

# FERROVAC

ULTRA HIGH VACUUM TECHNOLOGY

## Liquid nitrogen UHV Booster and Fast Pump Down Dock CTH40/CTDH40/VSCT40

Operation Manual

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*Revision C [June, 2023]*

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It is the sole responsibility of all users to carefully read the operating instructions and keep them safe. Read and follow all safety instructions carefully before using the product described in this document. Ferrovac declines any and all responsibility and liability for any damage/injuries resulting from incorrect use/adjusting/controlling or programming of the product.

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**Warranty limitations**

The warranty for this product does not apply to defects resulting from the following:

- Non-observance of operational- and safety instructions
- Natural wear of components
- Consumables
- Modifications to our products without our written consent
- Misuse of any product or part of the product

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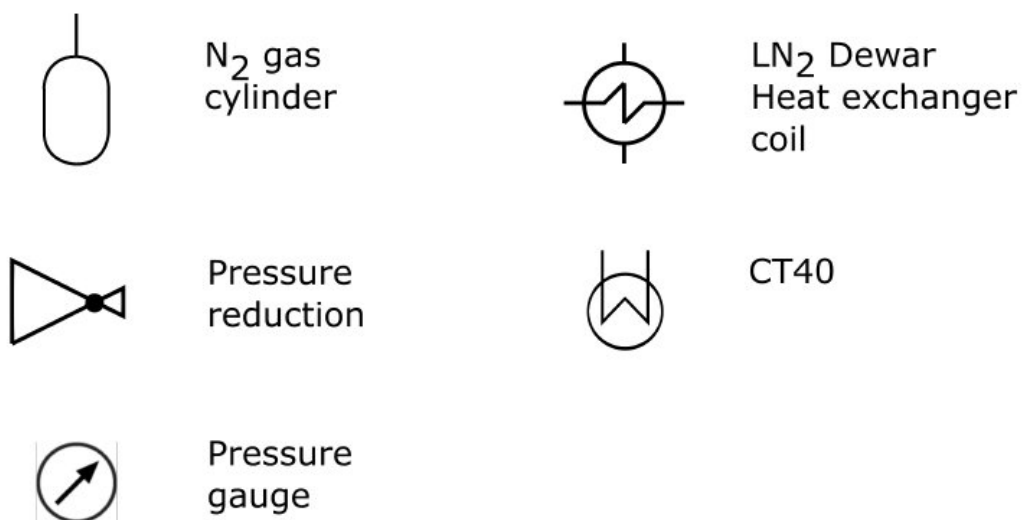
## Terms and Symbols

The information in this document represents the state of the product at the date of print. Technical changes may be made without notice. Ferrovac AG makes no warranties or representations with respect to accuracy or completeness of the contents of this publication. Figures and photos are not binding. The product names used are for identification purposes and may be trademarks of their respective companies.

| Symbol   | Meaning   |
|--|---|
|   | A triangle with exclamation mark indicates a passage in the manual with information that is crucial for the operator. READ THESE PARAGRAPHS CARE-FULLY or the product might be damaged by misuse.   |
|   | A triangle with a snow flake indicates a passage in the manual with information that is crucial for the operator with respect to cryo cooling and handling cryogenic liquids. READ THESE PARAGRAPHS CAREFULLY in order to protect the operator from any injury. |
|  | A triangle with a gas bottle indicates a passage in the manual with information that is crucial for the operator with respect to laboratory gases under pressure. READ THESE PARAGRAPHS CAREFULLY in order to protect the operator from any injury.             |

**WARNING!** The WARNING heading in a manual explains dangers that may result in personal injury or death. Always read the associated information very carefully.

**CAUTION!** The CAUTION heading in a manual explains hazardous situations that could damage the product. Such damage may invalidate warranty.



**Figure 1** : Symbols used in the drawings.

## General Information

This manual covers all important information about installation, commissioning and operation of your CTH40/CTDH40/VSCT40. It also provides essential safety information, maintenance- and fault finding procedures.

The product described was manufactured in accordance with the applicable national standards and guidelines. The information in this document represents the state of the product at the date of print. Technical changes may be made without notice. Ferrovac makes no warranties or representations with respect to accuracy or completeness of the contents of this publication. Figures and photos are not binding. The product names used are for identification purposes and may be trademarks of their respective companies.

## Designated Use

The product described in this document may only be used for its designated application. Designated use of the product is defined by the following rules:

The product is:

- Used with original cable sets supplied by Ferrovac which are explicitly specified for the use with the product described in this publication.
- Used in an indoor research laboratory environment or an industrial production or processing facility.
- Operated by personnel qualified for operation of delicate scientific equipment.
- Used in accordance with all related manuals.



### **Important!**

Carefully read all safety instructions and relevant manuals before using the product and any related equipment!

## Non Designated Use

**Non-designated use is defined if any of the following are true:**

- The product is used with other equipment not explicitly acknowledged by Ferrovac in writing.
- The product is used outdoors or at ambient conditions exceeding the values given in the product specification.
- The product is used by non-qualified persons.
- Operation of the product in disregard of the safety instructions.
- Operation of the product with disabled, modified, removed or damaged safety equipment and devices.

## General safety Information

Read the safety instructions very carefully. All safety precautions must be strictly observed at all times while using the product described in this manual and any associated instrumentation.

**Study this document** to learn how to operate your product correctly. Keep this instruction manual in a safe place close to the described product and inform all other users of the manual's location. Always include this manual when handing the product over to third party persons.

**Responsible body** is the individual or group of persons that are responsible for the proper use and maintenance of the product, ensuring that the product is operated within its specifications and operating limits. The responsible body must ensure that users of the product are adequately trained.

**Operators** use the product for its intended purpose. Users must be trained in electrical safety, handling of cryogenic liquids and adequate use of the instrument. They must be protected from electric shock and other potentially dangerous situations.

**Maintenance Personnel** perform routine tasks on the product to keep it in proper operating conditions, i.e. setting up the line voltage or replacing consumables. Maintenance procedures described in this manual must be followed.

**Service Personnel** are trained to work on live circuits and to work cryogenic liquids as well as perform fault finding measurements and repair work to the product. Only fully trained service personnel qualified to handle potentially lethal voltages may perform servicing and repair.

**Shock hazard:** The American National Standards Institute states that a shock hazard exists when voltage levels are greater than 30 V RMS, 42.2 V peak or 60 VDC. A good safety practice is to assume that hazardous voltages are present in any unknown circuitry.



**Warning!**

Always check for correct mains voltage before connecting any equipment!  
Mains supply voltage fluctuation must not exceed  $\pm 10\%$  of the nominal voltage.



**Warning!**

- Always observe and strictly follow the safety notes and regulations given in this document
- Always use the originally delivered cables with the product for all electrical connections.
- Always switch off the device before disconnecting cables.
- Never operate the device outside its dedicated environment.
- DO NOT OPEN the device unless you fulfill the requirements of a fully trained service personnel and you are familiar with live circuits and potentially lethal voltages.



