating hours exceed.	▶ Change vacuum pump oil if other vacuum pump is used.
5243	User pressed skip button during last method step in phase.	▶ Confirm step cancellation.
5270	The set ice condenser pressure cannot be reached during evacuation or vacuum regulation.	▶ Reduce sample loading for a smaller sublimation rate. ▶ Resolve possible leakages at sealings, manifold valves, etc. ▶ Check vacuum pump capacity (open gas ballast, check for oil contamination or aging).
5271	Actual ice condenser pressure is lower than the set value.	▶ Stop the process. ▶ Dry the ice condenser. ▶ Speed up the sample loading/ sublimation.
5273	Actual ice condenser pressure is higher than the set value.	▶ Stop flask attachment, until pressure is at the target pressure. ▶ Check if the vacuum regulation valve is closed correctly.
5274	Vacuum level cannot be reached within given timeout time.	▶ Resolve any leaks. ▶ Check oil condition. ▶ Check electrical connection of pump.

Error message	Possible cause	Solution
5275	Pressure of 500 mbar cannot be reached within 30s.	▶ Resolve any leaks.
5278	Pressure increases above level of 1.5 mbar during leak test.	▶ Resolve any leaks. ▶ Clean and dry condenser chamber. ▶ Clean O-rings.
5279	Leak test result above allowed limit.	▶ Resolve any leaks. ▶ Clean and dry condenser chamber. ▶ Clean drain valve with water. ▶ Clean O-rings.
5285	Sensor is disconnected.	▶ Check for cable breakage or sensor damage.
5295	Sensor is disconnected.	▶ Check for cable breakage or sensor damage.
5380	Cooling of new ice condenser side cannot be completed within 20 min.	▶ Use less sample. ▶ Add new sample later. ▶ Initiate a shutdown. Defrost the ice condenser manually.
5381	Preparation of vacuum in new ice condenser cannot be done within 30 min.	▶ Use less sample. ▶ Add new sample later. ▶ Check vacuum pump performance in vacuum test. ▶ Check for leakage such as in drain valve. ▶ Stop the process and check for leakage.
5441	Level sensor attached to 'Defrost water' socket and to fresh water canister is disconnected during a running process.	▶ Attach the sensor to the instrument.
5442	Level sensor attached to 'Waste water' socket and to waste water canister is disconnected during a running process.	▶ Attach the sensor to the instrument.
5471	Low fresh water level.	▶ Fill water in the water tank.
5472	High water level in waste canister.	▶ Empty waste water canister.
5473	Fresh water canister is empty. Air bubbles in the fresh water hose.	▶ Fill water in the water tank. ▶ Confirm the message. ▶ Prime pump using a syringe or wash bottle filled with water.

Error message	Possible cause	Solution
5570	Heatable shelf is disconnected.	▶ Connect a functioning shelf at the same connector position. ▶ Contact BUCHI Customer Service.
	Defective component (e.g. heating coil, cable, plug).	
5571	Sample temperature sensor is disconnected.	▶ Connect a functioning PT-1000 at the same connector position. ▶ Contact BUCHI Customer Service.
	Defective component (e.g. heating coil, cable, plug).	
5704	System must be restarted after changing the network settings.	▶ Restart the instrument.

11 Taking out of service and disposal

11.1 Disposal

The operator is responsible for proper disposal of the Lyovapor™.

⚠ CAUTION

Potential environmental hazard

The refrigerants R507 and R1150 are used in the instrument. Those refrigerants are toxic and must not be allowed to enter the soil or groundwater.

- ▶ Dispose of the appliance properly, if necessary using a professional disposal service.

- ▶ When disposing of equipment observe the local regulations and statutory requirements regarding waste disposal.

11.2 Returning the instrument

Before returning the instrument, contact the BÜCHI Labortechnik AG Service Department.
https://www.buchi.com/contact

12 Appendix

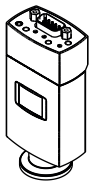
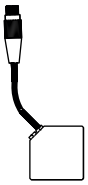
12.1 Spare parts and accessories

Use only genuine BUCHI consumables and spare parts in order to ensure correct, safe and reliable operation of the system.

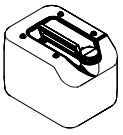
NOTE

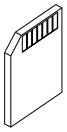
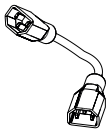
Any modifications of spare parts or assemblies are only allowed with the prior written permission of BUCHI.

12.1.1 Accessories

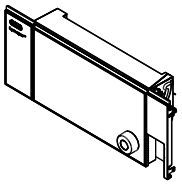
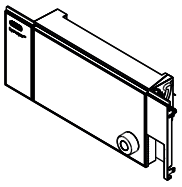
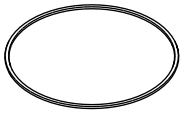
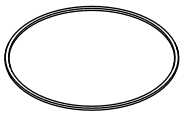
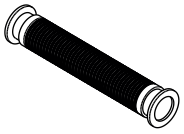
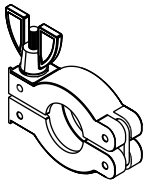
Description	Order no.	Image
Pirani pressure sensor Inficon PSG 550	11062229	
Capacitive pressure sensor Inficon CDG 020 D	11062230	
PT1000 sample temperature sensor	11064031	
Level sensor capacitive, for water canister	11069608	

