

FERROVAC GMBH

ULTRA HIGH VACUUM TECHNOLOGY

VSN40S(HLVR|HL|VL|V|VR|HR|HRVL) NexGeneration Ultra High Vacuum Suitcase

Instruction Manual

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THURGAUERSTR. 72, CH-8050 ZÜRICH, SWITZERLAND
TEL. +41 44 273 16 38, FAX. +41 44 273 16 30
WWW.FERROVAC.COM, SUITCASE@FERROVAC.COM

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

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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 exclamation 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.



The hot surface symbol refers to hot surfaces which can lead to injury and burns when touched.



The high voltage symbol, if found on a product or accessory of a product, indicates voltages that are potentially lethal.

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.

Normal use

The product described in this manual must always be used:

- With original cable sets supplied by Ferrovac which are explicitly specified for the use with the product described in this publication
- With all cabling connected and secured, if applicable
- With all electronic equipment switched on after all cables are connected properly
- In an indoor research laboratory environment
- By personnel qualified for operation of delicate scientific equipment
- In accordance with all related manuals.



Warning: lethal voltages!!

Any adjustment, fault finding procedure, installation and maintenance of the products described in this manual must be carried out by authorized personnel, fully qualified to handle potentially lethal voltages.



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

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 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 the line voltage or replacing consumables. Maintenance procedures are described in the manual and must be observed at all times.

Service Personnel are trained to work on live circuits and 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.

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

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** 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 above 1×10^{-5} mbar**.

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 $\pm 10\%$ of the nominal voltage

1. Introduction

The transport of samples under true UHV conditions from one instrument to another, sometimes from one institution to the other, is an increasingly important task in modern surface science.

The VSN40S NexGeneration UHV Suitcase is a full featured, miniaturized UHV-system for transport and storage of samples under ultraclean conditions. The vacuum suitcase is equipped with combined Non Evaporable Getter (NEG)/Ion-pump which is driven by a battery powered controller.

The usage of combined Non Evaporable Getter (NEG)/Ion-pump technology allows to build a fully featured, truly portable, at the same time compact and light weighted (8.8kg) UHV system. The weight (2.2kg) of the NEG/Ion pump used being less than one third of a 20lt/s ion pump, its nominal pumping speed is five times bigger (100lt/s). The NEG-element can be activated with any standard DC lab power supply. High voltage for the ion-pump element is delivered by our rechargeable battery driven power supply LSA2 for up to 60 hours without a power connection. Base pressures well below 1×10^{-10} mbar can be reached.

The suitcase can be individually configured for vertical or horizontal usage, type and travel range of the transfer arm as well as the sample grabbing mechanism. It is fully compatible with our wide range of manipulators such as linear/rotary feedthroughs, wobblesticks and sample transporters.

