INSTRUCTION MANUAL



CoolSafe Basic & Pro

Size 4-9-15 – Temperature -55-95-100-110

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Symbols used in this manual

	**Note**
	Used to direct attention to a special item.

	**Warning**
	Used in case of danger of a serious accident or lethal injury.

	**Caution**
	Used in case of danger of medium or minor injuries or physical damage.

This document is the original instruction manual in accordance with the current Machinery Directive. This document is the reference for any translation of this instruction manual. In case of doubts or uncertainties the text in the original instruction manual is the valid.

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1 Introduction

This manual covers the CoolSafe models Basic and Pro. The models are:

CoolSafe Basic: 55-4, 55-9 and 110-4

CoolSafe Pro: 55-4, 55-9, 55-15, 95-15, 100-9 and 110-4.

CoolSafe 4-15 l is an outstanding and versatile range of advanced bench-top freeze dryers. They are the product of more than 40 years' experience and expertise, and are the ideal choice for research, process development and small-scale production.

All sizes come with a choice of condenser temperatures and a wide range of high-quality chambers and accessories. All models offer both simplicity of operation and the highest performance characteristics to meet the demands of today's research and development laboratories.

- Lowest condenser temperatures of -55°C, -95°C, -100°C or -110°C.
- Seamless stainless steel condenser with external cooling coils, heavily insulated to conserve energy and increase performance Easy removal of water via drain valve.
- Easy draining with built-in valve, allowing removal of water after a completed freeze-drying session.
- Very simple to operate.
- Wide choice of manifolds, chambers and accessories to suit your sample requirements.
- Available with 4-litre condenser capacity and temperature options of -55°C or -110°C and condenser ice capacity of 2.5 kg/24 hours - max. 3 kg in total.
- Available with 9-litre condenser capacity and temperature options of -55°C or -100°C and condenser ice capacity of 4 kg/24 hours - max. 7 kg in total.
- Available with 15-litre condenser capacity and temperature options of -55°C or -95°C and condenser ice capacity of 6 kg/24 hours - max. 10 kg in total.

If you are not familiar with the freeze-drying process, please read the section "The freeze-drying process", which outlines the freeze-drying process.

2 Safety precautions

2.1 General information

Please read this entire manual to fully understand the safe and effective use of this product. Should you have any comments about this manual we will be pleased to receive them.

☞	**Note**
	If this equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

2.2 Safety

All CoolSafe models are electrically protected with an over current circuit breaker.

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All CoolSafe models utilize low temperature refrigeration to -55°C, -95°C, -100°C or -110 °C and under no circumstances should the cold surfaces of the condenser be touched whilst switched on, in operation or in the de-icing process.

Do not handle, move or service the vacuum pump whilst in operation or if it is switched off, until it has cooled down to ambient temperature. (See paragraph regarding maintenance & changing of oil in the vacuum pump).

It is advisable that safety glasses and personal protective garments are worn by all users of the equipment.

CoolSafe Basic or Pro models 95-15 and 100-9 are fitted with castors, the front pair being lockable. Once located in the position conducive to both the safety of the laboratory environment and personnel, it is advised that the castors be in the locked position.

The safety system is designed according to safety requirements for electric equipment, control and laboratory use (EN 61010-1), which assumes that two separate faults do not occur simultaneously.

3 Installation

3.1 Installation of CoolSafe

- Make sure that the mains supply is according to the specifications on the type label placed on the rear panel.

- It is important that free air circulation is available at the air inlet and outlet grills. If the CoolSafe is positioned against a wall, there must be at least 100 mm free space at the rear of the unit.

- The CoolSafe Basic or Pro 95/55-15 and the CoolSafe Basic or Pro 100-9 are both floor standing units fitted with castors, the front pair being lockable. Before operating the system insure that the castors are in the locked position.

3.2 Installation of vacuum pump

A two-stage vacuum pump (with 2-5 m^3/h capacity or greater) must be connected to the CoolSafe Basic or Pro via the connection on the rear of the CoolSafe Basic or Pro cabinet in order to allow cryo pumping.

