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HAAKE

Instruction Manual
Cryostat DC5-K75

Part No. 002-8851
1-1-041-2 11.1996

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1. Key to Symbols

1.1 Symbols used in this manual

! Warns the user of possible damage to the unit, draws attention to the risk of injury or contains safety notes and warnings.

☞ Denotes an important remark.

1 Indicates the next operating step to be carried out and…

⇒ …what happens as a result thereof.

1.2 Symbols used on the unit


Caution: Read the instruction manual!


Adjustment possibility for setting the cut-off point for excess temperature protection


Menu selection



Value alteration (↑) higher / (↓) lower


Enter key


Reset button (for usage after a fault or interruption)

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2. Quality Assurance

Dear customer,
HAAKE implements a **Q**uality **M**anagement **S**ystem certified according to EN 29001.
This guarantees the presence of organizational structures which are necessary to ensure that our products are developed, manufactured and managed according to our customers expectations. Internal and external audits are carried out on a regular basis to ensure that our **QMS** system is fully functional.
We also check our products during the manufacturing process to certify that they are produced according to the specifications as well as to monitor correct functioning and to confirm that they are safe. This is why we initiate this monitoring process of important characteristics already during manufacturing and record the results for future reference.

The “Final Test” label on the product is a sign that this unit has fulfilled all requirements at the time of final manufacturing.

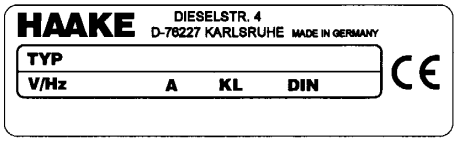
Please inform us if, despite our precautionary measures, you should find any product defects. You can thus help us to avoid such faults in future.

3. Your Contacts at HAAKE

Please get in contact with us or the authorized agent who supplied you with the unit if you have any further questions.

Gebrüder HAAKE GmbH,
Dieselstrasse 4,
D-76227 Karlsruhe
GERMANY

Tel. +49 (0)18050HAAKE
or +49 (0)721 4094-444
Fax +49 (0)721 4094-418
E-mail haake_helpdesk@bigfoot.com



The following specifications should be given when product enquiries are made:

– **Unit name** printed on the front of the unit,

– **TYP** as specified on the name plate.

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4. Safety Notes

These notes are intended to draw your attention to risks which only **YOU** can recognize and avoid or overcome. They are intended to enhance your own safety consciousness.

We have set the highest quality standards for ourselves and this unit during development and production. Every unit meets relevant safety regulations. **The correct unit usage and proper handling is however solely your responsibility.**

The intended workplace should correspond to a laboratory or pilot plant environment. The user should have an education level which is at least equivalent to a trained laboratory worker or specialized chemist. The following list should be seen as an example.

! **The device may not be operated if there are any doubts regarding a safe operation due to the outer appearance (e.g. damages).**

! **A safe operation of the instrument cannot be guaranteed if the user does not comply with this instruction manual.**

! **Ensure that this manual is always at hand for every unit operator.**

! **Only use this unit solely for the intended application.**

! **Repairs, alterations or modifications must only be carried out by specialist personnel. Considerable damage can be caused by improper repairs. The HAAKE service department is at your disposal for repair work.**

! **Do not operate the unit with wet or oily hands.**

! **Do not expose the unit to spray water or immerse it in water.**

! **Do not clean the unit with solvents (fire risk!) – a wet cloth soaked in household detergent is normally sufficient.**

! **This device is not designed according to the standard EN 60601-1: 1990 (DIN VDE 0750-1 and IEC 601-1) and should not be operated in rooms used for medical purposes and/or in the vicinity of patients.**

! **Many unit parts can become warm as a result of normal unit functioning! Please ensure that adequate contact protection is provided.**

! **Do not move the unit from the position where it was set up during operation or when it is still hot. There is a high risk of burns!**

! **Only use the heat transfer liquids recommended by HAAKE. Please refer to the respective EC – Safety Data Sheet.**

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! **The temperature controlling i.e. immersing of test-tubes, Erlenmeyer flasks or similar objects directly within the circulator constitutes normal circulator practise.**

We do not know which substances are contained within these vessels. Many substances are:

- inflammable, easily ignited or explosive
- hazardous to health
- environmentally unsafe

i.e.: **dangerous**

You alone are responsible for the handling of these substances!

Our advice:

- If in doubt, consult a safety specialist.
- Read the product manufacturer's or supplier's "*EC – SAFETY DATA SHEET*"
- Read relevant regulations concerning dangerous materials
- Observe relevant guidelines for laboratories in your country

The following measures were taken for the protection of the operator:

- Protection Class I according to VDE 0106 T1
  i.e. protection against electric shocks by grounding all parts which carry the risk of electric contact.

☞ The device must only be connected to mains receptacles with a protective ground.

- Protection IP 20 according to EN 60529
  i. e. regarding the protection against accidently touching live parts and damage by foreign matter, it has been ensured that foreign bodies with a thickness or diameter of more than 12 mm cannot penetrate.

☞ No special precautions were taken against the penetration of water and dust. The device should therefore not be used in a dusty atmosphere or in the neighborhood of spray water.

☞ Do not insert wires or tools in any of the openings.

! **Complete separation from the mains is required when:**

- **all dangers caused by this device are to be avoided,**
- **cleaning is carried out,**
- **repairs or maintenance work is about to be carried out.**

Complete separation means:

Pull out the mains plug!

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5. Unit Description

This unit fulfills the requirements of safety class 2 according to DIN 12879 and is thus suitable for unsupervised continuous operation.

The circulator pump motor is protected against thermal overloading.

5.1 Safety features

The comprehensive safety system is designed on the principle of the concept of the “single fault” (EN 61010). This assumes that two separate faults do not occur simultaneously. This system therefore offers protection against *one* (single) fault. This one fault will effectively occur automatically if you...

- do not read this manual,
- do not correctly set the excess temperature protection, i.e. your safety reserves have already been used up.

Such faults can include e.g.:

Fault in the temperature control unit:
⇒ Excess temperature ⇒ poss. fire danger

Leakage in the liquid circuit or
Evaporation of heat transfer liquid:
⇒ Low liquid level ⇒ poss. fire danger,

Pump blocked or
Heat transfer liquid is too highly viscous:
⇒ Motor overheating ⇒ poss. fire danger

Or also:
Excess temperature protection level not correctly set:
⇒ poss. fire danger

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5.2 Safety class 2 according to DIN 12879

A variably adjustable excess temperature protection and independent low liquid level protection which is preset to the lowest level allow the usage of different heat transfer liquids.

If a safety feature is triggered…

- the Fault Identification System (FIS) and an acoustic signal indicate the fault,
- the **safety-relevant components** of the heating unit (heating element and motor) are switched off immediately i.e. the safety circuit transfers the unit to a stable, safe condition,
- the heat transfer liquid in the heating unit gradually adjusts to ambient temperature, but…

! For units with switched on compressor cooling, this cooling remains functional and thus cools the heat transfer liquid to the lowest reachable temperature.

5.3 Applications

The circulator is intended for…

- temperature controlling samples within the circulator's own bath or for…
- temperature controlling closed temperature control circuits such reactors, heat exchangers or similar objects.

Open vessels cannot be temperature controlled as these circulators are only equipped with a pressure pump.

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6. Unpacking / Setting Up

6.1 Transportation damage?

- Notify carrier (forwarding merchant, railroad) etc.
- Compile a damage report.

Before return delivery:

- Inform dealer or manufacturer
  (Small problems can often be dealt with on the spot).

6.2 Information concerning the CE sign

HAAKE circulators and cryostats carry the CE sign which confirms that they are compatible with the EU guideline 89/336/EEC (electromagnetic compatibility). The tests are carried out according to module H (official sheet L380 of the European Community) as our quality assurance system is certified according to DIN / ISO 9001.
The specialist basic standards to be applied are EN 50081-2 for interference emission and EN 50082-2 for interference resistance. The following tests were carried out:

for	according to	
EN 50081	EN 55011 class B	(interference voltage)
	EN 55011 class B	(interference radiation)
EN 50082	EN 61000-4-2	(discharging static electricity)
	ENV 50140	(electromagnetic HF field, amplitude modulated)
	EN 61000-4-4	(quick transient interference variable)
	ENV 50141	(high-frequency asymmetrical, amplitude modulated)
	EN 61000-4-8	(magnetic field with power-engineered frequency)

There are thus no limitations placed on usage. A declaration of conformity can be supplied with the ordered unit on request.
Our strict standards regarding minimum operating quality and the resulting considerable amount of time and money spent on development and testing reflect our commitment to guarantee the high level of quality of our products even under extreme electromagnetic conditions. Practice however also shows that even units which carry the CE sign such as monitors or analytical instruments can be affected if their manufacturers accept an interference (e.g. the flimmering of a monitor) as the minimum operating quality under electromagnetic compatibility conditions. For this reason we recommend you to observe a minimum distance of approx. 1 m from such units.

The CE-sign also certifies the conformity with the EU-directive 72/23/EWG (low voltage regulation). The applied standards are EN61010-1 and EN61010-2-010.

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6.3 Ambient conditions according to EN 61010

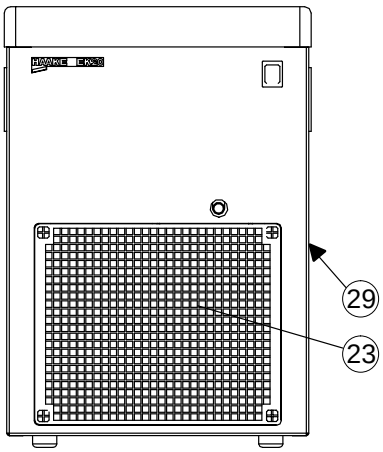
- indoors, max. 2000 meters above sea level,
- ambient temperature 5 ... 40° C,
- relative humidity max. 80%/31°C (→ 50%/40°C)
- excess voltage category II, contamination level 2

6.4 Resting time after transportation

As we can unfortunately not guarantee that our refrigerated circulators are always transported according to our recommendations (i.e. upright), lubrication oil can leak from the compressor into the cooling circuit.
If the refrigerated circulator is started up whilst still in this state, the compressor may be damaged to the lack of oil.

Therefore:

! Rest the unit for 24 hours after setting up.



