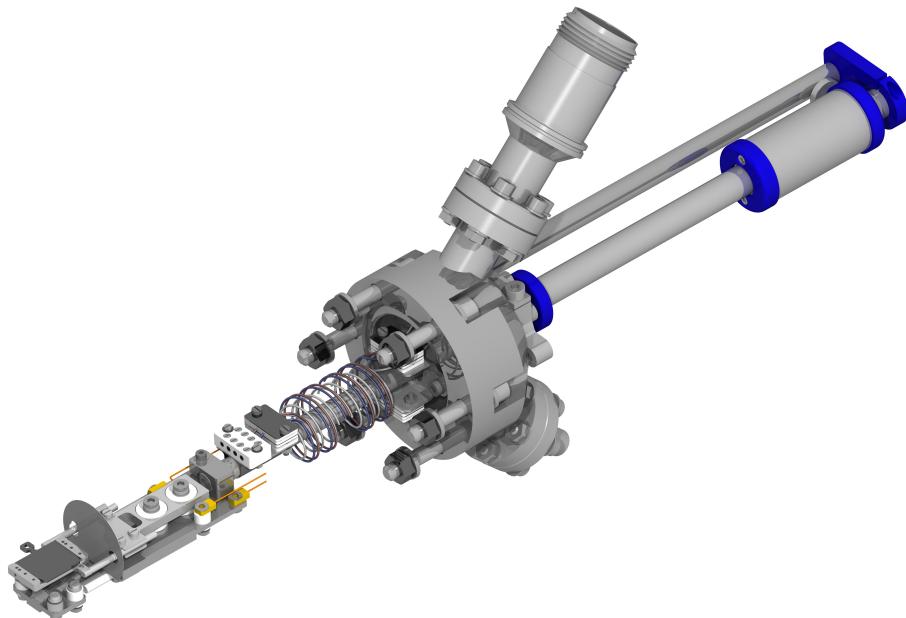


FERROVAC

ULTRA HIGH VACUUM TECHNOLOGY

HSASOM40(EBMD)-XXXX-YYYY

Electron Bombardment Sample Heating Stage
on Linear / Rotary Feedthrough



Version 1.4

March 2024

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Important!

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.

Warranty

Ferrovac warrants this product to be free of defects in material and workmanship for 24 months from the date of shipment. In the case of any defects, Ferrovac will either repair or replace the product at our discretion.

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 implied warranty of implied merchantability or fitness for a particular use. The remedies provided herein are the buyer's sole and exclusive remedies.

Neither the company Ferrovac 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 Ferrovac has been advised 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.

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1. General Information

This manual covers all important information about installation, commissioning and operation of your HSASOM40(EBMD). 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.

1.1. 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!

1.2. 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.

2. Terms and Symbols

Symbol	Term	Meaning
	Danger!	Risk of mortal danger when not observed
	Warning!	Risk of severe injury or danger to life when not observed
	Caution!	Slight risk of injury or damage to product when not observed
	High voltage!	Potentially lethal voltages are present
	Caution, hot surface!	Potential burn hazard if safety precautions are not followed
	Cryogenic Substances!	Potential cold burn hazard if safety precautions are not followed
	Important!	Important information for proper operation of the product
	Info, hint!	Useful hints, tips and clues

3. 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 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 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

3.1. Specific Safety Precautions for the HSASOM40(EBMD)

The electron bombardment sample heating stage on a linear / rotary feedthrough (Product code: HSASOM40(EBMD) is intended for use by qualified personnel who recognize shock hazards and are familiar with the precautions necessary to avoid possible injury.



Warning: Potentially Lethal Voltages!

This Product operates at potentially lethal voltages of up to 230VRMS.

Any adjustment, fault finding procedure, installation and maintenance of the product described in this manual must be carried out only by authorized service personnel.

- In case of malfunction, immediately disconnect the unit from the mains power supply
- Do not touch any electrical terminals, connectors or wires
- Report damaged cabling immediately to service personnel
- Always wear electrically isolating safety shoes when performing maintenance



Caution, hot surface!

- Certain components reach high temperatures during operation and represent a hazard - avoid direct contact.
- Covering the device and his components poses a fire hazard. Always keep objects, combustible objects, liquids, gases etc. well away from the heat source.