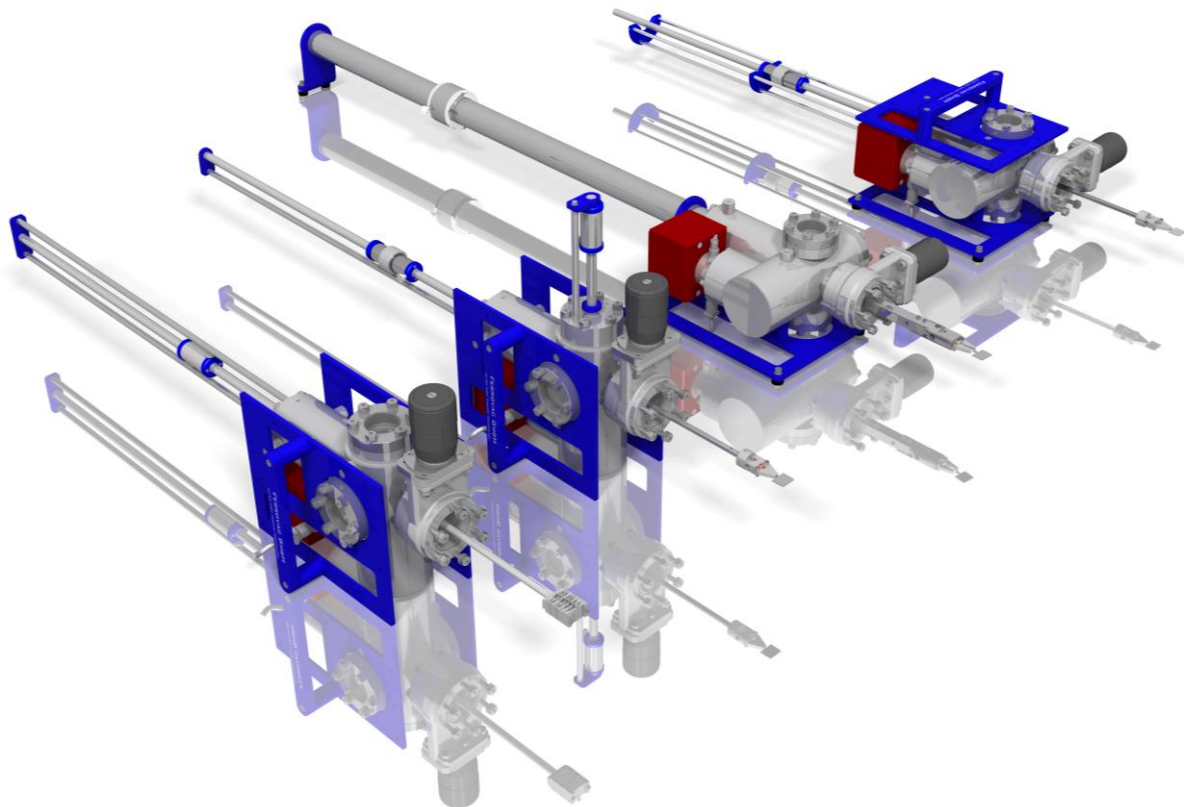


Fig. 1: Four configuration examples

The VSN40S NexGeneration UHV Suitcase is our newest model of NEG/Ion pumped UHV suitcases optimized in size, cost and performance.

2. Unpacking and inspection

Before unpacking, inspect the parcel for any visible damage. If any evidence for a damage of the package is, found take pictures of the parcel and send them to Ferrovac immediately.

Prepare a very clean workspace. Carefully unpack the suitcase and perform a visual check for any damage of the package, its contents and accessories.

The UHV Suitcase is shipped under vacuum, fully baked and ready to use.

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**.