6.5 Ventilation

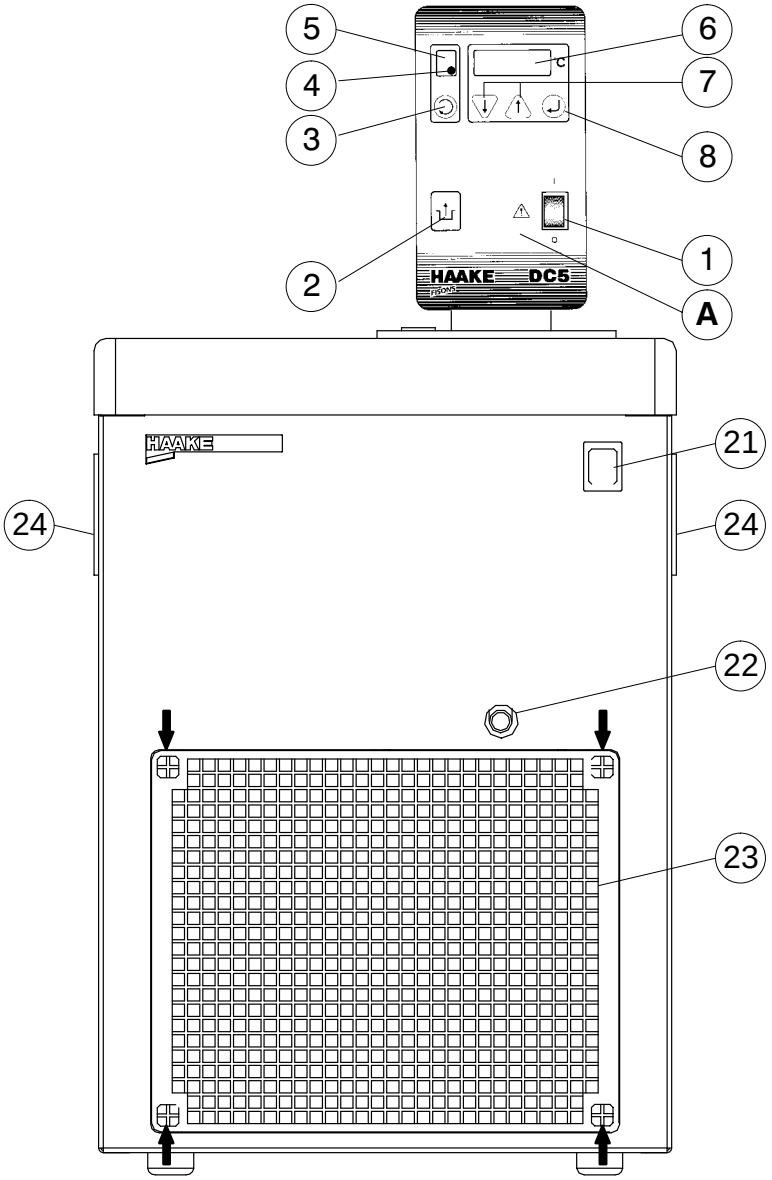
☞ Keep all ventilation grids **23** and **29** free from obstruction to ensure unhindered air circulation.

! Blocked ventilation grids lead to increased unit heating which in turn reduces the cooling capacity and thus impairs correct functioning.

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7. Functional and Operating Elements

7.1 Front

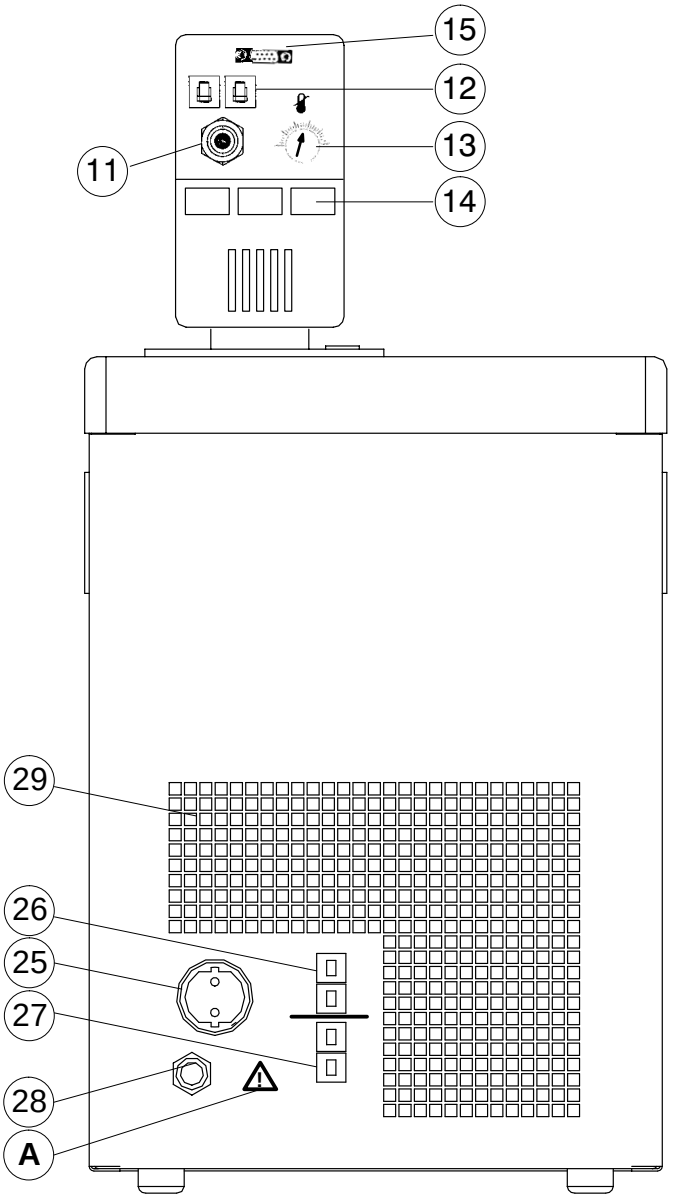


A Symbol: Read the instruction manual!
1 Mains switch
2 Reset button (also Start key)
3 Menu selection key
4 Heating control lamp
5 Menu position display
6 Set or actual temperature display / fault display
7 Value alteration (↑) higher / (↓) lower
8 Enter key

21 Cooling unit mains switch
22 Drainage nozzle
23 Ventilation grid (removeable, four mounting points: ⬇)
24 Handles

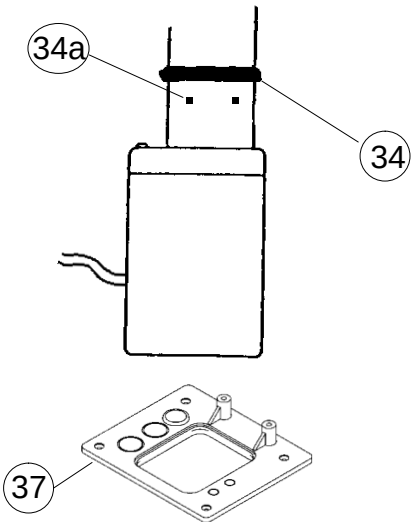
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7.2 Rear



11 Mains cable
12 Fuses (if this fuse is triggered, see chap. 12.4)
13 Excess temperature setting dial
14 Air inlet opening
15 RS232C interface
25 Mains socket for temperature control unit
26 Fuses for mains socket **25** (if triggered, see chap. 12.4)
27 Fuses for cooling circuit (if triggered, see chap. 12.4)
28 Mains cable
29 Ventilation grid

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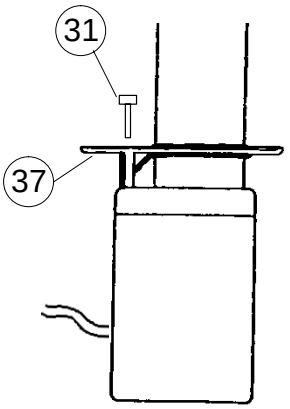


8. Assembly
(if necessary after servicing)

1 Stand the temperature control module DC5 upside-down,

! Dry unit first if necessary, in order to avoid exposing the electronics to water penetration.

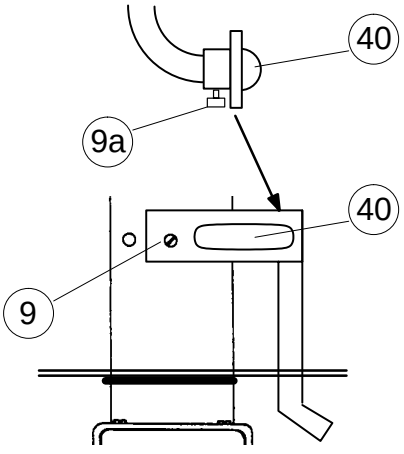
2 Slide the seal **34** over the shaft up to shortly before the screw heads **34a**. Please note the the screws are not symmetrically aligned!



Mounting the plate:

3 Slide the plate **37** with the accessories already fitted over the shaft as far as the seal **34.** Now slide it and the seal as far as the screw heads or stopper.

4 Insert the screws **31** through the plate and screw tight.

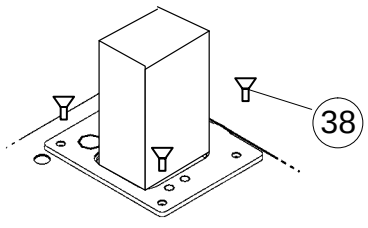


Mounting the swivel part of the circulation set **40**:

5 Preparation:
Unscrew the screw **9** from the unit shaft and loosen screw **9a** of the circulation set **40**.

6 Locate swivel part **40**,

7 Insert screw **9**. Slightly tighten both screws **9** and **9a**.



Mounting the plate onto the cooling unit K75:

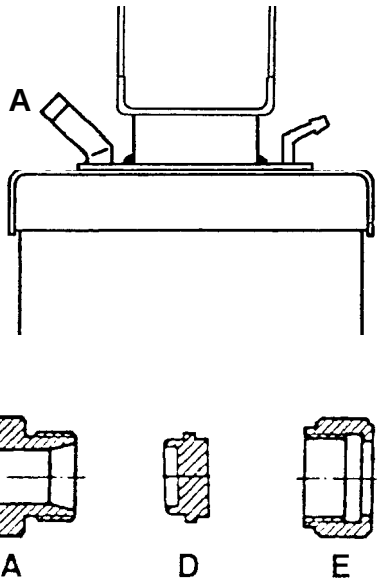
8 Locate the plate **37** with the attached temperature control module on top of the bath vessel / cooling unit and secure using the four sunken screws **38**.

9 Fit the supplied conical bungs in the thermometer holes in the bridge.

☞ *If **disassembly** is necessary, follow these steps in reverse order.*

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9. Connecting Hoses



Pump nozzle **A**:

front: return flow from external object
rear: outlet to external object (pressure side)

Hoses are normally used to connect the pump with an external vessel. If objects are to be temperature controlled in the internal bath only, the pump nozzles **A** can be closed with a covering plate **D** attached with a union nut **E** (supplied as standard)**.** However, in order to achieve a better temperature constancy, it is recommended not to close but to connect the two nozzles with a short hose with a min. length of 50 cm.

General recommendations concerning the max. allowable length of hoses cannot be given. It all depends largely on the size, form and material of the external vessel to be temperature controlled. It should be understood that the length of a hose and its diameter combined with the circulating capacity have a large effect on the temperature control effectiveness. Whenever possible, the decision should be made in favor of the wider hose diameter and the vessel to be temperature controlled should be placed as close as possible to the circulator.

! High operating temperatures will lead to high temperatures on the hose surface, this is even more so at the metal nozzles. In this case: DO NOT TOUCH!

! The required hose material is dependent on the heat transfer liquid used.

