FERROVAC GMBH

ULTRA HIGH VACUUM TECHNOLOGY

CT40
UHV booster

INSTRUCTION MANUAL

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Warranty

Ferrovac GmbH warrants this product to be free of defects in material and workmanship for a period of 12 months from the date of shipment. In case of proof of any defective parts in the product, we will at our option, either repair the product or replace it.

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

This warranty stands in place of all other warranties, implied or expressed, including any warranty of merchantability implied or fitness for a particular use. The remedies provided herein are buyer's sole and exclusive remedies.
Neither the company FERROVAC GMBH *nor any of its employees shall be liable for any direct, indirect, incidental, consequential or special damages arising out of the use of its products, even if the company* FERROVAC GMBH *has been advised in advance of the possibility of such damages. Such excluded damages shall include but are not limited to: Costs of removal and installation, losses sustained as the result of injury to any person, or damage to property.*

Copyright

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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 GMBH 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.

A triangle with explanation mark indicates a passage in the manual with information that is crucial for the operator. READ THESE PARAGRAPHS CAREFULLY 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. Read the associated information always very carefully.

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

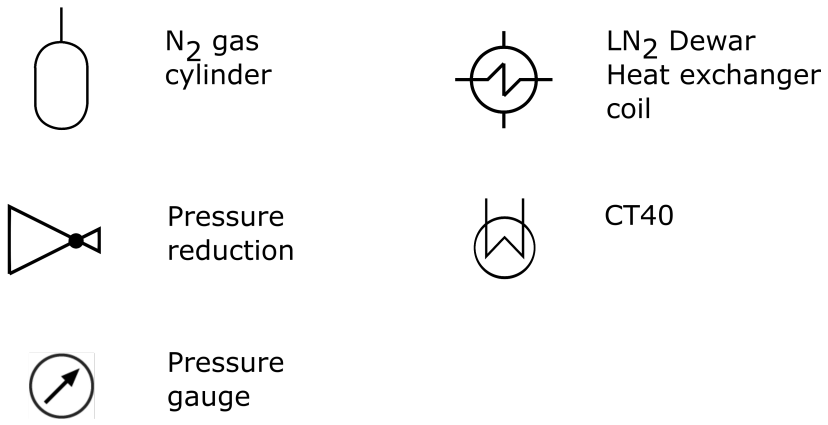

Figure 1: Symbols used in the drawings.

Normal use

The product described in this manual must always be used:

- In an indoor research laboratory environment
- By personnel qualified for operation of delicate scientific equipment
- By personnel trained in using cryogenic liquids and gas handling systems
- In accordance with all related manuals.

CAREFULLY READ THE SAFETY INFORMATION AND ALL RELEVANT MANUALS BEFORE USING THE PRODUCT AND ANY RELATED INSTRUMENTATION!

WARNING: Cryogenic liquids, liquid nitrogen (LN_2)

The handling of liquid nitrogen is only allowed by authorized and trained personal respecting the general safety precautions for cryogenic liquids.
Always use the safety equipment, i.e. wear safety glasses and gloves.
The handling of liquid nitrogen is only allowed with closed shoes.
In addition to this manual, read carefully the safety instructions given by your liquid nitrogen supplier.

WARNING: Gaseous nitrogen (N_2) in high-pressure cylinders

The handling of industrial nitrogen gas in high-pressure cylinders is only allowed by authorized and trained personal respecting the general safety precautions for compressed gases.
Do not drag, slide or roll cylinders. Use a suitable hand truck for cylinder movement. Use a pressure reducing regulator when connecting the cylinder to lower pressure piping or systems.
In addition to this manual, **carefully read the safety instructions given by your supplier for nitrogen gas**.

WARNING: Cryogenic liquids, liquid nitrogen (LN_2), nitrogen gas (N_2)

Nitrogen is a colourless, odourless and tasteless non-toxic substance. LN_2 is a clear liquid. Be aware that an amount of 1 liter liquid turns into about 700 liters of gas which can cause large pressure build up in a closed system when warming up. Make sure to take precautions for overpressure and prevent any blocking by ice formation.
LN_2/N_2 can cause rapid suffocation without noticing, therefore these substances have to be stored and handled in areas with **adequate ventilation**. Be aware that N_2 gas accumulates on the ground.
If any symptoms such as drowsiness, dizziness, headache, unconsciousness or even vomiting occur, bring victim to fresh air, provide oxygen or artificial respiration if needed. Look for professional medical assistance.
LN_2 can cause severe frostbite. In case of injury, warm up exposed parts, but don't use hot water. Look for medical assistance.