**Important! Ambient conditions and environment:**

This product is only to be used indoors, in locations meeting the following requirements:

- Room temperature lies between 5°C/41°F and 40°C/104°F
- Humidity up to maximum of 80%
- Altitudes up to 2000m
- Pollution Degree 2 environments



## Technical Specifications

### CTH40

- Flange type: DN40CF
- Heat exchanger: Aluminum cooling blocks
- Core : OFHC (Copper), stainless steel
- Heating wire: Kanthal  $\varnothing$  0.3 mm
- Max. HEATING current: 4.0 A
- Cryogenic liquids: Liquid nitrogen only
- Maximum allowed inlet pressure: 2.5 bar
- Temperature sensor type: Pt100
- Temperature range sensor: -200°C – 170°C
- Maximum heating/baking temperature: +150°C

### Miniature feedthrough

- Pins: 6 ×  $\varnothing$  1.6 mm
- Test voltage: 500 V DC
- Max. voltage for device usage: 49 V
- Max. current: 5 A

### CTDH40

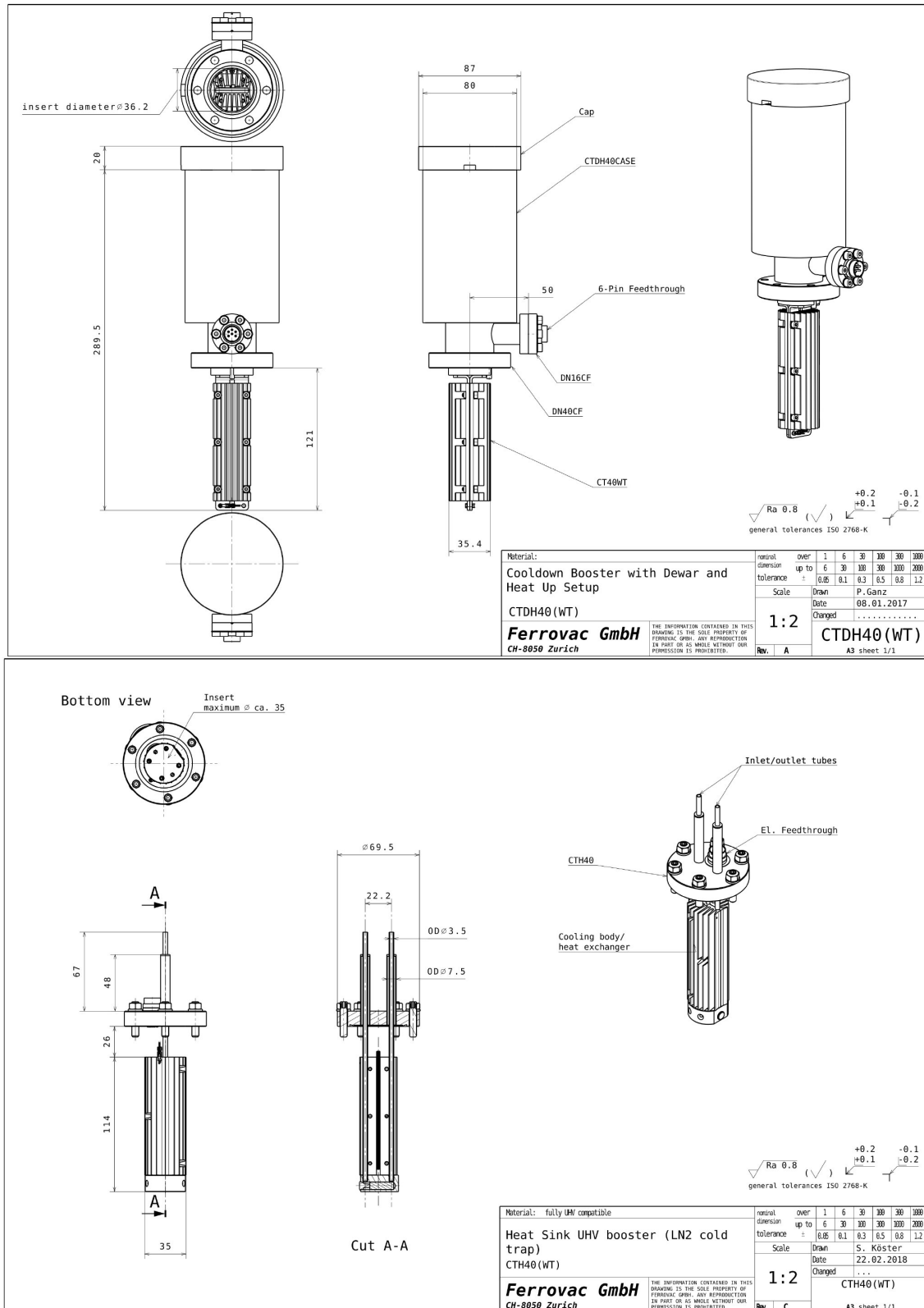
- Flange type: DN40CF
- Heat exchanger: Aluminum cooling blocks
- Core : OFHC (Copper), stainless steel
- Heating wire: Kantal  $\varnothing$  0.3 mm
- Max. heating current: 4.0 A
- Cryogenic liquids: Liquid nitrogen only
- Maximum allowed inlet pressure: 2.5 bar
- Temperature sensor type: Pt100
- Temperature range sensor: -200°C – 170°C
- Maximum heating/baking temperature: +150°C

### Miniature feedthrough

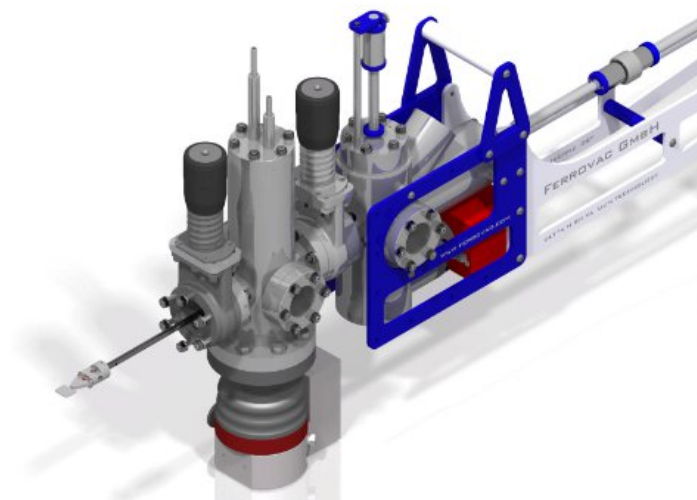
- Pins: 6 ×  $\varnothing$  1.6 mm
- Test voltage: 500 V DC
- Max. voltage for device usage: 49 V
- Max. current: 5 A
- Flange type: DN16CF

### VSCT40

- Maximum bakeout temperature: 150°C
- Leak rate:  $< 5 \times 10^{-10}$  mbar
- Maximum overpressure: 0.3 bar (windows)
- Tolerances for chamber:
- Machine parts: ISO 2768 -m -K
- Welded parts:  $\pm 1$  mm and  $\pm 1^\circ$



**Figure 2:** Overview / technical drawing of CTDH40/CTH40 with their components. All measures are in mm. The original drawings can be downloaded from our homepage in the category UHV suitcase accessories.