! Hoses must not be folded or bent!
A wide radius should be used if turns have to be made!

! Hoses may become brittle after prolonged use or they may get very soft. They should, therefore, be checked regularly and exchanged if necessary!

! Secure all hose connections using hose clamps!

9.1 Plastic hoses

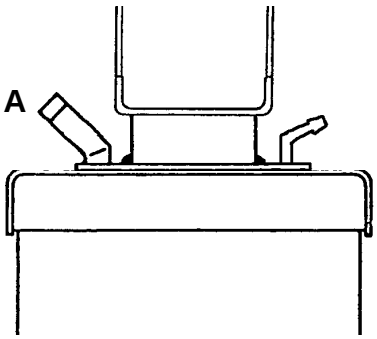
It must be ensured that the hoses selected are fully suitable for the particular application, i.e. that they will not split, crack or become disengaged from their nozzles.

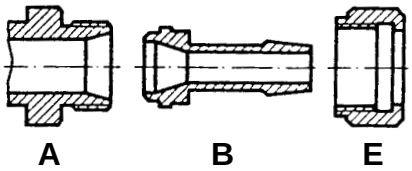
HAAKE circulators are supplied with Perbunan hoses as standard. They have proven their versatility in the temperature range between - 30 to + 100°C.

Perbunan is resistant against water, alcohol and most oils.

! The hose delivered as standard is not suitable for temperatures below –30°C.!

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Hoses for other thermal liquids and temperature ranges can also be supplied by HAAKE:

Hose material:	Permissible Temperature range:	Remarks:
PVC	10 to 60°C	For water only!
Viton	– 75 to 200°C	
Silicone	– 30 to 220°C	Not for silicone oil!
Metal	–100 to 350°C	universally suitable

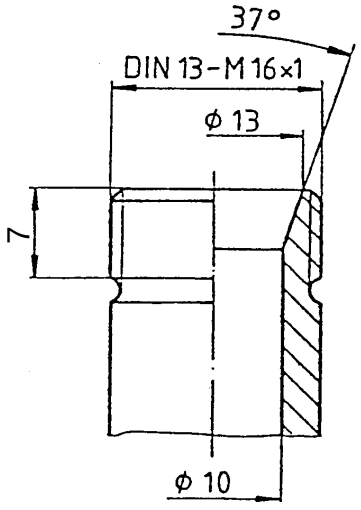
The hoses are connected using the hose fittings **B** supplied for 8 or 12 mm ∅ which are attached to the pump nozzle **A** with the coupling nut **E**.

9.2 HAAKE metal hoses

HAAKE metal hoses (stainless steel insulated) offer a particularly high degree of safety and are suitable for both low and high temperatures.

The metal hoses are attached directly to the nozzle **A**, gaskets are not required.

! The hoses must not be extremely bent or subjected to mechanical strain!

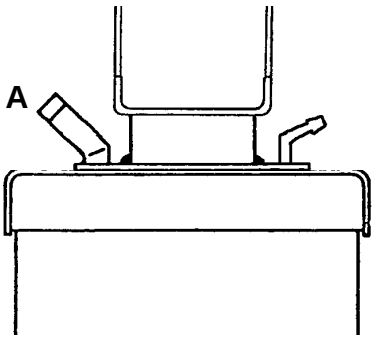


These hoses are available in lengths of 0.5, 1.0 and 1.5 meters from HAAKE. Couplings for connecting two hoses are also available if other lengths should be required for a particular application.

The smallest opening inside the metal hoses is 10 mm. The metal hoses are provided with coupling nuts (M16 x 1, DIN 12 879, part 2) at either end. The counter piece for attaching them complies to the left hand sketch.

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9.3 Pressure pump



9.3.1 Temperature controlling an object in the internal bath

Close pressure and return port **A** with the closing pieces and coupling nuts or, better yet, connect the two nozzles with a short hose.

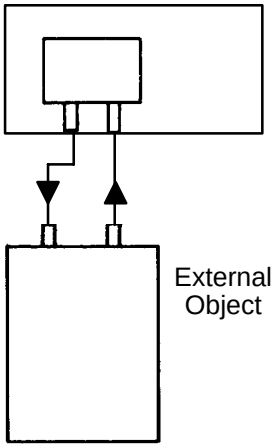
9.3.2 Connection of external <u>closed</u> systems

E.g. instruments with a pressure-tight temperature jacket or coil or a heat exchanger.

Hose connection:
From the pressure port (at the rear) to the external object and then back to the return port (at the front).

If it c annot be avoided that the external object is situated higher than the circulator, the heat transfer will only not flow back on the condition that the system is completely tight and leak-free. To be on the safe side it may be considered necessary to fit stop cocks to the inlet and outlet hoses.

Heating / Open-bath circulator



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10. Filling with Bath Liquid

The selection of the proper bath liquid (heat transfer liquid) influences the capacity of a temperature control unit decisively. The technical data with special emphasis on the temperature accuracy was established in accordance with DIN 58 966 (water at 70°C).
The temperature accuracy will decrease the higher viscosity of the heat transfer liquid and the lower its heating capacity is.
It is difficult to arrive at valid statements which can be applied as a general rule as the length of the hoses, the volume and the material of the connected systems have a great influence on this accuracy.

The heating up and the cooling down time of a system to be temperature controlled can be influenced by the bath liquid too. Oil, for instance, cuts this time in half when compared to water.

10.1 Recommended bath liquids

5 to 95°C

Distilled Water

- Normal tap water leads to calcareous deposits necessitating frequent unit decalcification.

! Calcium tends to deposit itself on the heating element. The heating capacity is reduced and service life shortened!

- Water, of course, can be employed up to 95°C, however above 80°C water vaporization reaches a level which necessitates the liquid to be constantly replenished.

–30 to 80°C

Water with Antifreeze

In applications below 5°C the water has to be mixed with an antifreeze. In doing so, the amount of antifreeze added should cover a temperature range 10°C lower than the operating temperature of the particular application. This will prevent the water from gelling (freezing) in the area of the evaporating coil the surface area of which is much colder than the working temperature. An excess of antifreeze deteriorates the temperature accuracy due to its high viscosity.

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Other heat transfer liquids supplied by HAAKE:

–75 to 32°C	*HAAKE SIL 100*
–40 to 100°C	*HAAKE SIL 180*
–75 to –30°C	*HAAKE Synth 20*
–50 to 34°C	*HAAKE Synth 60*

Please get in contact with us should you have any questions. We are glad to advise you and can help you to choose a heat transfer liquid suitable for your application
HAAKE heat transfer liquids are supplied with an EC Safety Data Sheet.

! Important ! **HAAKE takes no responsibility for damages caused by the selection of an unsuitable bath liquid.**

Unsuitable bath liquids are liquids which e.g.

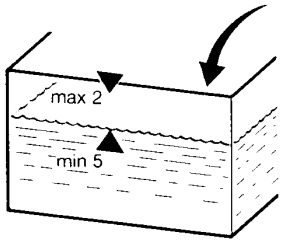
- are very highly viscous (much higher than 30 mPa·s at the respective working temperature)
- have corrosive characteristics or
- tend to cracking

! Important ! **It is absolutely mandatory that the overtemperature cut-off point is set lower than the flash point for the heat transfer liquid selected. (See chapter 16).**

! Important ! **The highest working temperature as defined by the EN 61010 (IEC 1010) must be limited to 25°C below the flashpoint of the bath liquid.**

! Important ! **Please ensure when selecting the heat transfer liquid that no toxic gases can be generated and bear in mind that inflammable gases can build up over the liquid during usage.**

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10.2 Filling with heat transfer liquid

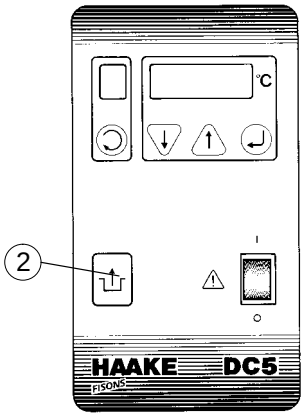
Filling level of the interior bath:

max. up to 2.0 cm below the cover plate,
min. up to 5.0 cm below the cover plate.

External systems included within the circulating circuit have to be filled with the same heat transfer liquid in order to avoid too much liquid being drawn from the internal bath.

☞ The bath level should be checked when the preset temperature has been reached!

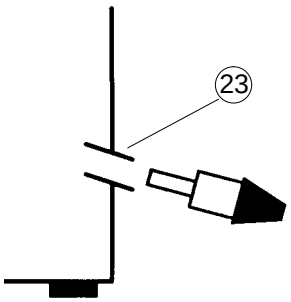
Quite often closed external systems cannot be prefilled as suggested. In this case the internal bath of the unit has to be filled to the max. level. After starting the unit, the pump will feed the necessary liquid to the external system. Should the demand be higher than the volume difference between high and low, the low liquid level sensor will be activated and the pump switched off.



In this case:

1. Replenish the liquid,
2. Reset the safety circuit,
   Depress the key **2** (at the front)
   ⇒ The unit starts up again
3. Repeat this action if necessary.

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11. Draining

The temp. control unit is drained at the nozzle **23**.

1 Place a suitable vessel underneath nozzle.

☞ Bear in mind that the liquid will run out in a slight arc.

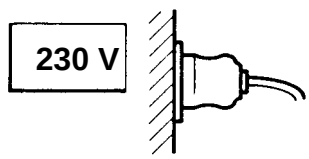
2 Turn plug slowly until it becomes disengaged from the thread. A pin will prevent the liquid from running out right away.

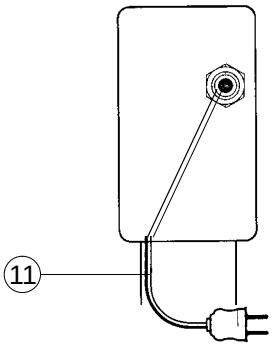
3 Pull out plug (pin) in one quick motion. The liquid will start to run out.

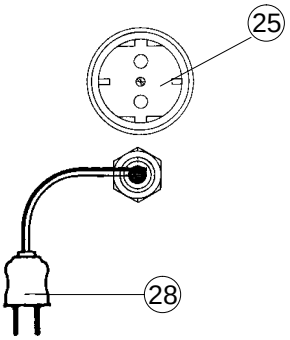
4 Possible residues can be drained by tilting the circulator slightly.

! Hot heat transfer liquid should not be drained! When certain conditions make draining necessary, please act safety conscious: Wear protective clothing and protective gloves!

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12. Connecting Up

12.1 Connecting to the mains

Only attach this unit to mains sockets with a grounded earth. Compare the local mains voltage with the specifications written on the name plate. Voltage deviations of +/- 10% are permissible. The socket must be rated as suitable for the total power consumption of the unit.

1 Insert the mains plug **11** of the temperature control module into the socket **25** at the rear of the refrigerated bath.