The handling of liquid nitrogen is only allowed by **authorized and trained personal** respecting the general safety precautions for cryogenic liquids.
Always use the safety equipment, i.e. wear safety glasses and gloves as well as closed shoes.
In addition to this manual, read carefully the safety instructions given by your liquid nitrogen supplier.

Safety precautions

The following safety precautions must be observed at all times before using the product described in this manual and any associated instrumentation.
The product described in this manual is intended for use by qualified personnel who recognize shock hazards and are familiar with the precautions necessary to avoid possible injury.

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 are using 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 contact with potentially dangerous situations.

Maintenance Personnel perform routine tasks on the product to keep it in proper operating conditions i.e. setting up and controlling the LN_2 filling lines, cooling setups, gas bottles, dewars or replacing consumables. Maintenance procedures are described in the manual and must be followed at all times.

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.

CAUTION: Always check for correct mains voltage before connecting any equipment!

WARNING: Lethal Voltages! Adjustments and fault finding measurements may only be carried out by authorised service personnel. Lethal Voltages may be present at parts of the instrument during operation.

WARNING:

- **Always** observe and strictly follow the safety notes and regulations given in this and related documentations.
- **Always** use the configured cables delivered with the product for electrical connections.
- **Always** disconnect the mains supplies of all electrically connected units before venting, pump-down, opening the vacuum chamber, touching any part of the in-vacuum components.
- **Always** observe and strictly follow the safety notes and regulations given in this and related documentations.
- **Never** operate the high voltage supply when the ion pump is not connected and under vacuum.
- **Never** operate the ion pump in a pressure range above 1×10^{-5} mbar.
- **Read** safety instructions first and be familiar with general safety precautions for cryogenic liquids and compressed gases.
- **Always** strictly follow the safety notes and regulations of handling cryogenic liquids given by the vendor of cryogenic liquids.
- Make sure that a **proper ventilation** is present in the laboratory while using cryogenic liquids.

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

- Room temperature lies between 5°C/41°F and 40°C/104°F.
- Mains supply voltage fluctuations must not exceed ± 10% of the nominal voltage.

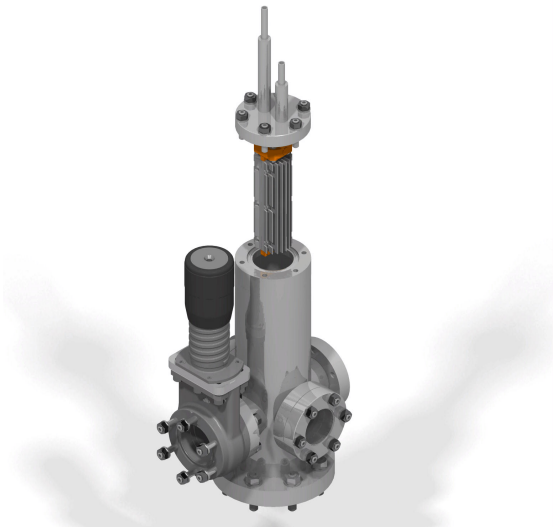

Figure 2: Standard **VSCT40 with CT40**

1 Introduction

The **CT40** is intended for use with a small transfer chamber (for example as VSCT40, Fig. 2) to 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 **CT40** acts in addition as a **cryogenic pump**. Thus a sufficient vacuum is established within approximately 30 minutes, as opposed to many hours when pumping the buffer volume conventionally. The turbo pumping system, chamber and cool-down equipment are not part of the product. The **CT40** can be ordered together with a chamber and valve, the **VSCT40**.

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 GMBH immediately. Prepare a very clean workspace. Carefully unpack the **CT40** and perform a visual check for any damage of the package, its contents and accessories. Only touch the vacuum side parts of the **CT40** with clean, powder-free gloves.
The **CT40** is shipped fully assembled as one piece and cleaned, see Fig. 3.
Compare the contents of the package with the delivery note. Any damage or missing items must be reported to FERROVAC GMBH within 48 hours after delivery.