On the floor-standing models, the vacuum pump can be installed on the rear of the CoolSafe on a shelf support delivered with the equipment. On table models the vacuum pump must be placed near to the freeze dryer.

LaboGene recommends the VacuuBrand RZ2.5 rotary vane pump for which a variety of protection accessories, against aggressive materials are available. The vacuum pump outlet/exhaust is fitted with an oil mist filter as standard.

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- Check that the mains supply for the pump is according to the specifications on the type label.
- Connect the vacuum hose to the suction side of the pump.
- Connect the pump to the vacuum connection pipe on the rear panel of the CoolSafe.
- Check the oil level on the pump and fill it if necessary. The oil level sight glass should be 1/2 - 3/4 full.

LaboGene recommends that when the pump is running the gas ballast valve is in the open position.

3.3 Installation of accessories

The CoolSafe Basic or Pro is a basic unit and must be equipped with the necessary accessories to run a specific freeze-drying process. Select from the wide range of accessories listed in the accessories section.

Make sure to mount the correct manifold, chamber and shelf arrangements and always check that all connections are tight.

4 Functional description

The CoolSafe Basic or Pro including a vacuum pump and a chamber or manifold is a standalone unit.

On the Basic models the chamber temperature is displayed and on the Pro models the chamber temperature and the chamber pressure is displayed. Further the status of the freeze-dryer is shown in the display.

4.1 Control panel

The basic models display comprise an AWO-indicator and a two-line alphanumerical display as shown below.

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The Pro models display is the same with the exception that condenser pressure is displayed as shown below.



4.2 Valves and connections

The CoolSafe is equipped with several valves and connections that makes the freeze-dryer function and operate correctly. Each must be set correctly and plugged in correctly to make the CoolSafe operational.

4.2.1 Power supply and ON/OFF switch

The CoolSafe is designed to be plugged into a standard wall socket with build in earth and minimum 10 A fuse.

The CoolSafe is delivered with a country specific power cable, which is connected to the unit on the lower left hand side on the back panel. The main ON/OFF switch is placed on the front panel of the unit. When switched on the switch is illuminated green.





4.2.2 Vacuum pump connection

The connection for the vacuum pump is placed on the back of the cabinet. The connection between the vacuum pump and the freeze dryer is a vacuum hose, which is clamped to the nozzles on the vacuum pump and the freeze dryer with the delivered clamps.

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4.2.3 Electrical vacuum valve

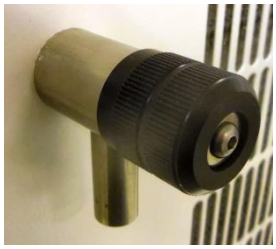
All models are equipped with an electrical vacuum valve. It is operated via a switch located on the front of the cabinet.



Do not open the vacuum valve until the AWO-indicator is green.

4.2.4 Drain valve

The drain valve is placed on the front of the cabinet. After de-icing or cleaning of the ice condenser it can be drained through the drain valve.



A hose may be attached to the nozzle to minimize spillage. Remember to close the drain valve after use.

5 Operation

The freeze-drying process is a balance between the heat absorbed by the sample to vaporize the ice, and the heat removed by the condenser to convert the water vapor into ice.

It is important to remember following factors when trying to obtain efficient utilization of the freeze dryer system.

The efficiency of the freeze-drying process depends upon:

- The surface area and the thickness of the sample.
- The temperature of the condenser and the vacuum obtained.
- The eutectic point (melting temperature) and the concentration of the sample solution.

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5.1 User interface

On start-up, the display will show the CoolSafe model designation, the software version number and the total number of hours the unit has run since last reset of the hour counter.

When running the display will show the current status of the unit and the AWO-indicator will either show constant or blink with the colour appropriate (see below).