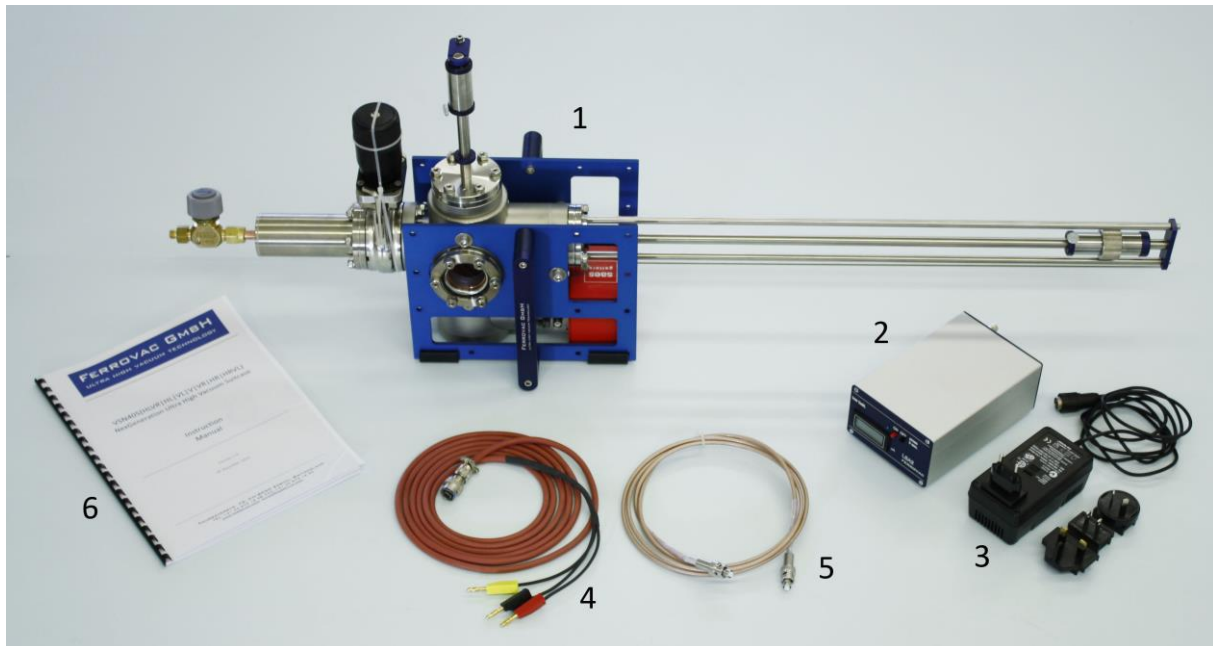


Fig. 2: Package contents of a complete system

1. Fully assembled NexGeneration UHV Suitcase
2. Battery Powered Ion Pump Controller
3. Battery Charger including 4 power adapters
4. Cable LSA2 PUN Silicone for activation of the getter element
5. Cable LSA2 PUN SHV for operation of the ion pump
6. This manual and any manuals of additional subunits

CAUTION!

- **Please** ensure enough working space for unpacking and inspection.
- Never open the gate valve before the suitcase is mounted to a system with reasonable base pressure.
- Read this manual carefully before using the device.
- **Never** expose the suitcase and its manipulators to physical shocks.
- **Never** hit the knife edge nor the bellows.

3. Overview

The main parts of the NexGeneration UHV suitcase are named as follows:

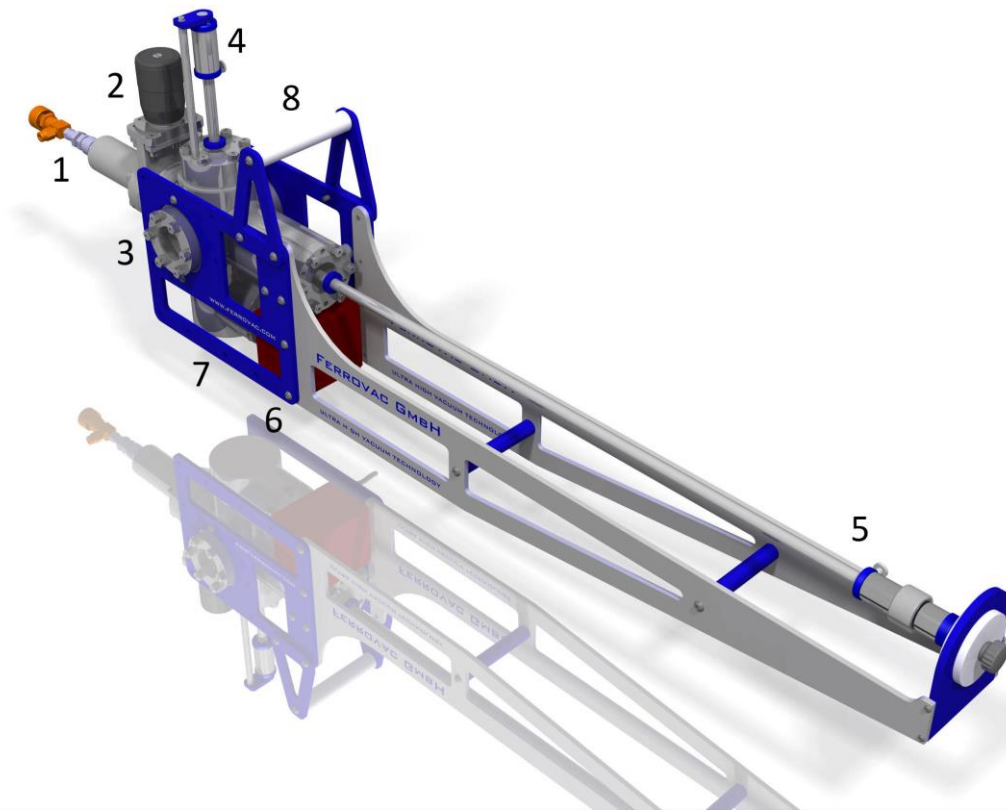


Fig. 3: Overview NexGeneration UHV suitcase

1. Buffer volume
2. Gate valve
3. Chamber with 1-3 viewport(s)
4. Storage manipulator (or viewport)
5. Transfer manipulator (or blank flange)
6. Pump
7. Side/ baseplate(s) 1-2 items
8. Carrying handle

4. Setup and installation

Your VSN40S vacuum suitcase is being shipped under vacuum. During transport, the NEG-element maintained its base pressure. Unpack the universal battery charger that is shipped with the suitcase and plug its cable into the rear socket of the LSA2 Battery Powered Ion Pump Controller. Plug the battery charger into a mains supply socket.