The package should contain:

- The fully assembled CT40
- This manual

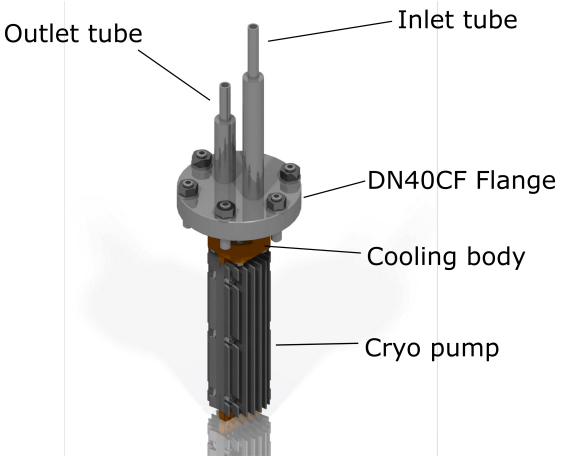

Figure 3: Overview of the **CT40** and its parts.

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 CT40 to physical shocks or aggressive chemicals.**
- **Never hit the knife edge.**

3 Overview and description

The **CT40** is cooled down with liquid nitrogen in order to cool the cryo pump body attached on the vacuum side. The liquid nitrogen flows through the tube of the **CT40** in which a porous material is placed in order to enhance the surface for cooling and slow down the flow within the tube. The **CT40** can be connected to a liquid nitrogen supply via the tube fittings on top of it. **The longer tube is the inlet and the shorter one the outlet.** During warm-up, dry nitrogen gas can be blown through the tube of the **CT40**. For the details of the procedures and handling read the respective chapters of this manual.

4 Setup and installation

Carefully unwrap the **CT40** and make sure not to hit the knife edge. The **CT40** is shipped clean, therefore use gloves for unpacking.

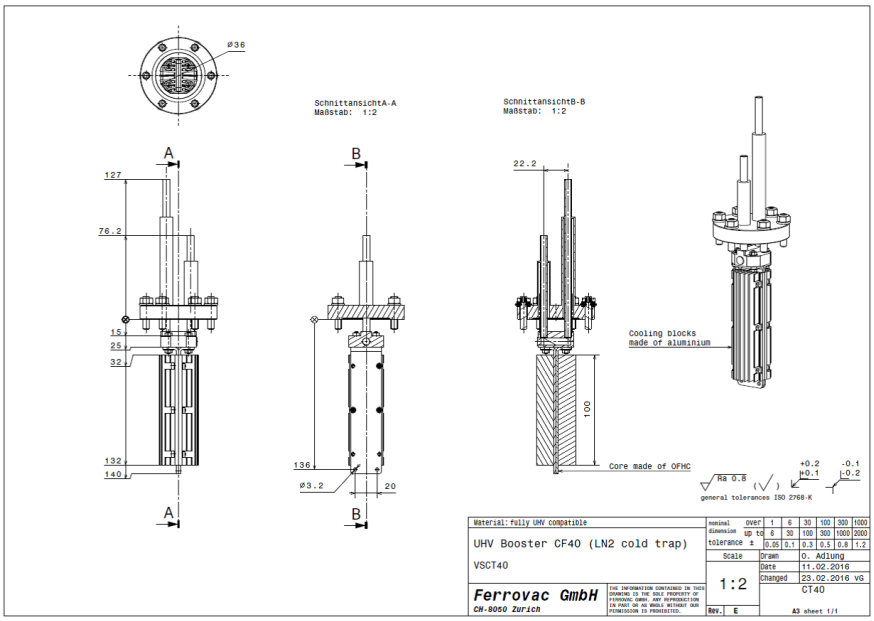

Figure 4: Overview of the **CT40** and its parts.

4.1 Installation on a UHV chamber

Install the **CT40** in a suitable chamber with sufficient diameter on a DN40CF flange with a Cu gasket.

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!

5 Preparation for vacuum usage, venting

This section describes the procedures for the recommended initial bakeout and general vacuum usage.

5.1 Initial bakeout

Before the first usage, a bakeout for initial degassing is recommended. The **CT40** should be baked under vacuum together with its chamber. This can usually be done together with the main system bakeout after installing the **CT40** and its chamber or on a separate turbo pumping stand. For the bakeout typical baking equipment such as heating cables and aluminium 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 cable and more Al foil.) After installation, pump down the closed chamber to a suitable high vacuum pressure of 10^{-6} mbar. Then bake the **CT40** 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.

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_2). It'll help with faster pump down afterwards, even when opened to air.

6 Cool down procedures

This section contains suggestions for step by step procedures to controlled cool down of the **CT40**. The user needs to provide the respective valves, hoses and connectors, liquid nitrogen (LN_2), vessels and nitrogen gas (N_2) cylinders. The user is responsible for the proper and secure set-up of the nitrogen filling system.