5.2 Error situations, status and error codes

5.2.1 Status codes

A number of different codes gives information on the current status of the freeze dryer:

AWO Colour	Description	-55 °C	-95 °C & -100 °C	-110 °C
OK	The ice condenser temperature is near or at reachable temperature. The ice condenser is ready for the freeze-drying process. The freeze dryer will be in Await-state until these temperatures are reached for the first time after power up. Ice condenser ready.	-40 °C	-90 °C	-90 °C
Wait	Will be shown while the ice condenser is cooling down. Change to OK-state when the ice condenser reaches this temperature for the first time. Ice condenser not ready.	-40 °C	-70 °C	-70 °C
Wait	If the temperature in the ice condenser increase to over this temperature, during the freeze-drying process, the Await-state is invoked until the ice condenser reaches this temperature again, where OK-state is returned. Ice condenser overloaded.	-30 °C	-70 °C	-70 °C
Wait (Alarm)	If the temperature in the ice condenser increase to over this temperature, during the freeze-drying process, the Alarm-state is invoked until the ice condenser reaches this temperature again, where Await-state is returned.	-20 °C	-50 °C	-50 °C

5.2.2 Error codes

The following situations will invoke an alarm that will be shown in the status line on the Basic or Pro screen:

Displayed code	Description	-55 °C	-95 °C & -100 °C	-110 °C
E1	PT-1000 element short circuited.	✔	✔	✔
E2	Not implemented.	-	-	-
E3	PT-1000 element interrupted.	✔	✔	✔
E4	Pressure sensor interrupted or shorted.	✔	✔	✔
E5	Switched on more than 8000 hours.	✔	✔	✔
E6	Supply voltage is too high.	✔	✔	✔
E7	Supply voltage is too low.	✔	✔	✔
E8	Pressure sensor signal is too high.	✔	✔	✔
E9	Pressure switch activated.	N/A	✔	✔

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5.3 Preparations

Check that the CoolSafe ice condenser is free from ice and water, and that all valves i.e. the drain valve is closed. Check that there is no water in the drain valve.

☞	**Note**
	Do not use any tools to close valves, as they will easily be damaged.

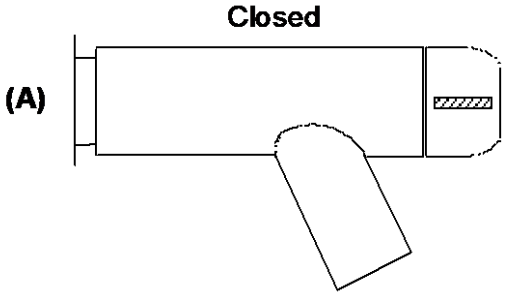
- Check that the gas ballast valve on the vacuum pump is open at all times.
- Check the oil level in the pump and the oil mist filter. The filter should have only a maximum 10 mm oil level (preferably it should be empty).
- Switch on the CoolSafe and the vacuum pump.
- The lowest temperature should be achieved within 60 minutes.
- The vacuum pump should now be allowed to run for at least 30 minutes to achieve the lowest vacuum performance. The electrical vacuum valve remains closed until you enter the freeze-drying modes (opened via the green switch button on the front of the Basic or Pro cabinets).

5.4 Freeze drying using manifolds



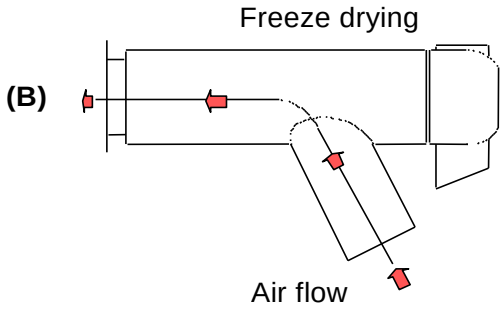
1. The manifold is connected to the conus in the lid. Make sure this connection is tight. Check that all rubber valves are closed **(A)** or in vacuum-release position **(C)**, and that the flange and lid are tight.