**Figure 3:** Example for usage of the VSCT40 with cold trap and our NexGeneration UHV suitcase.

## 1 Introduction

The **CTH40** and **CTDH40** are UHV boosters intended to be used with a small transfer chamber (for example as our fast pump down dock VSCT40, Fig. 3). They enable an exceptionally fast transfer of samples from a portable UHV-suitcase (e.g. VSN40S) into the UHV-System. Vacuum in the transfer chamber is created using a turbo pumping system while the UHV boosters act as additional **cryogenic pump**. Thus a sufficient vacuum is established within approximately 30 minutes, as opposed to many hours when pumping the buffer volume conventionally. On top the water partial pressure will be reduced. For a fast warm-up, the **CTH40** and **CTDH40** can be heated via a tungsten filament while the temperature can be monitored via a Pt100 temperature sensor. The **CTH40** and **CTDH40** can be ordered as stand-alone products or together with a chamber and valve, the **VSCT40**. The turbo pumping system and cool-down equipment are not part of the product. Configured cables can be ordered separately or as a kit with a small power supply.

## 2 Unpacking and inspection

Before unpacking, inspect the parcel for any visible damage. If any evidence for damage of the package is found, take pictures of the parcel and send them to Ferrovac AG immediately. Compare the contents of the package with the delivery note. Any damage or missing items must be reported to Ferrovac within 48 hours after delivery. Prepare a very clean workspace. Carefully unpack the CTH40 and perform a visual check for any damage of the package, its contents and accessories. Only touch the vacuum side parts of the CTH40 with clean, powder-free gloves. The CTH40 and CTDH40 are shipped fully assembled as one piece and cleaned, see Fig. 4. Compare the contents of the package with the delivery note any damage or missing items must be reported to Ferrovac AG within 48 hours after delivery.

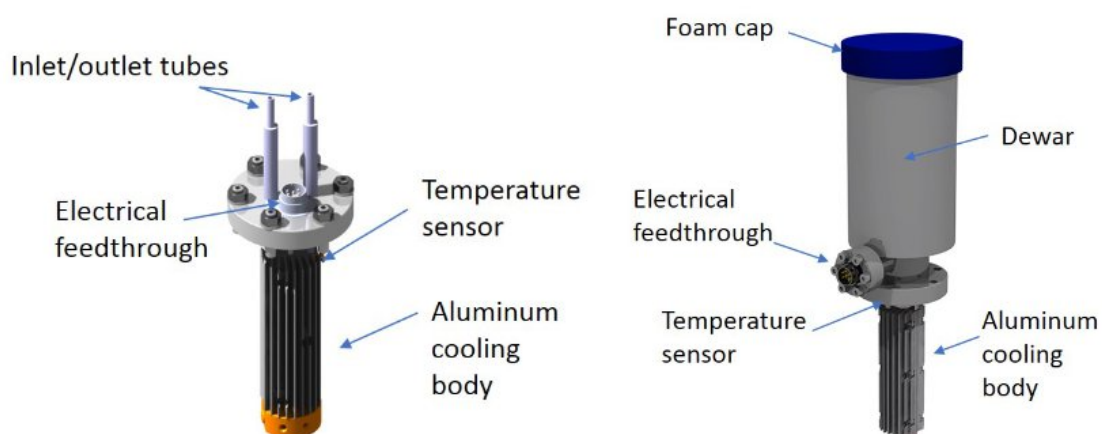


Figure 4: Overview of the CTH40 (left) and CTDH40 (right) with their components.

**The package should contain for CTH40:**

- The fully assembled CTH40
- This manual
- Optional: Cabling
- Optional: Subsequent manuals (if applicable e.g. for a kit)

**The package should contain for CTDH40:**

- The fully assembled CTDH40
- A blue foam cap
- This manual
- Optional: Cabling
- Optional: Subsequent manuals (if applicable e.g. for a kit)

**For VSCT40:**

- Fully assembled VSCT40 with gate valve (Optional without gate valve)
- This manual
- Optional: cabling
- Subsequent manuals (e.g. gate valve)

**CAUTION!**

- Please ensure enough working space on a clean table for unpacking and inspection, use powder-free examination gloves.
- Read this manual carefully before using the device.
- Never expose the body of the CTH40 to physical shocks or aggressive chemicals.
- Never hit the knife edge.

### 3 Overview and description

The **CTH40** and **CTDH40** are cooled down with liquid nitrogen ( $\text{LN}_2$ ) in order to cool the cryo pump body attached on the vacuum side. In case of the **CTH40** liquid nitrogen flows through the tube in which a porous material is placed in order to enhance the surface for cooling and slow down the flow within the tube. The **CTH40** can be connected to a liquid nitrogen supply via the tube fittings on top of it. It does not matter which tube is used as inlet or outlet. The liquid can be blown out by purging with dry nitrogen gas. The **CTDH40** has a dewar which is filled with liquid nitrogen to cool down a heat exchanger which is directly attached to it on the vacuum side. Both devices have a tungsten filament built-in which can be used for fast warm-up of the device. The temperature can be monitored by a Pt100 sensor attached inside. For the details of the procedures and handling read the respective chapters of this manual.

### 4 Setup and installation

Carefully unwrap the device and make sure not to hit the knife edges. All parts are shipped in a clean state, therefore use gloves for unpacking.

#### 4.1 Installation on a UHV chamber

Install the **CTH40/CTDH40** in a suitable chamber with sufficient space on a DN40CF flange with a Cu gasket. The available inner diameter should be at least 38 mm. (Some DN40CF flange tubes might be too small!) For optimized pumping speed it is advisable to use an oversized tube flange with e.g. about 64 mm inner diameter or the open space of a chamber. The **CTH40** can be installed with the tube openings in a vertical/up-right, horizontal or orientation in-between. The **CTD40** can only be installed in an up-right position! If the product was delivered together with a buffer chamber, the VSCT40, attach the chamber to your system via the CF40 flange with the valve (or free CF40 flange if no valve is attached). The bottom CF63 flange is meant for attachment of a turbo molecular pump (turbo pump). It could be necessary to add a mechanical support for the VSCT40 and its turbo pump installed. This has to be provided by the customer and adapted to the respective system.



Figure 5: Demonstration of mounting orientations for the CTDH40 and CTH40. The CTDH40 should only be mounted in the up-right orientation.