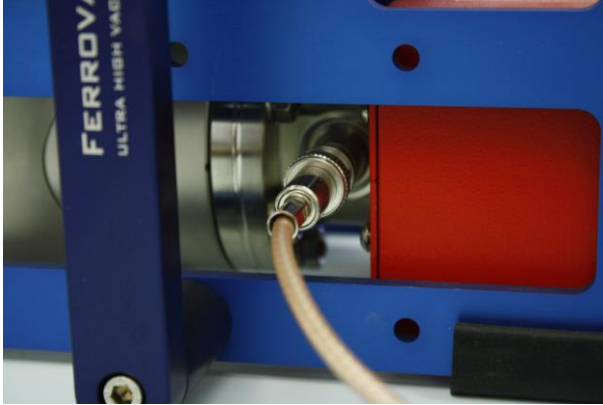


Fig. 4: Plug the SHV cable in

Before using the controller please consult the manual of your specific LSA2 device. Press the "ON" button of the LSA2 for five seconds.



Fig. 5: LSA2 front

Check the readings of the display. If vacuum conditions are sufficient, the ion pump will start and the display will indicate the pump current in micro amps. An overload ("1.") reading for the first few seconds after power on might occur and is normal.

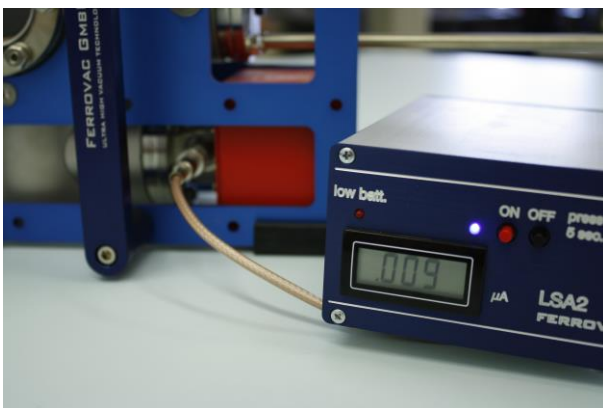


Fig. 6: Connected LSA2.1

The pump current is directly proportional to the pressure in the vacuum system. The diagram Fig. 7 "Pump Current vs pump pressure (for N₂)" provides the current to pressure conversion curve of the SAES™ NexTorr pump models D100-5 and D200-5.