2 Connect the refrigerated bath's mains plug **28** to a grounded mains socket.

! Socket 28 **is live as soon as this connection has been made whether the refrigerated bath has been switched on at the mains switch or not!**

12.2 Checking the liquid circuit

Before switching on, check again to make sure that the pressure and suction ports are either connected with each other or blocked with covering plugs or alternatively if an external object is to be temperature controlled, that the hoses are connected correctly and secured (see chapter 9.3).

12.3 Changing the mains plug (e.g. for Great Britain)

! This should only be carried out by qualified specialist personnel!

The mains cable wires have the following colors:

Brown	**=**	**Live**
Blue	**=**	**Neutral**
Green/Yellow	**=**	**Earth**

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12.4 Fuses on the unit

All units are equipped with automatic thermally-triggered fuses.

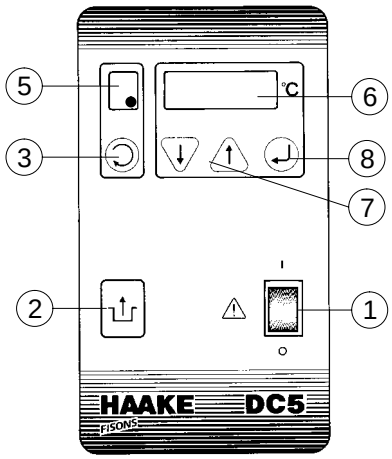
If the fuse has triggered…

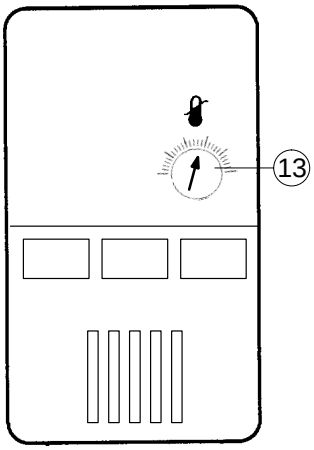
- the fuse does not have to be exchanged – resetting suffices;
- a red marking is visible;
- a certain cooling down time should be allowed (approx. 5 min) before the (dip) switch can be pressed again.

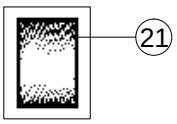
! Do not use tools; do not use force. Both destroy the fuse.

! If the fuse should be triggered again after resetting, the unit probably has a defect. In this case the unit should be sent in for servicing.

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13. Operating

13.1 Switching on

1 Set the excess temperature protection clearly above the desired operating temperature using the dial **13**.

2 Switch the circulator on at the mains switch **1**.
This causes:

⇒ The version number of the operating software is briefly shown at display **6**: e.g. “n 1.5”

⇒ Display **6** flashes over all segments 88888

3 Press the Reset key **2** (= start).

⇒ Display **6** shows the actual temperature at the control sensor (resolution 0.1°C).

⇒ Pump motor starts up – the heat transfer liquid starts to circulate.

The cooling unit is switched on via its own mains switch **21**. Only activate cooling device if cooling is actually required. The compressor starts with a slight jerk.

! If the DC5-K75 was already in operation before, please switch on the unit only after the refrigeration section has been switched off for at least 60 minutes. If switch on is attempted earlier, the compressor will try to start several times but without success. This could lead to burn-out of the compressor motor windings.

The second compressor of the K75 is always switched on automatically after a delay of 30 seconds (for protection).

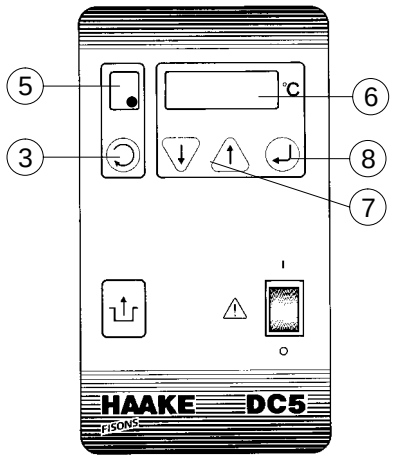
! When the unit is started under unfavourable environmental conditions, the pressostat safety device may respond after about 1 minute. If this happens, please press the reset button 2 . Usually the unit will then start correctly without going into fault status again. However, if fault status appears several times in succession, the unit is defective and must be sent-in for servicing.

13.2 Starting up again after a power failure

The temperature control module switches itself off in case of a power failure. Display **6** flashes over all segments 88888 Switching on again is only possible after the reset key **2** has been pressed. This is due to safety reasons.
The unit reacts in the same way if is switched on via a mains switch in the laboratory.

You can choose if you want to retain these standard default settings. The units can be switched to automatic resetting in both cases mentioned above. This is activated via a separate menu option which can be accessed by pressing the “menu”-key **3** whilst simultaneously switching on the unit.

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Keep pressing the key **3**, until…

8 on is shown in the display.
This is the default setting.

If you switch with key **7** (↑) to…

8 oFF and confirm this using the Enter key **8**, the DC5 will switch on again automatically from now on and resetting after the circulator is switched on is no longer necessary.
Please consider any possible resulting risks!

Please wait, until the display returns to showing the actual temperature and switch the circulator off. The standard menu appears after restarting the unit.

13.3 Displaying the software version

If a key is held depressed as the unit is switched on, the operating software version no. (e.g. 'n 1.5') is shown on the display until the key is released.

13.4 Setting the set temperature

1 Press the menu key **3** repeatedly until "S" (for set value) is shown on the small display **5**.

2 Increase (↑) or decrease (↓) the value shown on the display **6** via the keys **7**.
If you keep one of the keys **7** depressed, the first degree of temperature alteration is shown slowly in tenths of a degree. After this the temperature alteration rate accelerates to five times quicker.

3 Press the Enter key **8**.

⇒ The selected value is confirmed as the new set value.

☞ **The new value is not saved until the Enter key has been pressed. The circulator continues to use the old set value.**
Warning: **The correction factor "c" may have to be determined again if the set temperature is altered! (see chapter 13.6)!**

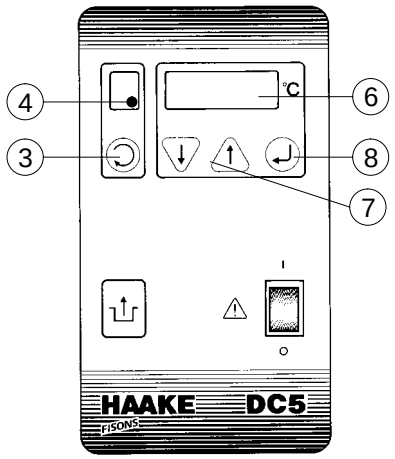
If the symbols S and H in the display **5** flash alternately, then S = H
Go to chapter 13.7.

The display **6** automatically switches back to actual temperature display after a short time.

After the Enter key **8** has been depressed, the set value remains stored even in case of a power failure.

☞ **If it is not possible to set the desired temperature due to a fault (display "H_ xx"), please read chapter 15.**

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13.5 Heating control lamp

The display **4** lights up when the heating is switched on (set temperature is higher than the current temperature).

⇒ display **4** lights up constantly during the heating up phase,

⇒ display **4** flashes on and off during the control phase.

The display **4** does not light up if the heating is not activated (set temperature is lower than the current temperature).

13.6 Displaying the actual temperature

Display **6** shows the actual temperature at the control sensor with a resolution of 0.1°C.

This temperature does not correspond directly to the temperature in the circulator's bath and even less to the temperature in the external connected system.

The temperature difference is determined by measuring the actual current temperature using a suitable measuring device (calibrated or gauged thermometer).
It is entered into the circulator as the correction factor " c " (RTA system) and remains stored there.

The resolution of the correction factor " c " according to the RTA system is 0.01°C. Possible change ± 2,5°C.

Entry (see example overleaf):

1 Press the key **3**, until " c " is shown on the small display **5**.

2 Alter the value shown on the display **6** using the keys **7** (↑) or (↓)

3 Press the Enter key **8**.

⇒ The selected value is confirmed as the new correction factor.

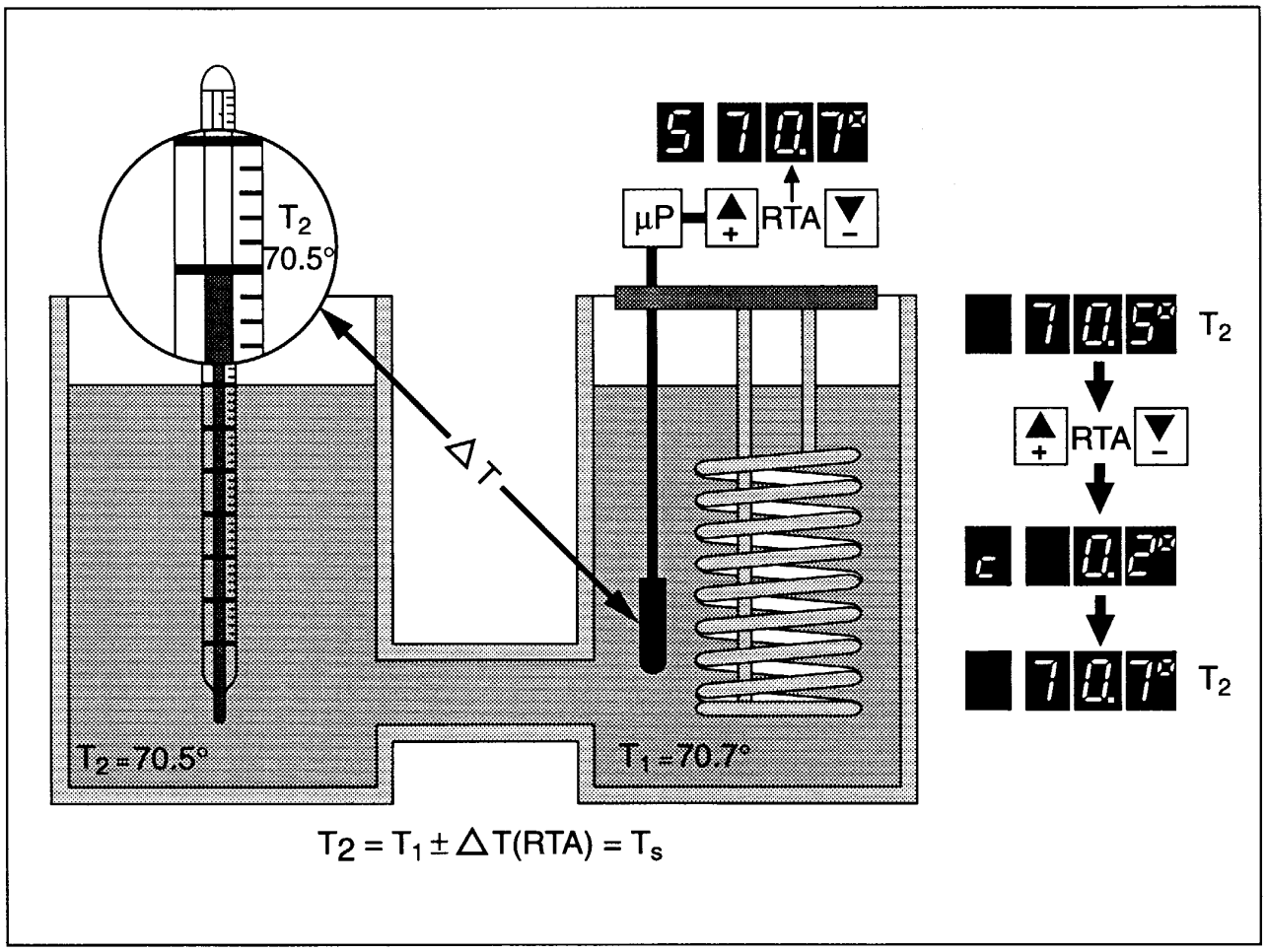
☞ **The new value is not saved until the Enter key has been pressed. The circulator continues to use the old value.**
Warning: **The correction factor "c" may have to be determined again if the set temperature is altered!**

The display **6** automatically switches back to actual temperature display after a short time.