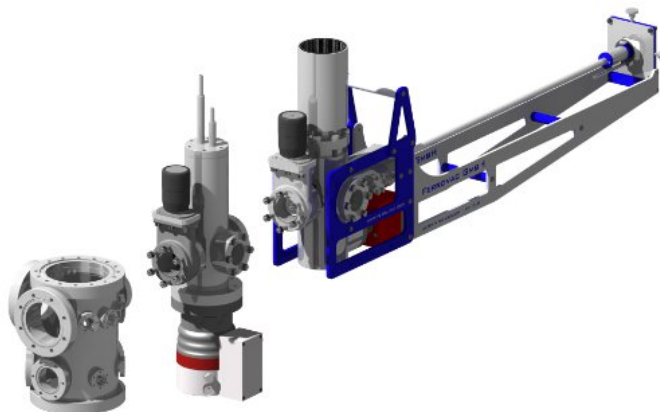


Figure 6: Schematic example for the usage of the VSCT40 with a chamber together with our NexGeneration UHV suitcase.  
(Be aware that the valve and short flanges of the VSCT40 have tapped holes.)



**CAUTION:**  
**CF knife edges are very sensitive!** Avoid using any sharp instrument in the vicinity of the knife edge. CF flanges must be handled by qualified personnel only!

## 4.2 Temperature measurement and heating

The CTH40 and CTDH40 have a Pt100 temperature sensor installed inside. For the wiring diagram please refer to Fig. 10 (and Fig. 11 if you have bought the respective cable).

Useful items:

- CABCTH40HTB4M, CABCTH40HT4M or your own cabling
- Multimeter
- Standard laboratory power supply for at least 48 W.
- Optional: temperature detection for a Pt100 sensor.

If using CABCTH40HTB4M or CABCTH40HT4M connect the 6-pin connector to the feed-through in the appropriate orientation.

The temperature measurement can be done as 4-wire or 2-wire measurement. The latter is usually enough, but less accurate. (A little margin should be taken into account for a 2-wire measurement.) For the 2-wire measurement just connect  $-V$  and  $+V$  to a multimeter. If using CABCTH40HTB4M or CABCTH40HT4M connect one black ( $-$ ) and one yellow ( $+$ ) banana plug to a multimeter for resistance measurement. Leave the other two disconnected without producing a short circuit. If a 4-wire measurement should be performed, a constant current of 1 mA is recommended. Connect  $-I$  and  $+I$  for the current and  $-V$  and  $+V$  for the voltage measurement. If using CABCTH40HTB4M or CABCTH40HT4M use one black ( $-$ ) and one yellow ( $+$ ) banana plug for the current and the other two for the voltage measurement. For resistance-temperature conversion refer to Fig. 12 or the respective data for Pt100 sensors from internet.

### CAUTION!



- Never let the temperature exceed  $+150^{\circ}\text{C}$ .
- Only use the heating coil when the device is under vacuum.
- Never apply a current of more than 4 A.
- Always monitor the temperature when using the heating.

Be aware: A current of 4 A can cause temperatures higher than  $+150^{\circ}\text{C}$  when the device is in warm state.

Be aware: Only the bakeable cable can be used for typical UHV bake-out, the other cable should not be used for temperatures higher than  $40^{\circ}\text{C}$ .

When using the heating coil, the device should be under vacuum! Before connecting, make sure that the output of the power supply is switched off. Connect the blue (-IF ) and red (+IF ) banana plug to a standard laboratory supply. A current of up to 4 A (about 12 V) can be applied to the heating coil. Further details for cool-down and warm-up will be described in the sections below. For available upgrades and options, see Sec. 11. A 4-wire measurement electronics is not available at the moment (and usually not necessary).

### **4.3 Installation for cool-down**

The responsible body is liable to take care of a proper cooling set-up and the respective safety measures. The installation of a gas handling and cooling system should only be done by trained service personnel. Please read section 6 and decide for an adequate set-up in your laboratory for installation on the system. In general a bake-out of the cryo trap is not necessary, the purpose of the cryo trap is to shorten transfer times including pump-down procedures. If the system should be baked (see Sec. 8.1) with the cryo trap installed, please make sure that any heat-sensitive material as plastics etc. can be removed and no overpressure would built up in the tube system.

## **5 Preparation for vacuum usage, venting**

This section describes the procedures for a potential initial bake-out and general vacuum usage. During normal operation no regular bake-out is needed. The cryo pump replaces this action to make the pump-down faster and more efficient.

### **5.1 Pump-down**

Close the valve and unused flanges or additional valves, depending on what is connected in your setup. Start the roughing pump and subsequently the turbo pumping. If used in warm condition, wait at least 90 min or longer before starting any transfer action of samples. The cooling can be started shortly after the turbo pumping had been started (not before). Please read section 6.

### **5.2 Venting**

Although the chamber will be opened to air in typical transfer situations, it is recommended to vent the chamber (and turbo pump) first with clean and dry nitrogen gas (N<sub>2</sub>). It'll help with faster pump down afterward, even when opened to air for a short time. The overpressure for the dry nitrogen should not exceed 250 mbar as the windows (VSCT40) are not meant to be exposed to large overpressure from inside the chamber compared to normal atmospheric pressure. They could start leaking.



## 6 Cool-down procedures

### 6.1 Cool-down of the dewar version CTDH40

For cool-down the dewar of the CTDH40 is filled with liquid nitrogen. (Only operators trained in handling cryogenic liquids are allowed to perform this task.) The dewar should only be filled up to 3 cm below its upper rim! Be careful to not spill large amounts of LN2 on sensitive parts in the environment (e.g. cabling and windows). When the dewar is filled, place the foam cap on top of the dewar.

### 6.2 Cool-down of the tube version CTH40

This section contains suggestions for step by step procedures to controlled cool down of the CTH40. The responsible body needs to provide a respective set-up including valves, hoses and connectors, liquid nitrogen (LN2), vessels and nitrogen gas (N2) cylinders. The set-up should be established by a trained service personnel. The responsible body is liable for the proper and secure set-up of the nitrogen filling system respecting the typical security measures for such systems.



**WARNING:**  
**Never close the exhaust line to prevent excessive pressure built-up!**

#### 6.2.1 Cool-down with a pressurized liquid nitrogen dewar

It is possible to use a liquid nitrogen vessel that is pressurized to pump liquid nitrogen through the CTH40.

Required equipment:

- Liquid nitrogen cylinder with pressurizing possibility, over pressure valve and venting valve
- Liquid nitrogen vessel for exhaust LN2
- At least 10 liters of liquid nitrogen (the amount of LN2 used depends on the period of time for which the CTH40 should be cold).
- Valves, connectors and hoses suitable for low temperature usage
- Hose insulation.