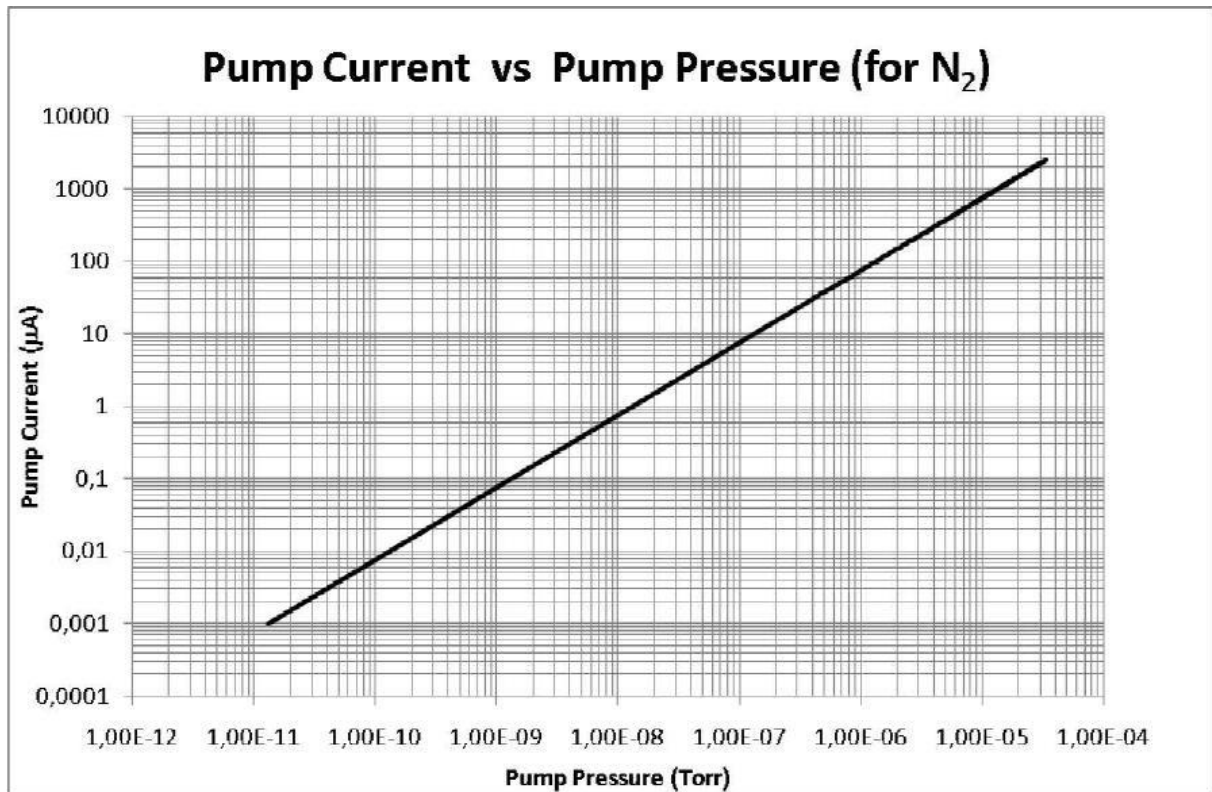


Fig. 7: Pump current vs pump pressure (for N₂)

Depending on the readings of the LSA2 display, choose one of the following options:

1. The pump current indicates that the pressure is higher than 1×10^{-6} mbar (i.e. the LSA2 shows "1."):

Switch the ion pump controller off and proceed to section 7.2 "Pumpdown" on page 14.
2. The pressure is between 1×10^{-9} mbar and 1×10^{-6} mbar:

Proceed to section 8 "NEG activation and bakeout" on page 15.
3. The pressure is below 1×10^{-9} mbar:

Proceed to next section 5 "Installing the Suitcase to a UHV System" on page 12.

5. Installing the suitcase to a UHV system

This section contains step by step procedures for installing the suitcase to a host UHV system and transferring samples.

5.1. *Preparing the host UHV system*

Your host UHV-System must be equipped with a DN40CF flange. Usually a gate valve and a short CF40 T-piece is installed as a buffer volume for pumpdown using a turbopump. If the UHV System is equipped with a load lock system, the load lock can be used as buffer volume.

The UHV suitcase must be properly aligned in height and position and it's weight must be supported by a suitable structure depending on the selected configuration (type and length of manipulators). A height adjustable spindle trolley for instance, provides a good solution.



CAUTION: Always support the UHV-suitcase by a suitable structure which is stable enough to suspend its weight depending on the selected configuration!



CAUTION: If the suitcase is not properly aligned and supported, leakages may result and welds can be damaged depending on the selected configuration.



CAUTION: The height adjustable structure should not be a hydraulic lift. Hydraulic lifts can usually not guarantee long time stability.

5.2. *Pump-down of the buffer volume*

After attachment of the UHV suitcase (gate valve closed) to the buffer volume, pump down the buffer volume until a sufficiently low vacuum level is reached. "Sufficiently low" in this context depends on the sensitivity (reactivity) of your sample surface. Baking of the buffer volume might be necessary case by case.

If the UHV Suitcase is in ex-works condition (delivered fully assembled including UHV conditioning) the system is now ready for transferring samples. Otherwise your UHV suitcase should already have been conditioned as described in sections 7.2 "Pumpdown" page 14 and 8 "NEG activation and bakeout" page 15 of this manual.

5.3. *Transfer of samples*

Open the gate valve of the suitcase and recheck the reading of the LSA2 display. If the pump current reading, i.e. pressure, is as expected, you can start with sample transfer between the host UHV system and the suitcase.

For more information about transfer please consult the specific manipulator(s) manual.

6. Transporting samples under UHV

6.1. *Preparing the suitcase for transport*

Firmly close the gate valve of the suitcase and open the CF40 connection between T-piece and gate valve of the suitcase. For protection of the knife edge of the gate valve, install a blank flange (or the buffer tube VSN40SBT, see next capture 6.2 "Prevent air diffusion").

Disconnect all cables except the cable for operation of the ion pump. After disconnecting the power adapter from the LSA2, recheck that the high voltage is on and the ion pump is running properly.

Your suitcase, now running on batteries, is ready for transport. The maximum power-up time on batteries is approximately 60 hours.

6.2. *Air diffusion*



IMPORTANT: The gate valve of your VSN40S is sealed with an FPM rubber gasket. There is always a certain diffusion of air through such a gasket. Thus, starting from a base pressure in the low 1×10^{-10} mbar range, with the gate valve securely closed, you may still observe a slight increase of the base pressure in the suitcase after venting the buffer volume.