After the Enter key **8** has been depressed, the correction value c (like the set value) remains stored even in case of a power failure.

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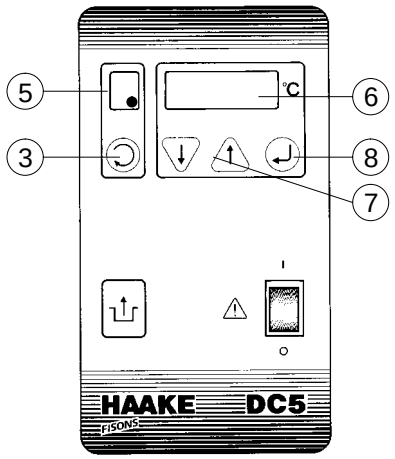
Example:



Set value programmed at the circulator	T_{set} =	70.7°C
Actual temperature in bath / system	T_{act} =	70.5°C
⇒ Deviation, calculated according to $\Delta T = T_{set} - T_{act}$	ΔT =	0.2°C
⇒ Entry of the corrected value ΔT as correction factor "c"	c =	+0.2°C

The temperature control is thus internally altered so that the desired 70.7°C is also attained in the external system. The temperature displayed at the circulator and that of the external system now correspond with each other.

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13.7 Temperature limitation H

The setting range of the operating temperature of the circulator can be limited if the application or the flash point of the selected heat transfer liquid requires this.

! This is not a safety element but merely an aid to help avoid user faults when operating the unit. The excess temperature protection must be set separately.

Setting the set value limitation can only be carried out via the keyboard and not via the RS232C interface. Only set values that correspond to S < H can be entered.

Temperature limitation:

1. Press the key **3**, until " H " is shown at the display **5**.
2. Alter the value shown on the display **6** using the keys **7** (↑) or (↓). Setting is possible with a resolution of 1°C. and only with positive values.
3. Press the Enter key **8**.
   ⇒ The selected value is confirmed as new limit value.

The new value is not saved until the Enter key has been pressed. The circulator continues to use the old value.

The display **6** automatically switches back to actual temperature display after a short time.

13.7.1 Subsequently altering the temperature limitation H

When subsequently altering the set value limitation H to a value below that of the already preset temperature set value S, the set value S is automatically reduced to S = H and saved permanently with H .

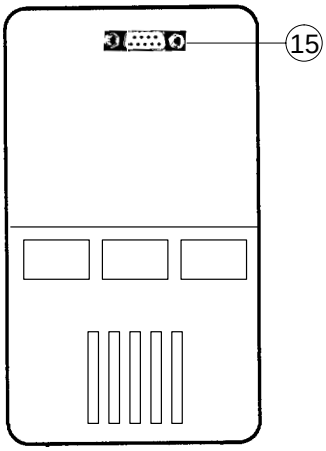
An alteration of H to a value > S does not alter the set value S .

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13.8 Cooling

The refrigerated bath enables temperature controlling in the circulator's own bath below ambient or tap water temperature or to rapidly lower the temperature of a heated bath to a lower level.

The attainable working temperature range is detailed in the technical specifications.



13.9 RS232C Interface

The DC5-K75 is equipped with an RS232C interface **15**.

For applications and commands see chapter 17.

13.10 The display cannot be altered

It can happen that the microprocessor 'freezes' under certain unfavorable external conditions e.g. mains voltage surges or electro-magnetic disturbances. In this state it no longer reacts to further entries and displays a random value as the set value (e.g. -90°C) which cannot be altered.

The unit can be rendered operable again by a simple **RESET** as follows:

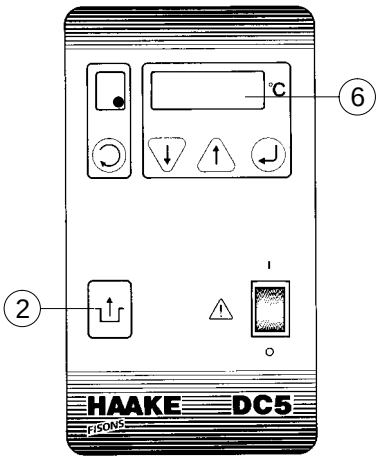
1. Switch the unit off at the mains switch.
2. Keep the keys ▽ and △ simultaneously depressed whilst you switch the unit back on again.

   Release the keys as soon as you see the word P rESEt shown on the display.

The microprocessor is now reset to its basic default settings.

! ALL other parameters must now be entered again.

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14. Excess Temperature Protection

If one of the safety devices is triggered:

- The fault cause is shown in the display **6** (see also chapter 15).
- An acoustic signal is sounded
- all voltage conducting unit components (the heating element and pump motor) are switched off immediately i.e. the safety circuit transfers the unit to a stable, safe condition.

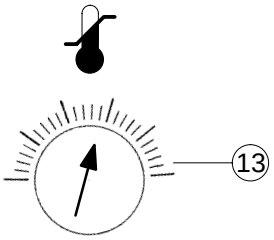
☞ **The fault cause must be identified and remedied.**

After the fault has been eliminated the unit can be started again by pressing the Reset key **2**.

14.1 Excess temperature protection dial

It offers protection against dangers caused by an uncontrolled heating up of the heat transfer liquid above the desired set temperature.

The cut-off temperature is adjusted with the excess temperature setting dial **13**.

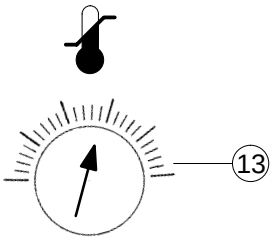


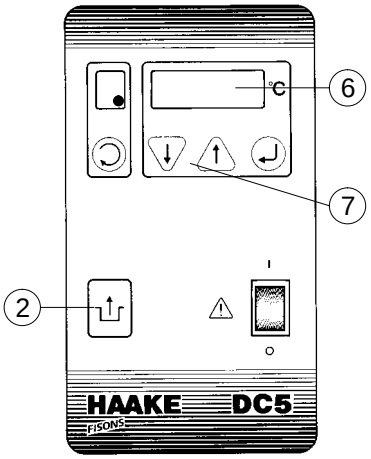
☞ **Proper protection can only be guaranteed if the cut-off point has been correctly set.**

There are two main aims for correct setting:

- **Safety (primary importance):**
  Protection against ignition of the heat transfer liquid. The cut-off point must be set at least 25°C **below** the flash point of the bath liquid used.
- **Protection of the object to be temperature controlled (secondary importance):**
  Additional protection, e.g. of a biological sample. The cut-off point should be set as close as possible to the desired temperature value.

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14.1.1 Setting the excess temperature

The cut-off point is set with the excess temperature dial **13** with a rough scale of temperature values arranged around it. This scale, of course, can only serve as an approximate setting means for this cut-off point. However, the cut-off point can be determined to act exactly if the following procedure is adhered to:

If for instance a bath liquid has a flash point of 60°C the unit should cut off after reaching 35°C at the latest:

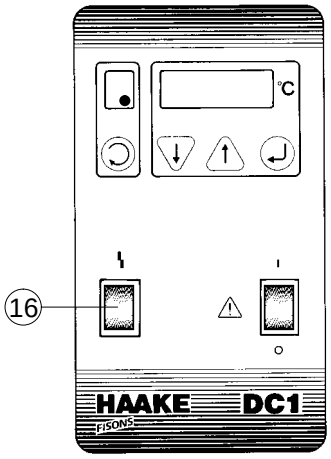
1. First set the desired set value " " using keys **7** (↑) or **8** (↓) to exactly 35°C.
2. After the circulator has reached this temperature, turn the excess temperature dial **13** backwards very slowly (to the left) until the unit cuts off (acoustic signal, fault shown at display **6**).
3. Then set the set temperature to the actual temperature (< 35°C).
4. Reset the unit via the Reset key **2** after the heat transfer liquid has cooled down somewhat.

   ⇒ The unit can now be used for temperatures below 35°C. As soon as 35°C is reached, it is securely switched off.

14.1.2 Testing the cut-off point

Set the set temperature to a higher value than 35°C, set the unit to heat up and watch the digital display or thermometer. The value indicated when the alarm goes off is the real cut-off temperature. The reaching of the cut-off point is indicated at the display by the following message:

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15. Fault Displays

An acoustic signal is sounded and "E1 xx" is shown on display **6.**.
The heating element and pump are completely switched off.

The following faults are possible:

E1 OT	=	Excess temperature
E1 -n	=	Low liquid level
E1 -P	=	Pump or motor overloading
E1 -F	=	Sensor breakage or short circuit
E1 -r	=	Undefined fault
0 Err	=	Range exceeded
5 Err	=	Parity fault

15.1 Excess temperature

E1 OT

The excess temperature protection can be triggered if:

- Excess temperature has been set too closely to the desired working temperature
  ⇒ increase value slightly according to specifications made in chapter 14.1.1.
- the control function is defective
  ⇒ Return unit for servicing.

15.2 Low liquid level

E1 -n

The low liquid level protection can be triggered if:

- there is not enough liquid in the bath
  ⇒ check for leaks, top up if necessary,
  ⇒ fluid has evaporated, top up if necessary.

15.3 Pump or motor overloading

E1 -P

The motor or pump is blocked:

⇒ It can take 10 min or longer, until the motor temperature has sunk far enough so that the unit can be switched on again by pressing the reset key **2**. If the circulator switches off again after a short time, return the unit for servicing!

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15.4 Sensor breakage or short circuit

The sensor must be exchanged by qualified service personnel. Please return unit for repairs.

15.5 Undefined fault

This can be caused by fault which only occurs for a short period of time, i.e. with a fluctuating bath level when the filling level is very close to minimum.

Before returning the unit, top up with heat transfer liquid. This fault can often be remedied in this way!

In all other cases this unit must be checked by qualified service personnel.

15.6 Range exceeded

The set value and high limit value are cyclically checked for their validity. The fault message **"**B Err**"** is shown on the display in case of the range being exceeded. The heating is switched off.

⇒ Switch the unit off and start it up again according to the instructions detailed in chapter 13.10.