Connect the outlet of the liquid nitrogen cylinder to the inlet tube (long tube) of the CTH40. A proper insulation of the hose is recommended (e. g. standard foam insulation for tubes). Do not exert much force onto the tubes of the CTH40 while fixing the hoses. Connect another insulated hose to the outlet tube (short tube) and let the emerging liquid flow into a proper vessel that is big enough to hold about 5 liters of LN2. Make sure that the hoses are properly fixed and cannot jump off. Slowly open the valve of the liquid nitrogen cylinder and put the liquid nitrogen cylinder under small overpressure. First flush the system with some nitrogen gas and wait until the system and hoses start to cool down. Then slowly increase the pressure to let liquid nitrogen flow through the system. In general only 0.2-0.3 bar overpressure are sufficient to achieve a liquid nitrogen flow, depending on the cylinder and hoses used. The exhaust liquid should be safely collected in a vessel. Keep a steady flow of liquid nitrogen through the CTH40, such that there is always LN2 in the tube of the CTH40. This generally doesn't require a large flow or high pressure.

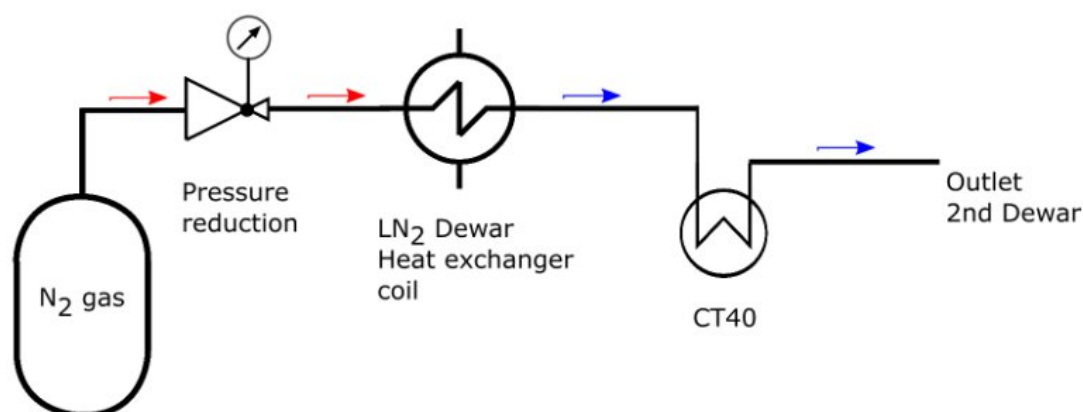


Figure 7: Flow chart for cooling with N2 gas and heat exchanger.

After about half an hour the CTH40 is fully cooled down and reaches its base temperature while the pressure should drop more than an order of magnitude. Now you can open the valves for transferring samples. Although the CTH40 won't warm up immediately, it is recommend not to stop the LN2 flow too early during transfer. When the transfer is finished stop the nitrogen flow, but don't open or detach the hoses as the system is still cold to prevent condensation in the tube.

### 6.2.2 Cool-down with liquefying N2 gas

A second possibility is to cool-down the CTH40 by liquefying N2 gas with a heat exchanger.

Required equipment:

- High quality N<sub>2</sub> gas in a gas cylinder with pressure regulation
- Cu tube with about 10 loops as heat exchanger

- Liquid nitrogen vessel big enough to insert the heat exchanger tube
- At least 20 liters of liquid nitrogen (the amount of LN2 used depends on the period of time during which the CTH40 should be cold)
- Valves, connectors and hoses suitable for low temperature usage
- Hose insulation

Connect the gas cylinder to the heat exchanger coil and the latter to the inlet tube of the CTH40 according to Fig. 7. The outlet of the CTH40 should be connected with another tube which can let the exhaust LN2 flow into another dewar. Let some warm gas flow through the tubes with a pressure of approximately 0.5 bar. Then slowly insert the heat exchanger coil into the LN2 dewar and increase the pressure towards 2 bar. After about 10 min liquid nitrogen should run through the CTH40. Keep the N2 flowing during the transfer, that LN2 runs through the tube. When finished, the pressure can be reduced to 0.5 bar such that the flow of liquid is stopped. When the hoses are not frozen any more, the heat exchanger coil can slowly be taken out of the dewar. (Depending on the hose material used, the hoses might be slightly heated for warm up, but make sure that the hoses don't become too hot or a high pressure builds up in the system, to prevent any damage.)

## **7 Warm-up procedures**

### **7.1 Warm-up CTH40**

When the transfer is finished stop the nitrogen flow, but don't open or detach the hoses as the system is still cold. (Be aware that some hoses might break when moved in the frozen state.) Also don't break the vacuum while the system is cold to prevent water condensation and ice formation on the cryo pump. (The cryo pump won't be damaged by water condensation, but it is preferable not to have any water in the chamber.) Without any further action, it takes several hours until the cryo pump has warmed up. Therefore the heating coil can be used to fasten the warm-up procedure.


#### **7.1.1 Warm-up by heating with the heating coil**

Connect the heating coil as described in section 4.2. Make sure that the chamber is under vacuum (which should be the case when it is used for cooling). Slowly increase the current up to 2.5A and carefully monitor the temperature. Be careful towards the end of the warming procedure when the sensor reaches room temperature. At high currents the temperature might rise fast, therefore the current should be reduced at the end of the heating procedure. Please be aware that the lower Cu part of the CTH40 takes usually a little longer than the upper part to warm up. Therefore it is advisable to wait about 5 min when the sensor had reached 20°C or higher. Afterwards the temperature should be high enough to vent the chamber without the danger of condensation.

The heating has to be switched off before venting the chamber (or otherwise the heating coil can be damaged).

Some example data can be seen in Fig. 9

**CAUTION!**



- Never let the temperature exceed +150°C.
- Only use the heating coil when the device is under vacuum.
- Never apply a current of more than 4 A.
- Always monitor the temperature when using the heating.

Be aware: A current of 4 A can cause temperatures higher than +150°C when the device is in warm state.

Be aware: Only the bakeable cable can be used for typical UHV bake-out, the other cable should not be used for temperatures higher than 40°C.

An example program for warming up could use the following steps:

| Steps             | 1             | 2              | 3            |
|-------------------|---------------|----------------|--------------|
| Current (Voltage) | 2.5 A (~12 V) | 1.8 A (~7.4 V) | 1 A (~3.7 V) |
| Time              | 5 min         | 10 min         | 10 min       |

**Table 1:** Suggestion for a warm-up program for CTH40. (Voltage statements are only rough numbers as they vary with temperature and exact length of the coil.) This program is very similar to the one used for the test data in Fig. 9. Using this program it takes about 25 min to reach room temperature while it ensures that everything warms up uniformly.

### 7.1.2 Warm-up with hot gas

This is a method used for older devices which don't have a heating coil installed. It costs more time and nitrogen gas and is therefore not recommended for devices with a heating coil. For faster warm up it is possible to let warm or hot N<sub>2</sub> gas flow through the tube at a pressure of about 0.5 – 1.0 bar. In case the heat exchanger method is used, it is also possible to dip the heat exchanger coil into hot water (60°C – 80°C) while N<sub>2</sub> gas is flowing through the tubes to accelerate the process. Warm up would then take about 1.5 – 2 hours. The period of time depends on the flow and temperature of the N<sub>2</sub> gas.