6.1 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 **CT40**.
Required equipment:

- Liquid nitrogen cylinder with pressurizing possibility, over pressure valve and venting valve
- Liquid nitrogen vessel for exhaust LN_2
- At least 10 liters of liquid nitrogen (the amount of LN_2 used depends on the period of time for which the **CT40** 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 **CT40**. 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 **CT40** 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 LN_2. 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 **CT40**, such that there is always LN_2 in the tube of the **CT40**. This generally doesn't require a large flow or high pressure.
After about half an hour the **CT40** 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 **CT40** won't warm up immediately, it is recommend not to stop the LN_2 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 Cool-down with liquefying N_2 gas

A second possibility is to cool-down the **CT40** by liquefying N_2 gas with a heat exchanger. Equipment required:

- High quality N_2 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 LN_2 used depends on the period of time dur-ing which the **CT40** 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 **CT40** according to Fig. 5. The outlet of the **CT40** should be connected with another tube which can let the exhaust LN_2 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 LN_2 dewar and increase the pressure towards 2 bar. After about 10min. liquid nitrogen should run through the **CT40** .
Keep the N_2 flowing during the transfer, that LN_2 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.)

6.3 Warm up

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.)

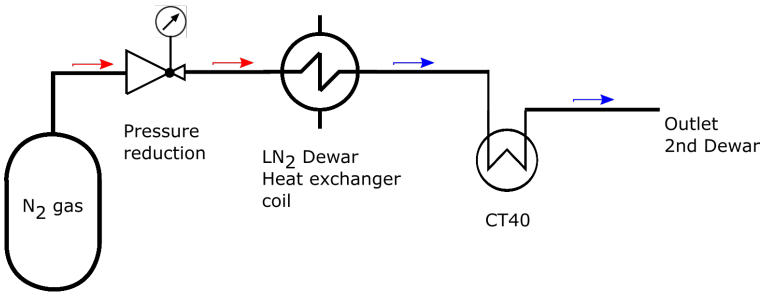

Figure 5: : Flow chart for cooling with N_2 gas and heat exchanger

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. For faster warm up it is possible to let warm or hot N_2 gas flow through the tube at a pressure of about 0.5 – 1.0 mbar. 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_2 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_2 gas.

7 Pressure and temperature plots for cooling and warm up

Some example data, Fig. 6 for the pressure and temperature measured with the **CT40** 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_2 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 LN_2 through the **CT40**. For warm-up the pressure was released while the system warmed up by itself (no additional action to accelerate warm-up).

8 Additional information

8.1 Return of defective items

FERROVAC GMBH 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.

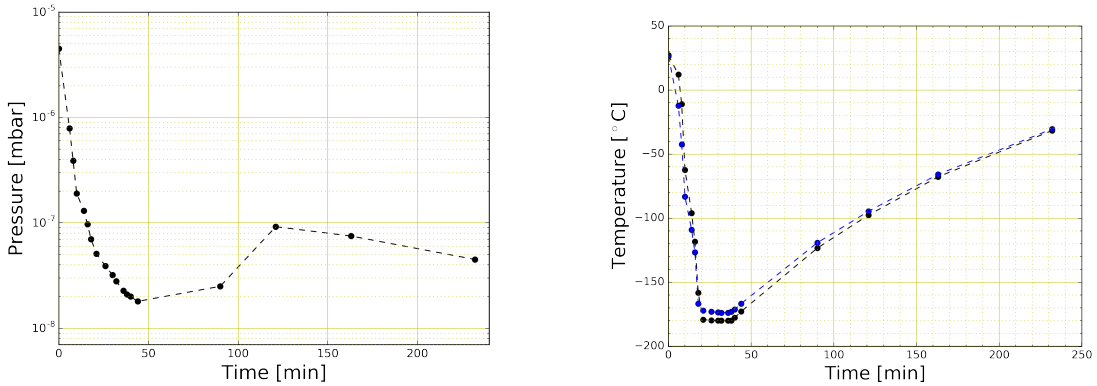

Figure 6: Examples for a pressure (left) and temperature (right) curves during cool-down and warm-up of the CT40.

8.2 Download

This manual can be downloaded from our website VSCT40. It can be found in the specifications of the **CT40** or **VSCT40**.
For any suggestions or questions considering this manual, please contact us and write an e-mail to sales@ferrovac.com.