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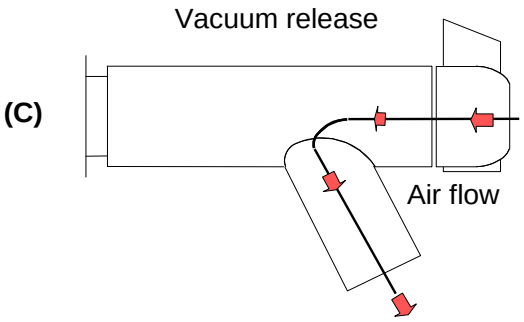


2. Start the creation of vacuum by opening the vacuum valve and check that the AWO-Indicator stays green indicating OK for freeze-drying.

3. Connect a flask to an appropriate cone on the rubber valve. Turn the rubber valve to position **(B)**. The AWO-Indicator should always be green prior to connecting the next flask. The freeze-drying process is now in progress.



4. To stop the freeze-drying process, turn the rubber valve handle 180° to position **(C)** to equalise the pressure in the flask, and remove the flask from the cone.



5. Close the vacuum valve after removal of the last flask.

6. To allow the system to equalise the vacuum in condenser, use the release function.

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5.5 Freeze drying using chambers



Cold shelves

1. Make sure that the vacuum valve is closed.

2. Mount the chamber and shelf arrangement. Check that all connections are tight and the chamber is closed. If heated shelves are to be used, refer to the controller manual.

3. Open the chamber place the frozen material on the shelves in the chamber. Close the chamber.

☞	**Note**
	Make sure that both drain valve and release valve are closed.

4. Open the vacuum valve. The freeze-drying process is now in progress.

5. To stop the freeze-drying process, close the vacuum valve and equalise the pressure by opening the release valve at the back.

6. Remove the material from the shelves.

5.6 Stopping the vacuum pump

☞	**Note**
	Keeping the pump at operation temperature and with open gas ballast valve minimises the risk for harmful condensation of vapours in the pump.

⚠	**Caution**
	Do not stop the vacuum pump during the freeze-drying process!

Close the vacuum valve and let the pump run for a minimum of 45 minutes after the freeze-drying has ended. This is to avoid any possible condenses remaining in the pump oil.

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If the freeze dryer is used regularly during the week, it is recommended that the vacuum pump run constantly with open gas ballast valve and closed vacuum valve.

5.7 Hints, tips and reminders

- The selection of the appropriate sample container is important to ensure samples are dried efficiently. Freeze drying emanates from the surface area of the sample, so the larger the surface area in respect to its depth/thickness is a determining factor in the speed of the drying cycle. “Never let the depth of sample exceeds its diameter” especially in vials, flasks trays etc.

- Maintain the vacuum pump regularly, oil changes must be made as per manufacturer’s instructions. Poor vacuum performance could mean contaminated oil.

- Ensure all seals and surfaces are clean and properly seated to avoid vacuum leaks. Always start the freeze dryer and the vacuum pump 30-40 minutes before use.

- Keep the freeze dryer operational if you expect to use it more than once during the day.

6 Maintenance

6.1 CoolSafe freeze-dryer

The air-cooled condenser must be cleaned minimum once a year. Use a vacuum cleaner and remove any dust in the cooling ribs on the front.

Rubber valves, black O-rings and valves on the manifold and black O-rings on chambers should be greased with an ultra-thin layer of vacuum grease and wiped off with a soft cloth every 3-4 months. The rubber must appear shiny, smooth and without cracks. All silicone gaskets need only dust removal (do not use any vacuum grease).

6.2 Vacuum pump

See the vacuum pump instruction manual for maintenance according to supplier’s recommendation. Maintenance for a vacuum pump in general will be to:

- Check the oil volume and colour conditions regularly. The oil should be changed every 400-500 working hours, more often if aggressive vapours have been pumped. Keep a Log book

- Drain the oil mist filter if the oil level is more than 10 mm.