⇒ Return the unit for repairs in case of repeated faults.

15.7 Parity fault

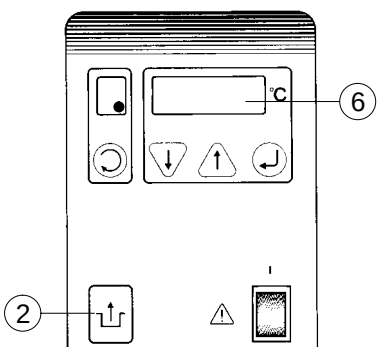
All data is saved together with a corresponding parity bit in the permanent storage (SRAM). When this data is accessed, the respective parity bit is checked. In case of a parity fault the fault display **"**S Err**"** is shown on the display. The heating then shuts itself down.

⇒ Switch the unit off and start it up again according to the instructions detailed in chapter 13.10.

⇒ Return the unit for repairs in case of repeated faults.

15.8 External fault

The DC5 can be switched to fault status via the RS232C interface. In this case see chapter 17.6 (command "ER").



15.9 Fault eliminated?

After the fault has been eliminated, the cause of the fault is shown on the display **6** (e.g. 000 E). The preceding three zeros mean that the fault has been eliminated

The reset key **2** must be pressed in order to start up the unit again.

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16. Testing the Safety Features

The safety features for excess temperature protection and low liquid level protection must be checked at regular intervals. The level of regularity of checking depends on the unit's designated application and the heat transfer liquid used (inflammable or non-inflammable). Practical experience has shown that between 6 to 12 times a year is sufficient.

16.1 Excess temperature protection

Set a cut-off temperature (see chapter 14.1) that is lower than the desired set temperature. Switch on the circulator and check if the circulator really does switch itself off at the set cut-off temperature
If not follow the specifications detailed in chapter 14.1.1.

It may be deemed necessary to have the unit checked over by qualified service personnel.

16.2 Low liquid level protection

Drain the heat transfer liquid **slowly** during operation (use a drainage tap if necessary) and check if the unit really does switch itself off (see chapter 11).
If not the unit must be checked over by qualified service personnel.

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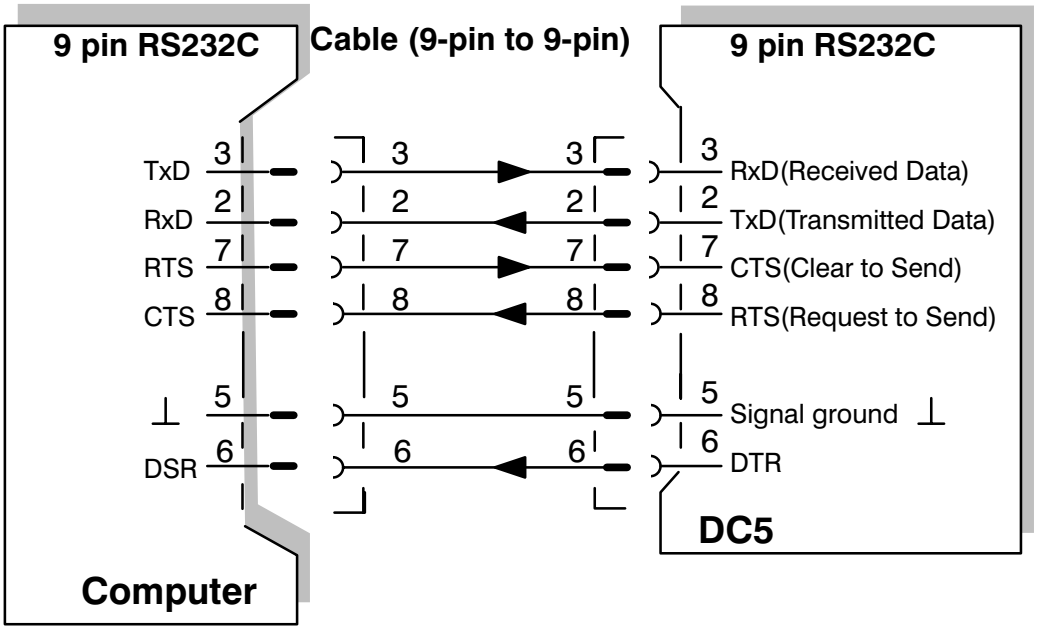
17. RS232C Interface for DC5

The following circulator functions can be controlled by a computer via the RS232C interface:

- Setting the desired set temperature “ ” and correction factor “ ” is possible;
- the actual temperature can be read off;
- the circulator can be reset, started or stopped;
- any fault messages can also be displayed.

17.1 Connecting the DC5 to a computer

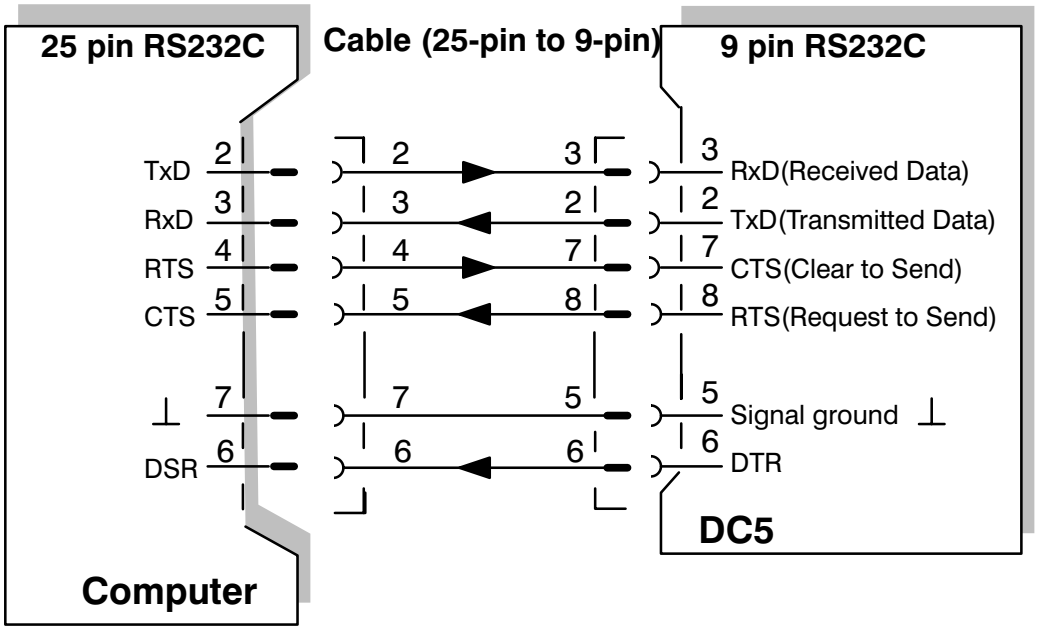
The pin assignment required when connecting a DC5 to a computer via a **9-pin** RS232C socket is as follows:



The pin assignment required when connecting a DC5 to a computer via a **25-pin** RS232C socket is shown overleaf.

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The pin assignment required when connecting a DC5 to a computer via a **25-pin** RS232C socket is as follows:



17.2 Interface parameters

Interface parameters can only be set/altered via the DC5 operating panel.

Baud rate (600, 1200, 2400, 4800, 9600)

Parität (OFF= without parity
odd = odd parity
E = even parity)

Handshake (OFF= without RTS/CTS
ON = with RTS/CTS)

These three transfer parameters cannot be altered via the interface.

DC5 maximum baud rate

We recommend a maximum Baud rate of **4800 bps.**

The communication between the PC and the DC5 circulator should take place at a maximum Baud rate of 4800 bps. Data transfer faults can occur at a Baud rate of 9600 bps.

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17.3 Requirements made of external units

☞ Only units which have been tested according to EN 60950 (=IEC 950) should be connected to the DC5 interface!

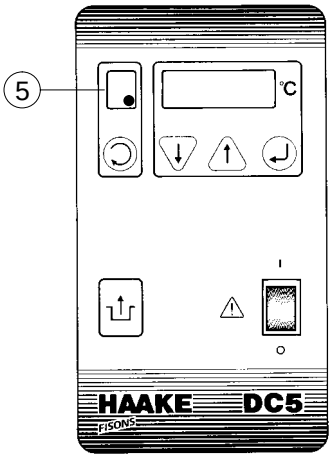
17.4 Setting the desired set value

If the desired value is set via the computer, two horizontal lines are shown on the display **5**.

Additionally:

a) If the RS232C connection is interrupted, the circulator controls the temperature to the last previously set temperature value.

b) After the mains supply current has been switched off and on, the circulator controls the temperature to the last value entered via the DC5 keyboard itself and not the value given by the computer



17.5 Correction value

If the correction value is set via the computer, two horizontal lines are shown on the display **5**. The correction value only remains saved for as long as the supply voltage is switched on

Additionally:

a) If the RS232C connection is interrupted, the circulator controls the temperature to the last previously set temperature value.

b) After the mains supply current has been switched off and on, the circulator controls the temperature to the last value entered via the DC5 keyboard itself and not the value given by the computer

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17.6 Commands for DC5 circulators

(Capital letters must not be ignored!)

V<cr> . . . . . current operating software version
e.g..: ”DC5 : 1.1–4/93$”

RS<cr> . . . . . RESET

Actual value

I<cr> . . . . . call up ACTUAL temperature:
<value> = <VZ>XXXX.XX␣C$<cr><lf>
e.g.: ”–0023.45␣C$” T = –23.45°C

Set value

S<cr> . . . . . call up SET temperature:
<value> = <VZ>XXXX.XX␣C$<cr><lf>
e.g.: ”+0023.45␣C$” ⇒ set = 23.45°C

S␣␣<value><cr> . . set SET temperature in 1/100°C, automatic switching to REMOTE operation as well as blocking the ENTER key
2 Spaces
<value> = {00000 .... 20000} ⇒ 0°C ... 200.00°C
<value> = {00000 .... –5000} ⇒ 0°C ... –50.00°C
e.g.: set = 20.0°C ⇒ ”S␣␣02000”
set = –10.5°C ⇒ ”S␣␣–1050”; VZ replaces 1. charac.