This does not indicate a leakage. The increase in base pressure happens very slowly within a time span of several hours and should not exceed 1×10^{-9} mbar. For maintaining the ultimate base pressure in the suitcase, it is recommended that it remains connected to any kind of oil-free vacuum available, so that both sides of the gate valve are under vacuum.

To prevent air diffusion use the buffer volume VSN40SBV as follows.

Install the buffer volume VSN40SB. Connect the angle valve of the buffer volume VSN40SBV to any oil-free vacuum. Pump down the buffer volume and close the angle valve.

A membrane pump with a base pressure around 5mbar is sufficient for this operation.

7. Venting and pumpdown

This section contains step by step procedures for controlled venting and pumpdown of the suitcase.

7.1. Venting

- The suitcase is delivered with the gate valve closed and blanked off by a CF40 blank flange or with mounted buffer volume VSN40SBV. **With the gate valve still closed**, unscrew the blank flange or VSN40SBV and take it off. The small volume between the gate and the blank flange or VSN40SBV will be vented with air.



CAUTION: Keep the gate valve firmly closed when taking off the blank flange or the buffer volume VSN40SBV!



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!

- For a controlled venting of the UHV suitcase, establish a pumping connection to a turbo molecular pump. This is usually done by means of CF40 flexible bellows tube. The turbo pump can be either a mobile pumping station or the turbo pumping system installed on a load lock for instance.
- Start the turbo pump and wait until it reaches its normal operation at full speed.
- If possible, connect the venting valve of the turbo pump to a source of dry nitrogen.
- Make sure that the ion pump controller and (if present) the vacuum gauge of the VSN40S are switched off.
- Open the gate valve of the suitcase and subsequently turn the turbo pump off.
- Wait until the turbo pump vents automatically or vent it manually through its venting valve.

7.2. Pumpdown

- Establish a pumping connection to a turbo molecular pump as described in section Venting
- Start the turbo pump and wait until it reaches its full speed.
- Start the ion gauge as described in the manual of this gauge.
- Wait until the ion gauge displays a vacuum level $< 1 \times 10^{-6}$ mbar. If no ion gauge is installed to the buffer volume, wait approximately 10 minutes before switching on the LSA2.
- Press the "ON" button of the LSA2 ion pump controller for five seconds.
- Confirm the reading of the pump current and compare it with the displayed value of the vacuum gauge.
- Your vacuum suitcase is ready for chapter 8 "NEG activation and bakeout" on page 15 when the vacuum level reaches 1×10^{-6} mbar.

8. NEG activation and bakeout

This section contains step by step procedures for controlled NEG activation and bakeout and of the suitcase.

8.1. *Preparing the system for bakeout*

In order to reach a good base pressure inside a UHV system, it must be baked at a temperature $>100^{\circ}\text{C}$ for a sufficiently long time. The time needed for bakeout depends on how long the system was exposed to air and other parameters, such as general cleanliness of the internal surfaces and many more. Your VSN40S system was factory baked for a period of 24 hours at a temperature of 100°C - 150°C and reached a base pressure of $< 1 \times 10^{-10} \text{ mbar}$. If you use the heating jacket **VSN40SBT-HE** read the additional information about the usage of the heating jacket.

- Perform a pumpdown as described in section 7.2 "Pumpdown" on page 14.
- If your VSN40S vacuum suitcase reaches a vacuum level below $1 \times 10^{-6} \text{ mbar}$, it is ready for bakeout and NEG activation.
- Make sure that there is nothing left inside the bakeout zone that does not withstand at least 150°C , i.e. plastic lids, packing material, tools...
- If not otherwise described in the manual, the manipulator(s) are bakeable up to 150°C . Please consult the specific manipulator(s) manual. Do not remove the magnetic coupling for the bakeout procedure. It is recommended to use the parking rail if provided during bakeout.
- Plug in the silicone cable for activation of the getter element into the matching socket of the NEG/Ion pump.



Fig. 8: Plug the silicone cable in

- Make sure that the bakeout temperature **never** exceeds **150°C** ! We recommend using a suitable bakeout controller (or the heater provided with our heating jacket).