- Drain, clean and eventually change the filter insert if smoke comes from the oil mist filter.

6.3 Cleaning

☞	**NOTE** When using strong materials such as strong acids or bases, radioactive substances and volatile organic solvents it must be handled carefully and promptly cleaned up if spilled.

If a sample is spilled in the concentrator chamber, it must be cleaned up immediately.

- Cleaning of acrylic components use only mild detergents solutions NEVER solvents.

- Wipe stainless steel surfaces with alcohol and then dry, do not use abrasives.

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The condenser of the CoolSafe once drained, wipe dry and then lightly cleaned with alcohol, ensure that the drain valve is open. Do not forget to close the valve once the condenser has dried.

6.4 Checking for leaks on the CoolSafe freezer-dryer

Always start from the vacuum pump and work forwards towards the chamber.

1. Check vacuum hose connection to the pump. If the pump is fitted with a nozzle and if this is held in place with a clamp, check that there is a centring ring with seal fitted between the flange on the pump and the nozzle. Make sure the clamp is tight and that the hose is pushed well onto the nozzle, and that the clip on the hose is tight.

2. Check the other end of the vacuum hose where it connects to the CoolSafe, make sure the clip is tight.

3. The drain valve on the front of the Cool Safe also has to be checked for leaks. First unscrew the drain valve (with black knob) all the way until its loose and then pull towards you. The barrel of the valve then comes away from the body. On the end of the barrel there is a white Teflon plug, make sure this is clean and without any scratches, also wipe the inside of the valve body. Replace the valve barrel into the body of the valve, push in and then screw the valve completely to the fully closed position. When vacuum is applied check that there is no leak from the drain-this can be done placing a finger over the drain spigot, you will feel if there is a leak.

4. Check the seal on the acrylic plate of the chamber that interfaces with the top stainless steel part of the CoolSafe. This can be done by squirting or brushing some frothy soap solution all around, if there is a leak this will be sucked in towards the condenser.

5. If leak(s) are found on the seals, clean both the surface of the s/steel and the seal, using a clean tissue slightly wetted with alcohol.

6. Check that the lid of the chamber is located correctly, again check that the seal is OK as previous.

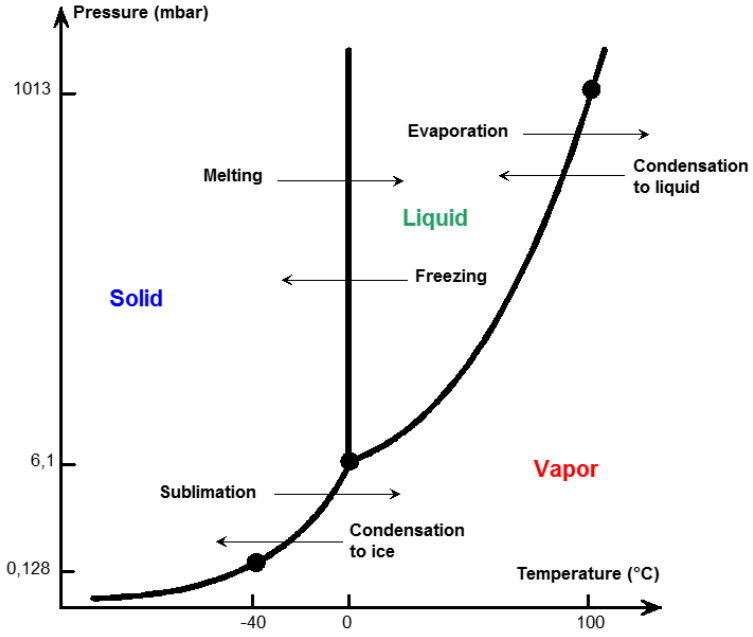
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7 The Freeze-drying process

To understand the freeze-drying process, this section describes the theory for the process in short.

For more detailed information about freeze-drying please consult available literature.

All material in free form will exist in one of three states: Vapour, liquid or solid.