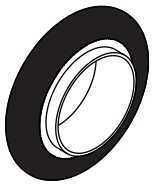
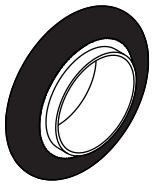
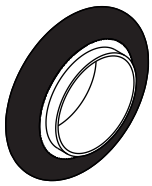
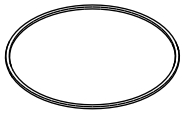
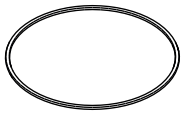
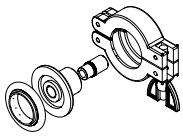
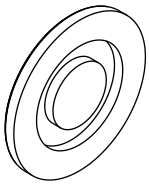
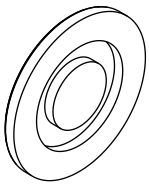
12.1.2 Further accessories

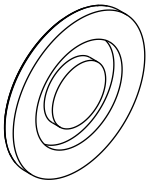
	Order no.	Image
Canister 20 L, for defrosting water	11066068	
Organic solvent filter set for water canister Inc. charcoal filter, cap, clamps	11073645	
Charcoal filter 2 pcs, for filter set	11073018	
Air filter	11057925	

	Order no.	Image
SD-Card 1 GB	11064730	
Connection cable, for vacuum pump	11064934	

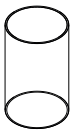
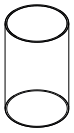
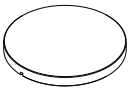
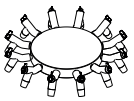
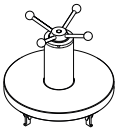
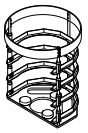
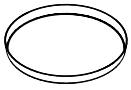
12.1.3 Spare parts

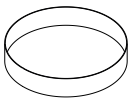
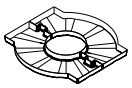
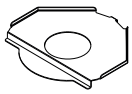
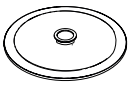
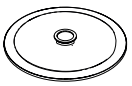
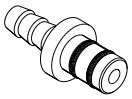
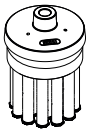
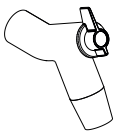
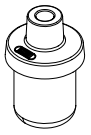
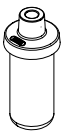
Description	Order no.	Image
User interface	11063580	
User interface Pro	11063581	
O-Ring Ø 300 mm	11065367	
O-Ring Ø 430 mm	11065343	
Vacuum hose, KF 25, L 1000 mm	11066031	
Vacuum clamp KF 16	11064939	

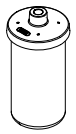
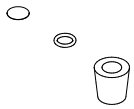
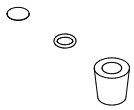
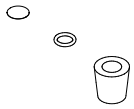
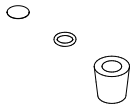
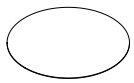
Description	Order no.	Image
Vacuum seal KF 16	11063455	
Vacuum seal KF 25	11063457	
Vacuum seal KF 40	11063659	
O-Ring, Silicone, 94.61 x 6.99 mm	11062420	
O-Ring, Silicone, 161.3 x 5.33 mm	11062421	
Edward vacuum pump outlet filter	11068459	
Blind flange KF 16	11064902	
Blind flange KF 25	11063660	

Description	Order no.	Image
Blind flange KF 40	11063661	

12.1.4 Top-mount drying rack accessories

	Order no.	Image
Drying chamber tube, PMMA, for 4 shelves L 368 mm, Ø 300 mm	11063278	
Drying chamber tube, PMMA, for 6 shelves L 480 mm, Ø 300 mm	11065093	
Top cover, PMMA, without sealing Ø 300 mm, H 50 mm	11062912	
Top cover manifold, PMMA, with 12 valves, without sealing Ø 300 mm, W 546 mm, H 127 mm	11065595	
Top cover stoppering, without sealing only for rack for 4 heatable shelves Ø 300 mm, H 330 mm, W 320 mm	11064314	
Rack for 4 heatable shelves H 356 mm, Ø 265 mm , shelf distance 30-75 mm	11065102	
Rack for 6 heatable shelves H 468 mm, Ø 265 mm, shelf distance 30-75 mm	11065103	
Heatable shelf, aluminum coated, with connection cable Ø 219.5 mm, surface area 376 cm²	11064095	
Sample tray, stainless steel Ø 220 mm, H 18.5 mm	11061439	

	Order no.	Image
Ferrule, Ø 218 mm, H 40 mm	11065816	
Drying rack manifold, stainless steel, with 12 valves H 340 mm, W 777 mm	11063664	
Drip pan, for manifold	11066358	
Support for rack, stainless steel H 4 mm	11063789	
Baseplate, stainless steel, for manifold rack	11064953	
Baseplate, PMMA, for manifold rack	11065733	
Suction nipple For manifold application to create vacuum in sample flasks	11065819	
Ampoule adapter for manifold with 19 ampoule connections and cap adapter	11065725	
Manifold valve, EPDM/Silicone, with SJ 29/32	11062300	
Flask beaker for manifold 100 mL with cap adapter and integrated filter	11066140	
Flask beaker for manifold 200 mL with cap adapter and integrated filter	11066141	
Flask beaker for manifold 800 mL with cap adapter and integrated filter	11069474	

	Order no.	Image
Flask beaker for manifold 1200 mL with cap adapter and integrated filter	11066143	
Manifold flask adapter set with 12 adapters, incl. filter paper	11066144	
Manifold flask adapter set with 6 adapters, incl. filter paper	11067334	
Manifold flask adapter set, US joint size with 12 adapters, incl. filter paper	11066171	
Manifold flask adapter set, US joint size with 6 adapters, incl. filter paper	11067333	
Filter round 20mm Set à 100pcs Filter for manifold valve	11065801	
Filter round 47mm Set à 100pcs Beaker flasks with volume above 600 mL	11065731	
Filter round 30mm Set à 100pcs Beaker flasks with volume below 600 mL	11065728	

12.1.5 Software

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