- Cover all windows and not used feedthroughs with two layers of aluminum foil.
- In case of using heating tapes, cover the chamber and the manipulator(s) with two layers of aluminum foil if you want to avoid heating marks from the cable.
- If no heating jacket with integrated heater, like the **VSN40SBT-HE** is available, place heating tapes around the gate valve, chamber and the manipulator(s). These should not cross. Any hot spots should be avoided and the system heated up evenly. Cover the chamber and the manipulator(s) with some layers of aluminum foil for thermal insulation.
- Recheck that the turbopump and the ion pump are running normal and that the vacuum level is below 1×10^{-6} mbar.
- Make sure that the **gate valve of the VSN40S is open.**



CAUTION! Never remove the magnetic coupling of the manipulator(s) for the bakeout procedure if that is not explicitly described in the manipulator(s) instruction. Make sure, its temperature **never** exceeds **150°C!**

- Before start with baking (re-)activate the getter material of the pump.

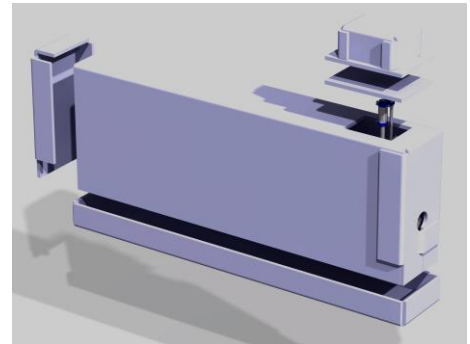
8.2. Bakeout with heating jacket VSN40SBT-HE

The comfortable heating jacket is provided with a heating element and integrated thermocouple of type K. When using the heating jacket **VSN40SBT-HE** prepare the vacuum suitcase as described above (removal of all non-bakeable items and coverage of windows/feedthrough with Al foil).

- Place the suitcase onto the (long rectangular) bottom part of the jacket
- Place the heater on the rails of the wobble stick as shown in the image with the heater facing downwards. The cables can be passed through one of the corners of the heating jacket.
- If wanted, place another thermocouple on the suitcase. This is not absolutely necessary if you use the provided heater and jacket correctly. The temperatures are limited to safe values.
- Carefully put together the heating jacket as shown in the figure. (The little hat on top might not be needed in case you don't have higher parts as a sample storage with sample transporter installed on top.) There should not be any opening left which might lead to lower bakeout temperatures.



Fig. 9: Bakeout jacket and heater placement



8.3. NEG (re-)activation

- Plug-in the banana plugs of the silicone cable for activation into any standard DC lab power supply. If it is not possible to monitor the current and voltage properly, two standard multimeters can serve as monitor display.



IMPORTANT: During (re-)activation and bakeout the ion pump of the combined NEG/ion pump must be turned off!

- The pressure should be at all times **below 5×10^{-5} mbar** during (re-)activation.
- The suggested current/time combination for the best (100%) activation for the pumps with St 172 alloy getter material is written in the table below. The chamber wall will act as thermal shield allowing the getter material to reach higher activation temperature. Lower current values might therefore be sufficient to reach 450°C.

<i>Pump model</i>	<i>Voltage</i>	<i>Current</i>	<i>Power</i>	<i>Time</i>	<i>Max. Current</i>
NexTorr D-100-5	9 V	5 A	45 W	60 minutes	5 A
NexTorr D-200-5	12.5 V	4.8 A	60 W	60 minutes	5 A

- The reactivation of the getter material is necessary every time the pump was exposed to air or when the pumping speed falls below acceptable limits. If reactivation is preceded by an air exposure and successive pump down cycle, follow the same procedure of activation.
- If the reactivation follows normal operation in vacuum without air venting, it can be shorter and carried out at lower temperature (approximately 25% lower)."

- For more information please consult the authoritative operating instructions of the pump manufacturer.



IMPORTANT:

The maximum applicable current for NEG (re-)activation is 5 Ampere.

8.4. Baking

- Connect the heater tapes to a temperature controller. Baking temperatures must be monitored using a suitable temperature sensor (typically K-type thermocouples).
- Start with evenly heating the UHV system. The temperature inside the bakeout zone should reach 100°C - 150°C within approximately 4h hours.
- At this stage, note down the vacuum conditions and the starting time of the bakeout.
- Bake the suitcase for at least 24 hours.
- Control the temperature on a regular basis during the bakeout.



CAUTION: The surface of the bakeout zone reaches a temperature of 100°C - 150°C. Keep all inflammable substances and items well clear of the bakeout zone.