As shown in the diagram for water, the physical state is dependent on the surrounding pressure and the temperature. The point where all three phases of water co-exist is called the triple point.

Freeze-drying is basically a change in state and properties of the material, (water), that is to be removed. In principle the process is very simple, but in reality, it also can be very complex as the product can consist of many components, which interact with each other.

Moving from one state to another requires the supply or removal of energy to or from the product. This energy flux will have an impact on the structure of the material being dried.

Freeze-drying is achieved using equipment that controls temperature and pressure in the environment of the product and is a 3-step process.

- In the first step, the product is frozen solid so that the water present in the material is converted to ice (pre-freeze).

- In the second step, the ice formed in pre-freezing is removed from the product by direct conversion from solid to vapour. This process is called sublimation. In order to start removing moisture in the sublimation process, the pressure surrounding the material has to be brought down to a value below that of the triple point, whilst keeping the temperature of the product below its freezing point. The condenser surface temperature must also be down to a temperature lower than the temperature of the material handled. When the product is heated, it will theoretically place itself somewhere on the transition line between the solid and vapour states. The heating will initiate sublimation of the moisture from the product to the surrounding environment. The vapour will move to the condenser surface because of the lower vapour pressure in the condenser.

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In the third step, water that is strongly bound to the solids of the sample (called sobbed water) is converted to vapour and removed from the product, this process being referred to as de-sorption. Removing moisture in the de-sorption phase or secondary drying phase, is done at a higher product temperature and at the lowest possible pressure

8 Technical Specifications

8.1 CoolSafe -55 °C

CoolSafe Basic or Pro 55-4	Unit	Item
Digital read-out of temperature		Yes
Digital read-out of pressure		Yes – Pro only
Ultimate temperature at 20°C room temperature	°C	-55
Power requirements	V/Hz	230/50-60
Power consumption	W	800
Insulation	mm	90
Condenser capacity	kg	3
Condenser capacity per 24 hours	kg	2,5
Total volume of Condenser	L	4
Weight net	kg	40
Cabinet dimensions (DxWxH)	mm	500x400x520
Cabinet material		Polyester coated steel
Condenser material		Stainless steel AISI 316
Cooling media		R 507
Vacuum Valve		Electrical
Drain tap		Yes

CoolSafe Basic or Pro 55-9	Unit	Item
Digital read-out of temperature		Yes
Digital read-out of pressure		Yes – Pro only
Ultimate temperature at 20°C room temperature	°C	-55
Power requirements	V/Hz	230/50-60
Power consumption	W	800
Insulation	mm	50
Condenser capacity	kg	7
Condenser capacity per 24 hours	kg	4
Total volume of Condenser	L	9
Weight net	kg	45
Cabinet dimensions (DxWxH)	mm	500x400x520
Cabinet material		Polyester coated steel
Condenser material		Stainless steel AISI 316
Cooling media		R 507
Vacuum Valve		Electrical
Drain tap		Yes

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CoolSafe Basic or Pro 55-15	Unit	Item
Digital read-out of temperature		Yes
Digital read-out of pressure		Yes – Pro only
Ultimate temperature at 20°C room temperature	°C	-55
Power requirements	V/Hz	230/50-60
Power consumption	W	800
Insulation	mm	90
Condenser capacity	kg	10
Condenser capacity per 24 hours	kg	6
Total volume of Condenser	L	15
Weight net	kg	70
Cabinet dimensions (DxWxH)	mm	620x495x745
Cabinet material		Polyester coated steel
Condenser material		Stainless steel AISI 316
Cooling media		R 507
Vacuum Valve		Electrical
Drain tap		Yes