## 7.2 Warm-up CTDH40

The warming procedure for CTD40 is very similar to CTH40. The best is to not fill the dewar to its maximum, but only with the amount of liquid nitrogen needed to perform the transfer. It is possible to blow out the remaining liquid nitrogen by letting warm nitrogen gas pass into the dewar. This needs to be done carefully and without high pressure. The liquid nitrogen should not be spilled in such a way that it could harm anybody. The usage of face and hand protection is mandatory.

Before warming up the CTDH40, remove the blue cap from the dewar to prevent any pressure built-up. Be aware that the remaining liquid nitrogen will boil more intensively when the device is heated. Connect the heating coil as described in section 4.2. Make sure that the chamber is under vacuum (which should be the case when it is used for cooling). Slowly increase the current up to 2.5 A and carefully monitor the temperature. Be careful towards the end of the warming procedure when the sensor reaches room temperature. At high currents the temperature might rise fast, therefore the current should be reduced at the end of the heating procedure.

An example program for warming up could use the following steps:

| Steps             | 1             | 2              | 3            |
|-------------------|---------------|----------------|--------------|
| Current (Voltage) | 2.5 A (~12 V) | 1.8 A (~7.4 V) | 1 A (~3.7 V) |
| Time              | 10 min        | 10 min         | 10 min       |

**Table 2:** Suggestion for a warm-up program for CTDH40. (Voltage statements are only rough numbers as they vary with temperature and exact length of the coil.)

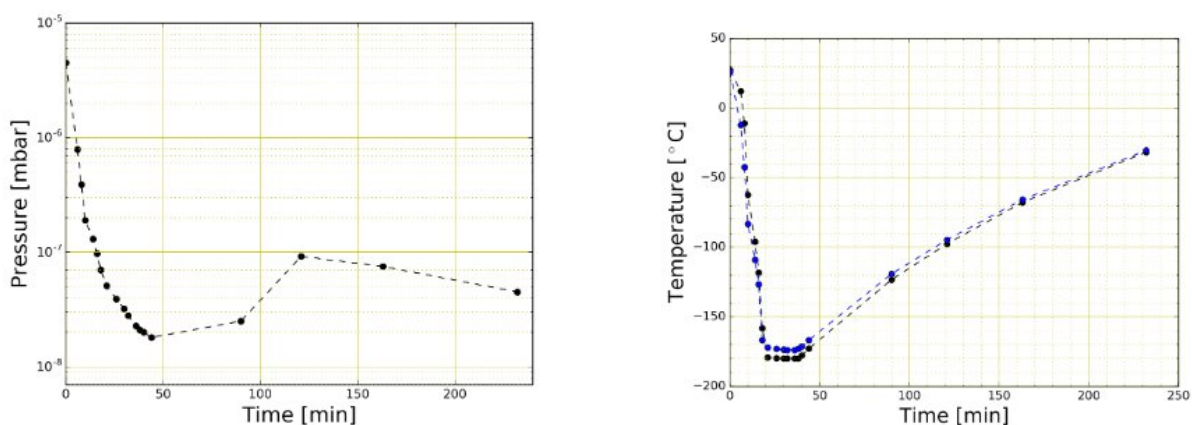
## 8 Maintenance

### 8.1 Bake-out

Under normal conditions a bake-out is not necessary. Nevertheless, it is possible to bake the CTH40, CTDH40 or VSCT40 with the system. The CTH40 and CTDH40 should be baked under vacuum together with its chamber. This can usually be done together with the main system bake-out after installing the CTH40 and its chamber or on a separate turbo pumping stand. For the bake-out typical baking equipment such as heating cables and aluminum foil or a tent can be used.

- To prevent marks on the chamber from the heating cable, first wrap a protective layer of Al foil around the chamber, before installing the heating tape and more Al foil.
- Cover the windows with Al foil.
- Wrap the complete chamber (without the turbo pump) in Al foil.

- Make sure that all heat-sensitive parts as plastic tubes, covers, etc. are taken out of the bake-out zone.
- The chamber needs to be pumped at least for 15 min.
- Then bake the CTH40 together with its chamber under high vacuum conditions (pumped with a turbo pumping system) for at least 24 hours at temperatures of 120°C - 150°C. Don't exceed 150°C.



**Figure 8:** Examples for a pressure (left) and temperature (right) curves during cool-down and warm-up of the CT40 (predecessor of CTH40).

## 8.2 Cleaning

In general the devices do not need any cleaning. To avoid marks on the metal chamber or windows from e.g. fingerprints it can be wiped with a soft lintless cloth moistured with a bit of isopropanol. No abrasive cloth or chemicals should be used. For the VSCT40: The inner part of the valve, in particular the part which is sealed should be kept clean. In case any particles or parts fallen down from a sample have fallen into the valve, the chamber needs to be vented and the valved cleaned. This cleaning depends on the contamination. Small particles can be wiped off by a clean lintless cloth moistured with isopropanol.

## 9 Performance data

### 9.1 Cool-down and warm-up of VSCT40

Some example data, Fig. 8 for the pressure and temperature measured with the CTH40 in a VSCT40. The chamber had been baked prior to the test. To simulate a typical transfer situation, the chamber had been vented by N<sub>2</sub> and then opened at the DN40 flange for about 10 min – 15 min to air. Then it was closed and pumped for 10 min. with the turbo pump attached directly underneath. Afterwards the cool-down was started. The temperature sensor was placed at the bottom of the cooling body. For this

example a pressurized dewar was used to pump LN2 through the CTH40. For warm-up the pressure was released while the system warmed up by itself (no additional action to accelerate warm-up).

## 9.2 Cool-down and warm-up of VSCT40 with the new CTH40 installed

Our new version of CT40, the CTH40, has a heating coil installed inside for fast warm-up. The rest of the functionality is comparable to CT40 while the thermal connection also was improved. The test chamber used was this time electropolished. The data measured with this device can be seen in Fig. 9. A pressure below 1 E-8 mbar can be reached withing 15 min! This is by far the fastest pump-down we've observed.

## 10 Wiring, cable layouts, temperature conversion

Here the most important technical information is summarized including the cable layouts and the temperature sensor.