RTA Factor c

c<cr> . . . . . call up Offset: <value> = <VZ>XX.XX␣C$<cr><lf>
e.g.: ”–01.20␣C$” ⇒ c = –1.2°C

c␣<VZ><value><cr>
set Offset in 1/100°C, automatic switching to REMOTE operation as well as blocking the ENTER key
<VZ> = {+, –};
<value> = {0000 .... +/–0255} ⇒ 0°C ... +/–2.55°C
”<Space>” and ”+” are possible as positive sign,
e.g.: c = 1.23°C ⇒ ”c␣␣0123”
or ”c␣+0123”

Start and stand-by operation

ST<cr> . . . . . STOP control (heating off, pump continues)

GO<cr> . . . . . START control

Alarm triggering and unlocking via the V24 interface

ER<cr> . . . . . unlocking after switching on or after fault has been remedied

AL<cr> . . . . . external alarm triggering (main relay missing, i.e. heating and pump off)

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17.7 DC5 keys

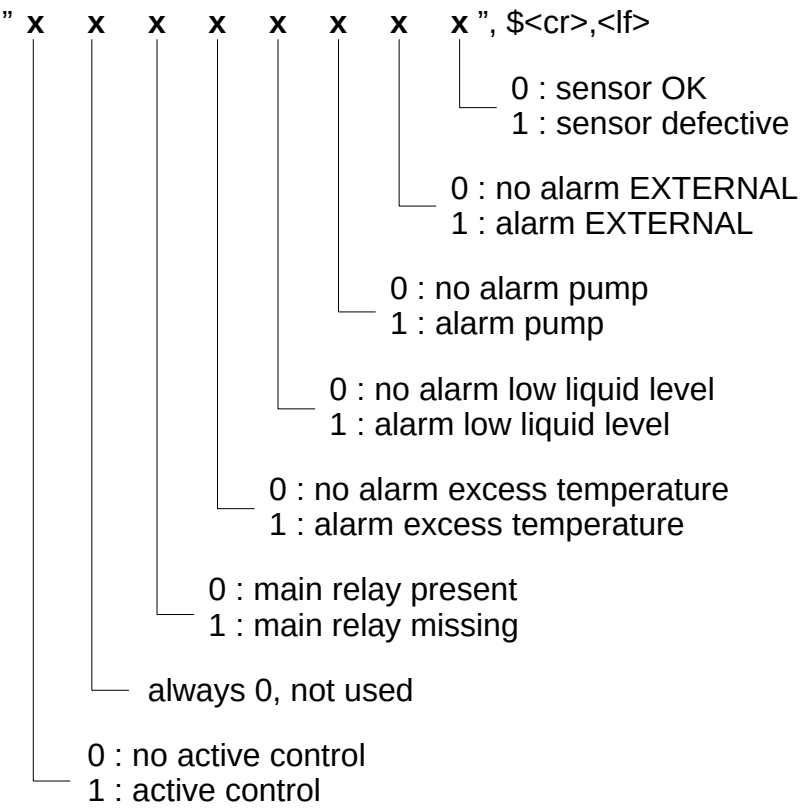
The Enter key on the DC5 can be blocked if the circulator is controlled via a PC. This prevents values set via the interface from being accidentally altered at the circulator. The key functions UP, DOWN and MENU remain available. Alterations can however no longer be confirmed with the Enter key.

L<cr> Switching to REMOTE operation as well as blocking the Enter key (Lock)

U<cr> Switching from REMOTE operation as well as releasing the Enter key (Unlock)

17.8 Operating status

B<cr> call up operating status:



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17.9 Example of a BASIC program

The range of commands stored in the DC5 can be activated by this simple program:

```
REM     command procedure for DC5
REM     enter 1st command
REM     2nd command is passed on to the DC5
CLOSE
OPEN   ”COM2:4800,N,8,1,CS0,DS0,CD0” AS #1

loop:
        b$ = ” ”
        INPUT ”command: ”;b$
        if b$ = ”X” then markend
        if b$ = ”x” then markend
repeat command:
        PRINT #1,b$
        PRINT
        PRINT ”return message”
        PRINT ”– – – – – – – –”

GOSUB enter

GOTO loop

markend:
END

enter:
        A$ = ” ”
read loop:
        X = ASC (INPUT$(1,#1))
        IF X = 10 THEN read end
        A$ = A$ + CHR$(X)
        GOTO read loop
read end:
        print a$
        RETURN
```

Note:
Only capital letters are accepted for commands!

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18. Maintenance

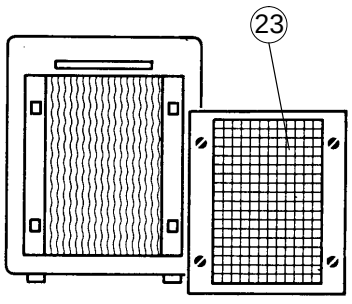
The stainless steel surfaces of the bath vessel and of the housing may after some time show spots and become tarnished. Normal stainless steel cleaners as they are used in the kitchen can be used. The bath vessel and built-in components should occasionally (at least every time the bath liquid is changed) be cleaned using a household cleaner. Vinegar-based cleaners have proved to be suitable used according to the manufacturers recommendations.

☞ **Do not use scouring powder!**

The inside of the bath vessel must be kept clean in order to ensure a long service life. Substances containing acidic or alkaline substances and metal shavings should be removed quickly as they could harm the surfaces causing corrosion. If corrosion (e.g. small rust marks) should occur in spite of this, cleaning with stainless steel caustic agents has proved to be suitable. These substances should be applied according to the manufacturers recommendations.

18.1 Cleaning the fins of the liquefier

In order to maintain the cooling capacity of the unit, cleaning has to be done two to four times per year, depending on the grade of soiling.



1. Loosen ventilation grid **23**: Rotate the mounting screws 90° in any direction and remove grid.
2. Clean fins with brush or similar tool.
3. Replace grid and push screws back in (do not rotate screws).

18.2 Discarding the unit

One day the life span of your cooling unit will end. Therefore:

! This unit contains ozone-friendly coolants R404A and R23. The unit may however only be discarded by authorized personnel.

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19. Technical Specifications

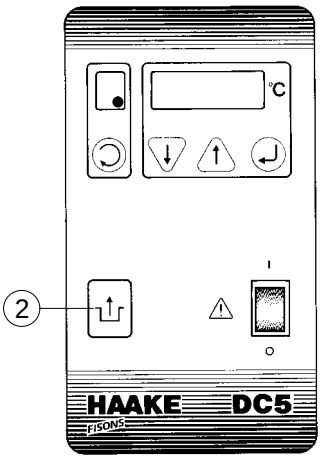
Technical specs. acc. to DIN 58966		DC5-K75
Working temperature range	°C	–75..100
Temperature accuracy	± K	0.1
Heating capacity	W	1000
Cooling cap. at 20°C at –10°C at –40°C at –60°C	W W W W	250 200 100 50
Compressor cooling		air
Refrigerant		R404A / R23
Pump: Pressure max. Flow rate max.	mbar l/min	320 12.5
Safety class (DIN12879)		2
Bath opening (WxL)	mm	130x100
Bath depth (T)	mm	200
Bath volume max.	l	6
Dimensions (WxT)	mm	380x460
Unit height (H)	mm	720
Weight	kg	65
Permissible ambient temp.	°C	10..40
Total wattage max.	VA	3450
Order no. for 230 V/50-60 Hz		**400-5751**

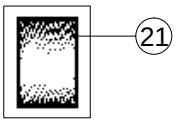
19.1 Fuse values

Unit type	Mains voltage	Fuse(s) at the rear panel	Fuse(s) in the unit
DC5	230V	2x6 A	1xT40 mA
	115V	1x15 A	1xT63 mA
	100V	1x12 A	1xT63 mA
K75	230V/50Hz	2x6 A/2x10 A	1xT630 mA
	200V/50–60Hz	2x6 A/2x10 A	1xT630 mA

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Supplement to the chapter ”Operation”





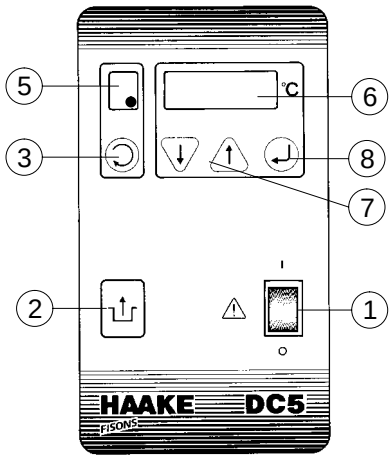
The cooling unit is switched-on separately with its own mains switch **21** . Switch on the cooling unit only when cooling is actually required. The compressor starts with a slight jerk.

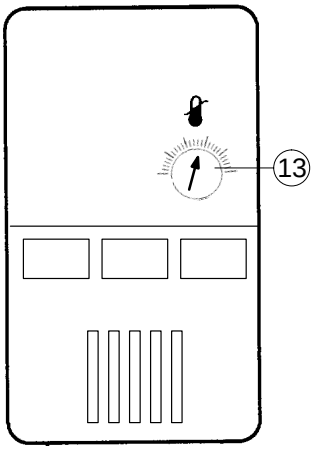
! If the DC5-K75 was already in operation before, please switch on the unit only after the refrigeration section has been switched off for at least 60 minutes. If switch on is attempted earlier, the compressor will try to start several times but without success. This could lead to burn-out of the compressor motor windings.

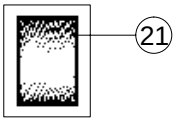
The second compressor of the K75 is always switched on automatically after a delay of 30 seconds.
This delay is for protection of the compressor.

! When the unit is started under unfavourable environmental conditions, the pressostat safety device may respond after about 1 minute. If this happens, please press the reset button 2 **. Usually the unit will then start correctly without going into fault status again. However, if fault status appears several times in succession, the unit is defective and must be sent in for servicing.**

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20. Operating

20.1 Switching on

1 Set the excess temperature protection clearly above the desired operating temperature using the dial **13**.

2 Switch the circulator on at the mains switch **1**.
This causes:

⇒ The version number of the operating software is briefly shown at display **6**: e.g. “n 1.5”

⇒ Display **6** flashes over all segments 88888

3 Press the Reset key **2** (= start).

⇒ Display **6** shows the actual temperature at the control sensor (resolution 0.1°C).

⇒ Pump motor starts up – the heat transfer liquid starts to circulate.

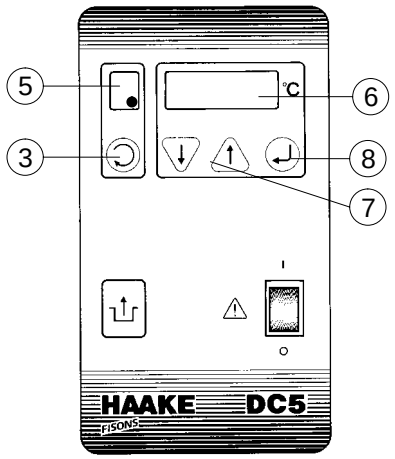
The cooling unit is switched on via its own mains switch **21**. Only activate cooling device if cooling is actually required. The compressor starts with a slight jerk.

20.2 Starting up again after a power failure

The temperature control module switches itself off in case of a power failure. Display **6** flashes over all segments 88888 Switching on again is only possible after the reset key **2** has been pressed. This is due to safety reasons.
The unit reacts in the same way if is switched on via a mains switch in the laboratory.

You can choose if you want to retain these standard default settings. The units can be switched to automatic resetting in both cases mentioned above. This is activated via a separate menu option which can be accessed by pressing the “menu”-key **3** whilst simultaneously switching on the unit.

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Keep pressing the key **3**, until…

oFF is shown in the display.
This is the default setting.