8.5. Cooldown

- Turn off the heaters.
- During cooldown of the UHV system **activate or flash the NEG element at a system temperature of around 80°C-100°C** (see next section 8.2 or 8.5 "NEG flashing").
- Let the system cool down until you can touch the handle of the gate valve.



CAUTION: Do not touch the handle of the gate valve without checking if its temperature is below 40°C. Use a laboratory thermometer.

- Close the gate valve as soon as you can touch it.
- Start the ion element (the pressure should have resettled from the NEG activation).
- If possible, degas the manipulator(s) by moving them occasionally while the system is still warm.
- Wait for another 24 hours and let it settle until your ultimate base pressure is reached.
- Let the turbo pump connected and running, even though your gatevalve is closed.

After the bakeout and NEG activation the system is ready for operation. Please go back to chapter 5 "Installing the suitcase to a UHV system" on page 12 in this manual.

8.6. NEG flashing

If the system has not been exposed to air, a shorter flashing could be sufficient after bakeout.

- NEG flashing is the same procedure as described in chapter 8.2 "NEG activation" on page 16 but during shorter time and carried out at lower temperature. We recommend flashing the getter material with: **3.6V - 2.5A (9W) for 30 minutes.**

9. Upgrades

There are different additional options and upgrades for the UHV suitcase available. For details visit also our website www.ferrovac.com. If you have any questions please do not hesitate to contact us (suitcase@ferrovac.com).

9.1. *Upgrade to LSA2.1 battery powered ion pump controller*

The LSA2.1's pumping current display has a 10 times better resolution than the LSA2.0 (1nA). This option allows to measure a base pressure in the 10E-11 mbar range.

9.2. *Additional ports*

9.2.1. *Additional service port UPGRADEVSN40S(+SP40)*

This option is only possible at the time the order is placed and cannot be retro-fitted. The suitcase is also available with an additional DN40CF service port for a vacuum gauge, electrical feedthrough, etc.

9.2.2. *Additional rare view window UPGRADEVSN40S(+RV)*

This additional RV-viewport provides an auxiliary viewpoint, which for example facilitates sample exchange from the storage. **Not compatible with SP40 option.**

9.2.3. *Two additional DN16CF service ports UPGRADEVSN40S(+SP2X16)*

The two additional DN16CFT service ports enable installation of multiple devices like vacuum gauges, electrical feedthroughs and other equipment.

9.3. *Upgrade to 200 l/s nominal pumping speed*

The ion pump element of the NexTorr D-200-5 with its magnet and housing is identical to the 100 l/s pump. The NEG element with 200 l/s capacity is a little longer but still fits into the suitcase chamber without modification.

9.4. *Heating jacket with heat available, VSN40SBT-HE*

The Heating Jacket VSN40SHJ allows easy and fast isolation for bakeout of the suitcase.

9.5. *Fast pump down dock with LN2 UHV Booster*

The VSCT40 transfer chamber enables the exceptionally fast transfer of a sample from a UHV suitcase into the UHV-System. Vacuum in the transfer chamber is created using a turbo pump as well as a **cryogenic pump**. Thus a sufficient vacuum is established within approximately 30 minutes, as opposed to 24 hours when baking out the buffer volume conventionally. The turbo pump is not part of the product.

9.6. *Retrofit your suitcase with other manipulators*

If the requirements for the suitcase have changed, maybe the retrofit with other manipulators are a possible solution. The VSN40S is fully compatible with our wide range of manipulators such as linear/rotary feedthroughs, wobblesticks and sample transporters.

The suitcase can be used in combination with a single sample transfer mechanism such as a pincer grip, fork or similar mounted on the suitcase-manipulator. Therefore the suitcase-manipulator grabs the samples directly from the connected UHV system. An optional key feature is to install an additional linear/rotary feedthrough featuring a stack of sample receptacles serving as sample storage for multiple samples. This allows the user not only to transport just one sample at a time, but also to store a larger number of samples under true UHV conditions and to exchange several samples at once from the connected system in a step-by-step mode.

Also the suitcase can be used in combination with a storage sample transfer mechanism such as a stack of receptacles, carousel or similar mounted on the suitcase-manipulator. Therefore an external manipulator of the UHV system, on where the suitcase is connected, must actively grab the samples from the extracted suitcase-manipulator's sample storage.

10. Additional information

10.1. 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.

10.2. Download

This manual can be downloaded from our website. It can be found in the specifications of the base module of the NexGeneration UHV suitcase.