8.2 CoolSafe -95 °C and -100 °C

CoolSafe Basic or Pro 95-15	Unit	Item
Digital read-out of temperature		Yes
Digital read-out of pressure		Yes – Pro only
Ultimate temperature at 20°C room temperature	°C	-95
Power requirements	V/Hz	230/50-60
Power consumption	W	1400
Insulation	mm	90
Condenser capacity	kg	10
Condenser capacity per 24 hours	kg	6
Total volume of Condenser	L	15
Weight net	kg	85
Cabinet dimensions (DxWxH)	mm	620x495x745
Cabinet material		Polyester coated steel
Condenser material		Stainless steel AISI 316
Cooling media		R 507/R170
Vacuum Valve		Electrical
Drain tap		Yes

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CoolSafe Basic or Pro 100-9	Unit	Item
Digital read-out of temperature		Yes
Digital read-out of pressure		Yes – Pro only
Ultimate temperature at 20°C room temperature	°C	-100
Power requirements	V/Hz	230/50-60
Power consumption	W	1300
Insulation	mm	90
Condenser capacity	kg	7
Condenser capacity per 24 hours	kg	4
Total volume of Condenser	L	9
Weight net	kg	75
Cabinet dimensions (DxWxH)	mm	620x495x745
Cabinet material		Polyester coated steel
Condenser material		Stainless steel AISI 316
Cooling media		R 507/R170
Vacuum Valve		Electrical
Drain tap		Yes

8.3 CoolSafe -110 °C

CoolSafe Basic or Pro 110-4	Unit	Item
Digital read-out of temperature		Yes
Digital read-out of pressure		Yes – Pro only
Ultimate temperature at 20°C room temperature	°C	-110
Power requirements	V/Hz	230/50-60
Power consumption	W	1300
Insulation	mm	90
Condenser capacity	kg	3
Condenser capacity per 24 hours	kg	2,5
Total volume of Condenser	L	4
Weight net	kg	55
Cabinet dimensions (DxWxH)	mm	500x400x520
Cabinet material		Polyester coated steel
Condenser material		Stainless steel AISI 316
Cooling media		R 507/R1150
Vacuum Valve		Electrical
Drain tap		Yes

9 Accessories

For accessories please contact your local LaboGene distributor or visit LaboGene's web site www.labogene.com where brochures are available.

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10 Declaration of conformity

Declaration of conformity

We declare under our responsibility, that the following product:

Product: CoolSafe Basic, Pro & Touch
Models: 55-4, 55-9, 55-15, 95-15, 100-9 and 110-4

to which this declaration relates is in conformity with the following standard(s), directives or other normative document(s):

In compliance with:

EN 61010-1 - Safety requirements for electrical equipment for measurement, control and laboratory use - General requirements

EN 61326-1 - Electrical equipment for measurement, control and laboratory use - EMC requirement - General requirements.

EN 378-1 - Refrigerating system and heat pumps - Safety and environmental requirements - Basic requirements, definitions, classification and selection criteria.

EN 378-2 - Refrigerating systems and heat pumps - Safety and environmental requirements - Design, construction, testing, marking and documentation.

Following the provisions of:

2006/42/EC - Machinery Directive, as amended

2006/95/EC - Low Voltage Directive, as amended

2004/108/EC - EMC Directive, as amended

97/23/EC - Pressure equipment, as amended

2011/65/EU - RoHS Directive

2012/19/EU - WEEE Directive

Allerød, November 2018

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11 Annex - Pressure of Aqueous Vapor