If you switch with key **7** (↑) to…

oFF and confirm this using the Enter key **8**, the DC5 will switch on again automatically from now on and resetting after the circulator is switched on is no longer necessary.
Please consider any possible resulting risks!

Please wait, until the display returns to showing the actual temperature and switch the circulator off. The standard menu appears after restarting the unit.

20.3 Displaying the software version

If a key is held depressed as the unit is switched on, the operating software version no. (e.g. 'n 1.5') is shown on the display until the key is released.

20.4 Setting the set temperature

1. Press the menu key **3** repeatedly until "SP" (for set value) is shown on the small display **5**.
2. Increase (↑) or decrease (↓) the value shown on the display **6** via the keys **7**.
   If you keep one of the keys **7** depressed, the first degree of temperature alteration is shown slowly in tenths of a degree. After this the temperature alteration rate accelerates to five times quicker.
3. Press the Enter key **8**.
   ⇒ The selected value is confirmed as the new set value.

☞ **The new value is not saved until the Enter key has been pressed. The circulator continues to use the old set value.**
Warning: **The correction factor "c" may have to be determined again if the set temperature is altered! (see chapter 13.6)!**

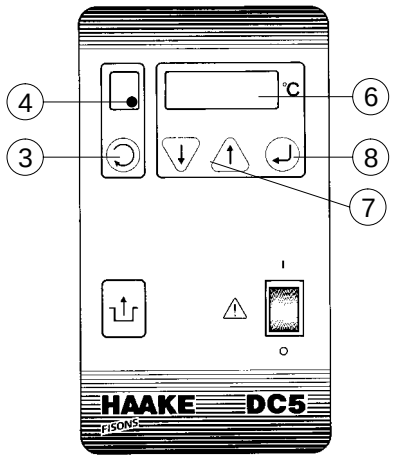
If the symbols SP and W in the display **5** flash alternately, then SP = W
Go to chapter 13.7.

The display **6** automatically switches back to actual temperature display after a short time.

After the Enter key **8** has been depressed, the set value remains stored even in case of a power failure.

☞ **If it is not possible to set the desired temperature due to a fault (display "E_ xx"), please read chapter 15.**

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20.5 Heating control lamp

The display **4** lights up when the heating is switched on (set temperature is higher than the current temperature).

⇒ display **4** lights up constantly during the heating up phase,

⇒ display **4** flashes on and off during the control phase.

The display **4** does not light up if the heating is not activated (set temperature is lower than the current temperature).

20.6 Displaying the actual temperature

Display **6** shows the actual temperature at the control sensor with a resolution of 0.1°C.

This temperature does not correspond directly to the temperature in the circulator's bath and even less to the temperature in the external connected system.

The temperature difference is determined by measuring the actual current temperature using a suitable measuring device (calibrated or gauged thermometer).
It is entered into the circulator as the correction factor " c " (RTA system) and remains stored there.

The resolution of the correction factor " c " according to the RTA system is 0.01°C. Possible change ± 2,5°C.

Entry (see example overleaf):

1 Press the key **3**, until " c " is shown on the small display **5**.

2 Alter the value shown on the display **6** using the keys **7** (↑) or (↓)

3 Press the Enter key **8**.

⇒ The selected value is confirmed as the new correction factor.

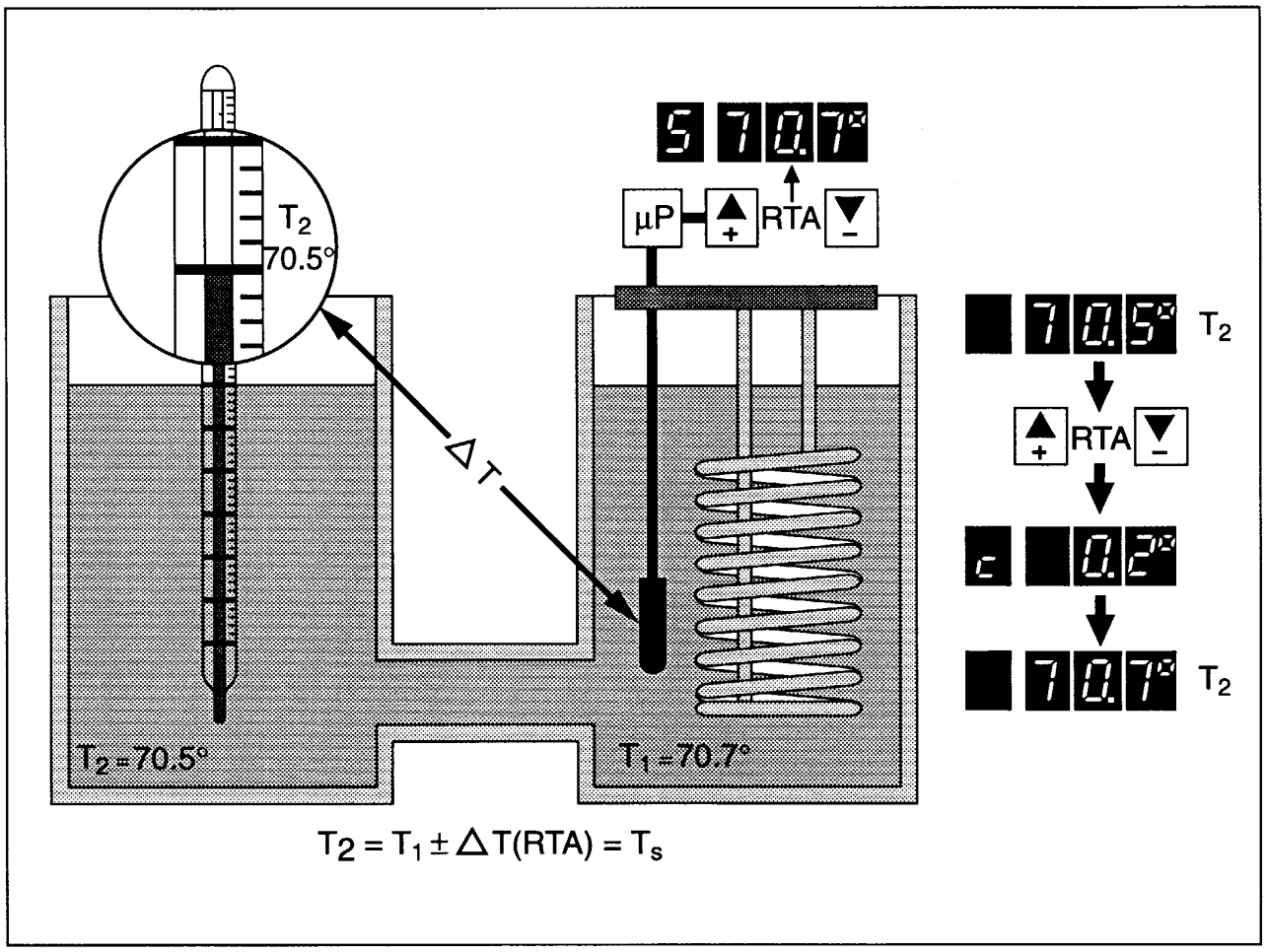
☞ **The new value is not saved until the Enter key has been pressed. The circulator continues to use the old value.**
Warning: **The correction factor "c" may have to be determined again if the set temperature is altered!**

The display **6** automatically switches back to actual temperature display after a short time.

After the Enter key **8** has been depressed, the correction value c (like the set value) remains stored even in case of a power failure.

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Example:



Set value programmed at the circulator T_{set} = 70.7°C

Actual temperature in bath / system T_{act} = 70.5°C

⇒ Deviation, calculated according to $\Delta T = T_{set} - T_{act}$

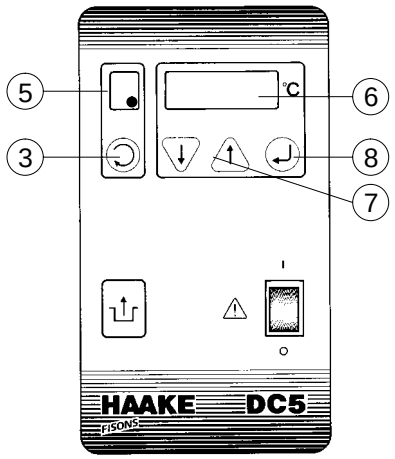
ΔT = 0.2°C

⇒ Entry of the corrected value ΔT as correction factor "c"

c = +0.2°C

The temperature control is thus internally altered so that the desired 70.7°C is also attained in the external system. The temperature displayed at the circulator and that of the external system now correspond with each other.

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20.7 Temperature limitation H

The setting range of the operating temperature of the circulator can be limited if the application or the flash point of the selected heat transfer liquid requires this.

! This is not a safety element but merely an aid to help avoid user faults when operating the unit. The excess temperature protection must be set separately.

Setting the set value limitation can only be carried out via the keyboard and not via the RS232C interface. Only set values that correspond to S < H can be entered.

Temperature limitation:

1. Press the key **3**, until " H " is shown at the display **5**.
2. Alter the value shown on the display **6** using the keys **7** (↑) or (↓). Setting is possible with a resolution of 1°C. and only with positive values.
3. Press the Enter key **8**.
   ⇒ The selected value is confirmed as new limit value.

The new value is not saved until the Enter key has been pressed. The circulator continues to use the old value.

The display **6** automatically switches back to actual temperature display after a short time.

20.7.1 Subsequently altering the temperature limitation H

When subsequently altering the set value limitation H to a value below that of the already preset temperature set value S, the set value S is automatically reduced to S = H and saved permanently with H .

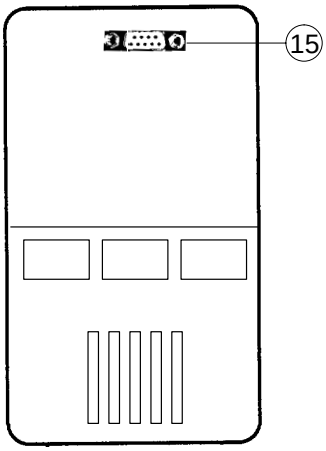
An alteration of H to a value > S does not alter the set value S .

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20.8 Cooling

The refrigerated bath enables temperature controlling in the circulator's own bath below ambient or tap water temperature or to rapidly lower the temperature of a heated bath to a lower level.

The attainable working temperature range is detailed in the technical specifications.



20.9 RS232C Interface

The DC5-K75 is equipped with an RS232C interface **15**.

For applications and commands see chapter 17.

20.10 The display cannot be altered

It can happen that the microprocessor 'freezes' under certain unfavorable external conditions e.g. mains voltage surges or electro-magnetic disturbances. In this state it no longer reacts to further entries and displays a random value as the set value (e.g. -90°C) which cannot be altered.

The unit can be rendered operable again by a simple **RESET** as follows:

1. Switch the unit off at the mains switch.
2. Keep the keys ▽ and △ simultaneously depressed whilst you switch the unit back on again.

   Release the keys as soon as you see the word P CODE shown on the display.

The microprocessor is now reset to its basic default settings.

! ALL other parameters must now be entered again.

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