### 10.1 Temperature sensor

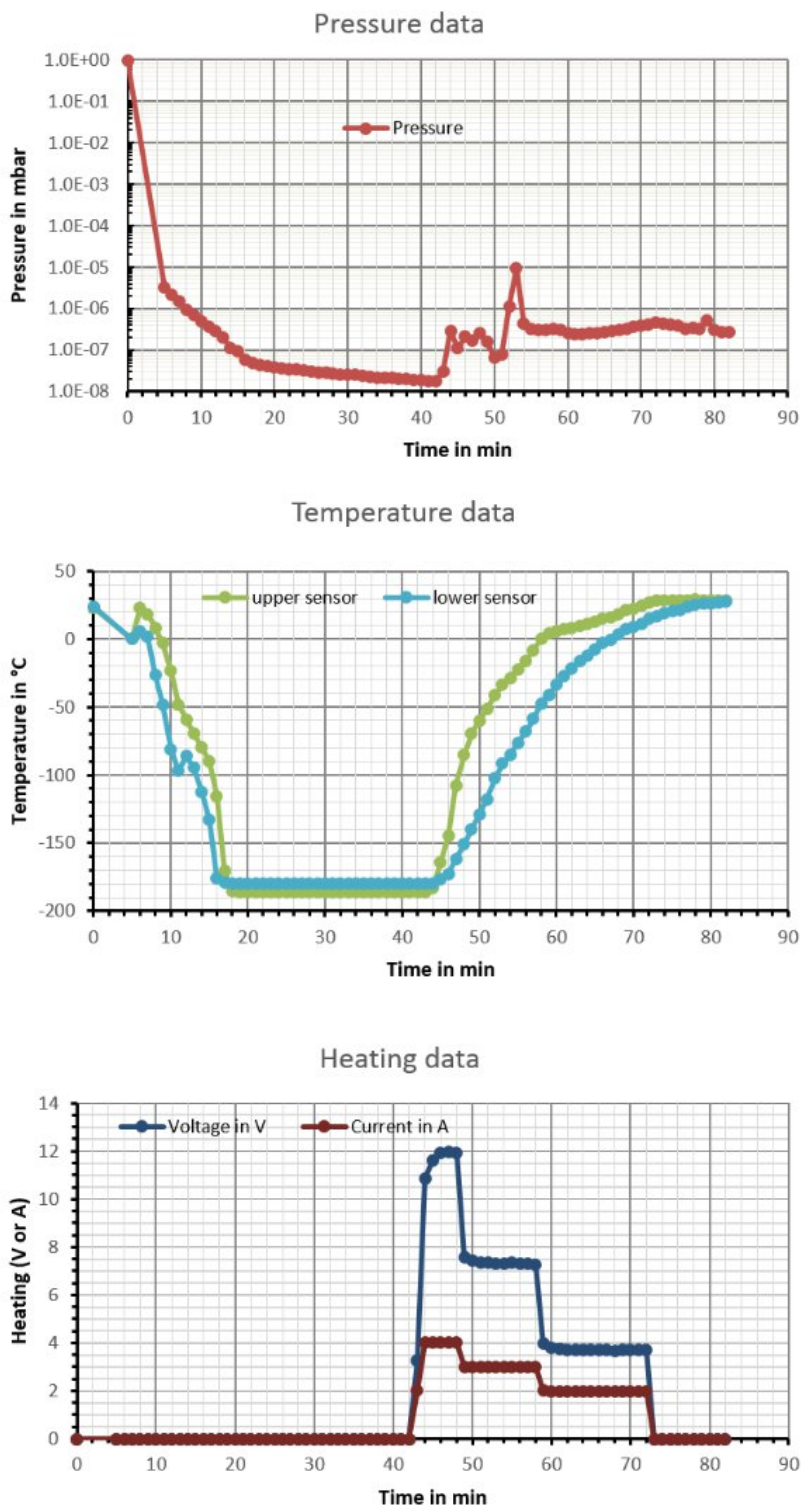
Inside the chamber on the sample cooling block or shield a Pt100 resistor (tolerance class A, DIN EN 60751 F 0.15:  $0.15 + 0.002 \times |T|$  | with T in °C) is mounted. This resistor has a resistance of 100 Ω at 0 °C and its calibration curve is well known (in °C):

$$R(T) = R_0(1 + A \times T + B \times T^2), \quad 0^\circ C - 850^\circ C \quad (1)$$

$$R(T) = R_0(1 + A \times T + B \times T^2 + C \times [T - 100] \times T^3), \quad -200^\circ C - 0^\circ C \quad (2)$$

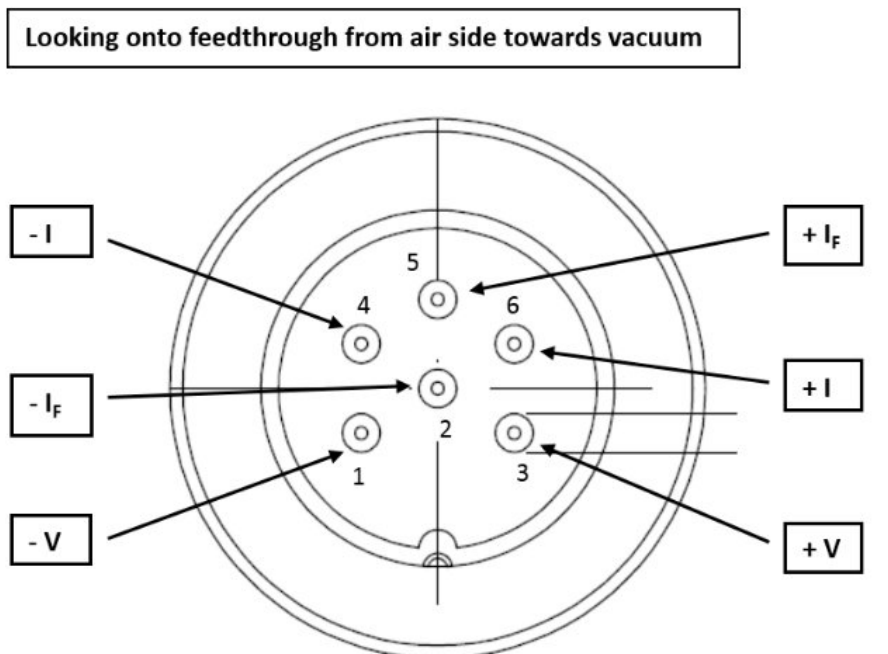
with  $R_0 = 100 \Omega$ ,  $A = 3.9083 \times 10^{-5} \text{ }^\circ\text{C}^{-1}$ ,  $B = -5.775 \times 10^{-7} \text{ }^\circ\text{C}^{-1}$  and  $C = -4.183 \times 10^{-12} \text{ }^\circ\text{C}^{-1}$ .

It is nearly linear in the range of interest, the standard resistance-temperature curve for such a sensor is given in Fig. 12.