Temperature	Pressure	Temperature	Pressure	Temperature	Pressure	Temperature	Pressure
0,0	6,103	-9,2	2,789	-18,4	1,204	-27,6	0,488
-0,2	6,003	-9,4	2,741	-18,6	1,182	-27,8	0,479
-0,4	5,906	-9,6	2,693	-18,8	1,159	**-28,0**	**0,468**
-0,6	5,810	-9,8	2,645	-19,0	1,138	-28,2	0,459
-0,8	5,714	-10,0	2,599	-19,2	1,116	-28,4	0,449
-1,0	**5,620**	-10,2	2,553	-19,4	1,095	-28,6	0,439
-1,2	5,527	-10,4	2,509	-19,6	1,074	-28,8	0,431
-1,4	5,436	-10,6	2,464	-19,8	1,054	**-29,0**	**0,422**
-1,6	5,347	-10,8	2,421	**-20,0**	**1,034**	-29,2	0,414
-1,8	5,259	**-11,0**	**2,379**	-20,2	1,014	-29,4	0,405
-2,0	**5,171**	-11,2	2,336	-20,4	0,995	-29,6	0,397
-2,2	5,086	-11,4	2,295	-20,6	0,977	-29,8	0,389
-2,4	5,002	-11,6	2,253	-20,8	0,958	**-30,0**	**0,381076**
-2,6	4,919	-11,8	2,213	**-21,0**	**0,939**	-32,0	0,308966
-2,8	4,838	-12,0	2,175	-21,2	0,921	-34,0	0,249652
-3,0	**4,755**	-12,2	2,135	-21,4	0,903	-36,0	0,200868
-3,2	4,677	-12,4	2,097	-21,6	0,883	-38,0	0,161147
-3,4	4,599	-12,6	2,060	-21,8	0,869	**-40,0**	**0,128758**
-3,6	4,522	-12,8	2,023	**-22,0**	**0,853**	-42,0	0,102366
-3,8	4,446	**-13,0**	**1,986**	-22,2	0,835	-44,0	0,081173
-4,0	**4,371**	-13,2	1,951	-22,4	0,819	-46,0	0,064112
-4,2	4,298	-13,4	1,915	-22,6	0,803	-48,0	0,050383
-4,4	4,226	-13,6	1,880	-22,8	0,789	**-50,0**	**0,039387**
-4,6	4,154	-13,8	1,847	**-23,0**	**0,773**	-52,0	0,030656
-4,8	4,085	**-14,0**	**1,814**	-23,2	0,758	-54,0	0,023725
-5,0	**4,016**	-14,2	1,780	-23,4	0,743	-56,0	0,018394
-5,2	3,948	-14,4	1,748	-23,6	0,729	-58,0	0,014128
-5,4	3,881	-14,6	1,716	-23,8	0,714	**-60,0**	**0,010769**
-5,6	3,814	-14,8	1,684	**-24,0**	**0,701**	-62,0	0,008184
-5,8	3,749	**-15,0**	**1,654**	-24,2	0,686	-64,0	0,006184
-6,0	**3,685**	-15,2	1,624	-24,4	0,673	-66,0	0,004651
-6,2	3,622	-15,4	1,594	-24,6	0,659	-68,0	0,003478
-6,4	3,561	-15,6	1,566	-24,8	0,647	**-70,0**	**0,002585**
-6,6	3,500	-15,8	1,536	**-25,0**	**0,634**	-72,0	0,001906
-6,8	3,440	**-16,0**	**1,508**	-25,2	0,622	-74,0	0,001399
-7,0	**3,381**	-16,2	1,480	-25,4	0,609	-76,0	0,001026
-7,2	3,322	-16,4	1,454	-25,6	0,597	-78,0	0,000746
-7,4	3,265	-16,6	1,426	-25,8	0,585	**-80,0**	**0,000533**
-7,6	3,209	-16,8	1,400	**-26,0**	**0,573**	-82,0	0,000386
-7,8	3,154	**-17,0**	**1,374**	-26,2	0,562	-84,0	0,000266
-8,0	**3,100**	-17,2	1,348	-26,4	0,551	-86,0	0,000186
-8,2	3,045	-17,4	1,323	-26,6	0,540	-88,0	0,000133
-8,4	2,993	-17,6	1,299	-26,8	0,529	**-90,0**	**0,000093**
-8,6	2,941	-17,8	1,274	**-27,0**	**0,518**	-92,0	0,000064
-8,8	2,889	**-18,0**	**1,251**	-27,2	0,508	-94,0	0,000044
-9,0	**2,840**	-18,2	1,227	-27,4	0,499	-96,0	0,000029
						-98,0	0,000020

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