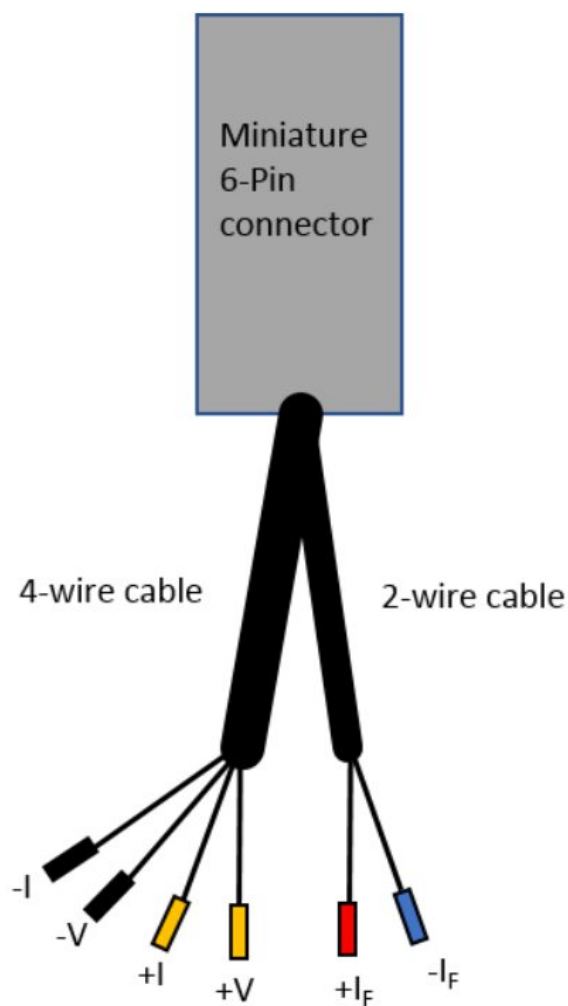
**Figure 9:** Measurement data taken with a VSCT40 on a typical CF63 turbo pump. On the chamber of the VSCT40 our new VSCTH40 was installed.



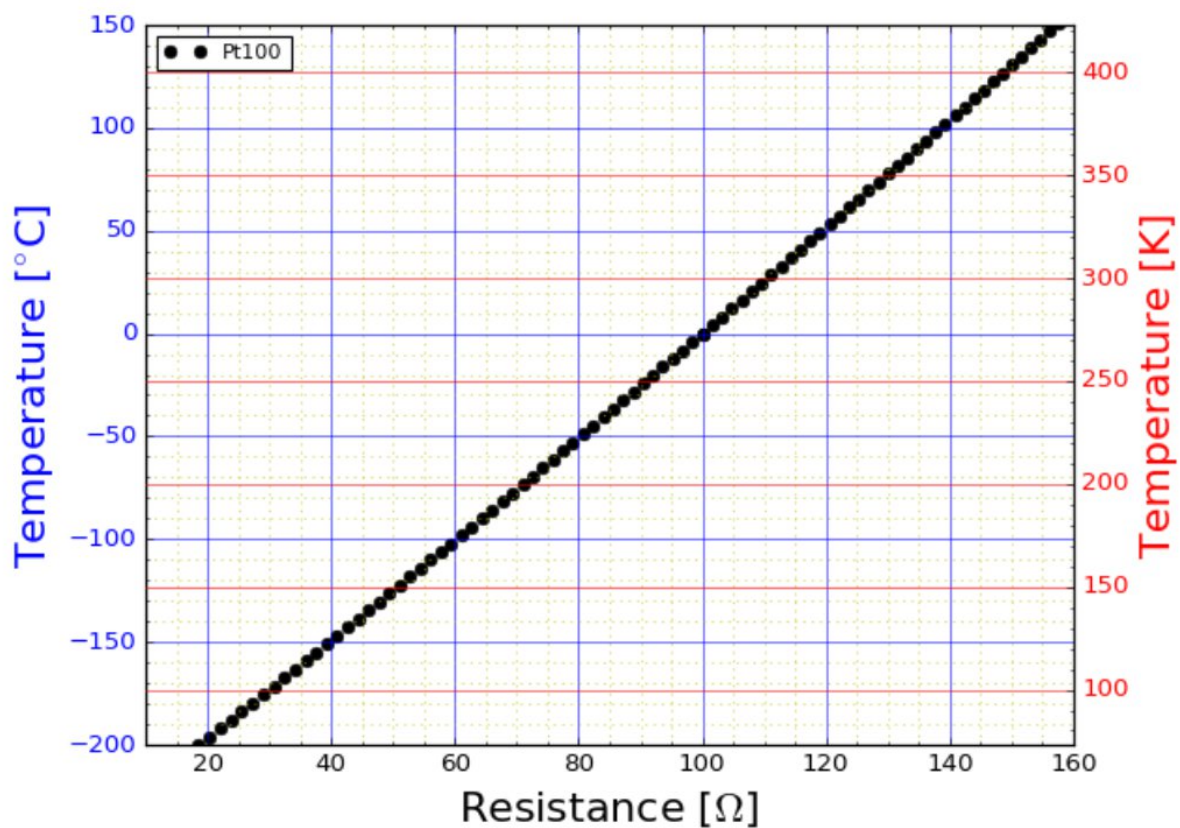


| Name             | Type             | Spec                | PIN on Allectra | Notes  |
|------------------|------------------|---------------------|-----------------|--------|
| - I              | Resistor current | About 0.1mA to 10mA | # 4             | red    |
| + I              | Resistor current |                     | # 6             | yellow |
| - V              | Resistor voltage | About 0.1V to 5.0V  | # 1             | green  |
| + V              | Resistor voltage |                     | # 3             | blue   |
| + I <sub>F</sub> | Filament current | Max. 4.0 A          | # 2             |        |
| - I <sub>F</sub> | Filament current |                     | # 5             |        |

**Figure 10:** Pin layout for miniature 6-Pin feedthrough for temperature measurement including Pt-Sensor and filament



**Figure 11:** Connection cable layout (CABCTH40HTB4M or CABCTH40HT4M) for temperature measurement including Pt-Sensor and filament. For the temperature sensor 4 wires are available, the heating coil only as 2 wires. For the pin layout of the 6-pin miniature connector please refer to Fig. 10, the pins are connected respectively.



**Figure 12:** Graphical conversion of resistance into temperature for the Pt100 sensor.



**Figure 13:** The CT-devices are available with a cable and power supply kit.

## **11 Upgrades and options**

### **11.1 Configured cabling**

Pre-configured cables are available as CABCTH40HT4M or CABCTH40HTB4M while the later is the bakeable version.

### **11.2 Kit with cabling and power supply**

The devices can also be ordered with configured cabling and a small programmable laboratory power supply. (Temperature measurement device not included.) For temperature measurement a conventional multimeter is sufficient and needs to be supplied by the user.

## **12 Additional information**

### **12.1 Return of defective items**

Ferrovac AG will require an RMA (Return of Materials Authorization) number and a complete declaration of contamination to be issued, before any item is returned to us. Please contact us therefore. You will be given an RMA number and information on how to proceed with the return of your defective items.

### **12.2 Download**

This manual can be downloaded from our website VSCT40. It can be found in the specifications of the CTH40 or VSCT40. For any suggestions or questions considering this manual, please contact us and write an e-mail to [sales@ferrovac.com](mailto:sales@ferrovac.com).