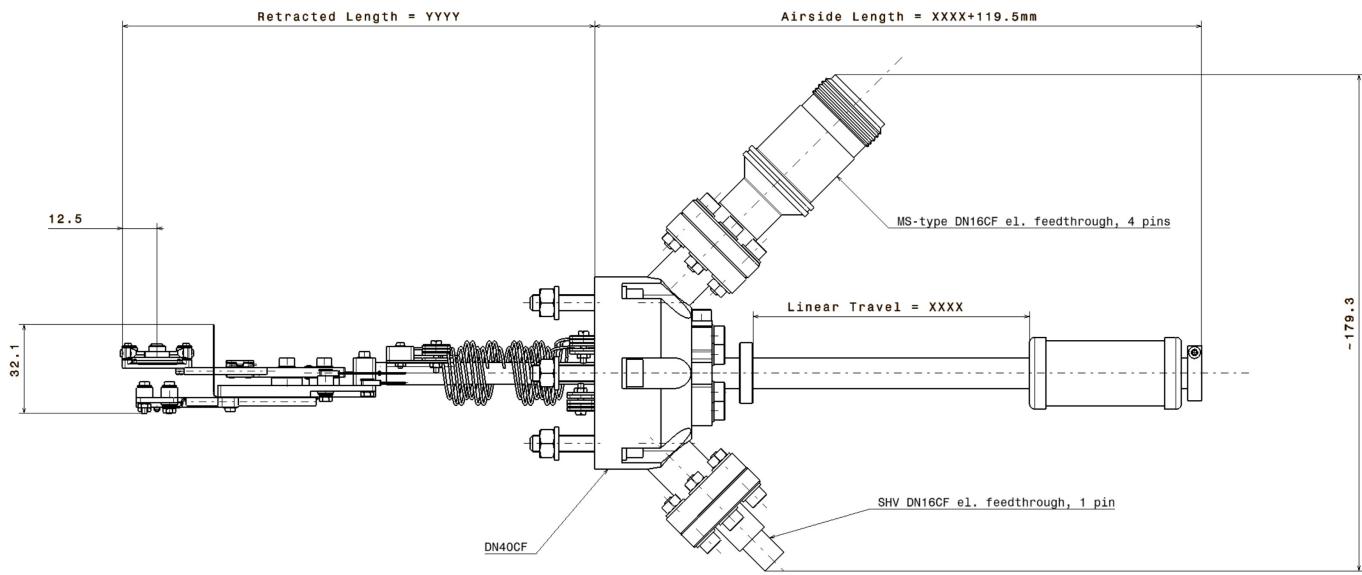
4. About

HSASOM40(EBMD) heating stage assembly for flag style sample plates. It can be used for a wide range of materials at operating pressures in the lower 10E-10 mbar range. The sample plate is heated by the principle of electron bombardment. The electrically heated filaments emit in their glowing condition free electrons, which accelerate by a positive high voltage up to 1kV onto the sample plate (high voltage applied to the sample!). With this very effective way of heating by electron impacts on the sample plate, temperatures of ~2000°C can be reached within a few seconds. For moderate heating up to ~500°C, irradiation of the sample plate by the tungsten filament is sufficient.

4.1. Dimensions

The HSASOM40(EBMD) is mounted to a DN40CF connection flange and includes built-in MS and SHV type electrical feedthroughs. The distance between flange surface and center of the sample plate can be customized completely and will be defined by the specifics of the ordered product.

The technical drawing side view below shows all important dimensions of the entire stage.



4.2. Product Configuration

- The E-beam heater assembly HSOME is completely mounted on an MD16 linear / rotary feedthrough fixed to a DN40CF special flange, incl. wiring and electrical feedthroughs.
- MS type air side connector included.
- SHV type air side connector included
- fully UHV compatible materials
- Controller not included
- Power supplies and airside cables not included
- Thermocouple can optionally be installed, but limits the maximum temperature to 1300°C

4.3. Specifications

E-Beam Heater Assembly for Flag Style Sample Plates: HSOME(P)

- Maximum Temperature: 2000°C
- Maximum HV Voltage: 1.6 kV
- Filament Resistance: 3.6 Ohm @26°C (measured at feedthrough)
*Diagram in chapter 6.1
- HV Power Supply: Not included
(Recommended: CE marked, DC voltage range 0-1.5kV, 600W, adjustable current limit, *Diagram in chapter 6.1 output current reading resolution 1mA)
- Low Voltage Power Supply: Not included
(Recommended: conventional lab PSU, CE marked, DC range 0-30V, 100W, adjustable current limit, output current reading)
*Diagram in chapter 6.1
- Materials:
 - Body/ Base Plates: Molybdenum, stainless steel (grade A4)
 - Sample Plate Receiver: Molybdenum
 - Heater Filaments: Tungsten
 - Isolators: Ceramics (Al2O3)
 - Screws/ Washers: Molybdenum, stainless steel (grade A4)
- Tolerances:
 - Machined Parts: ISO 2768-m-K
- Optionally Installed Thermocouple: K-type (chromel/alumel)
(Limits Max Temperature to 1300°C)

Linear / Rotary Feedthrough :

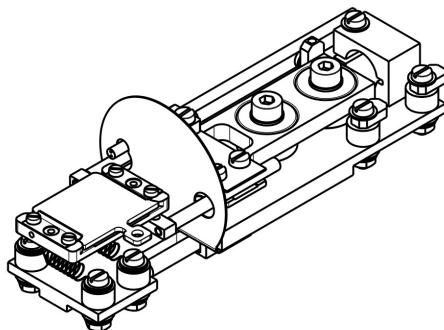
- Maximum linear force: 30N
- Maximum torque: 0.5Nm
- Maximum bakeout temperature: 200 °C
- Pressure range: 1E-11mbar to 1000mbar
- Materials:
 - Body: All used materials are fully UHV compatible
 - Glide bearings: Stainless steel (grade A4), aluminium
 - Magnets: PTFE
 - Screws/ Washers: Samarium cobalt
- Tolerances:
 - Machined Parts: Stainless steel (grade A4)

4.4. Configuration-specific specifications

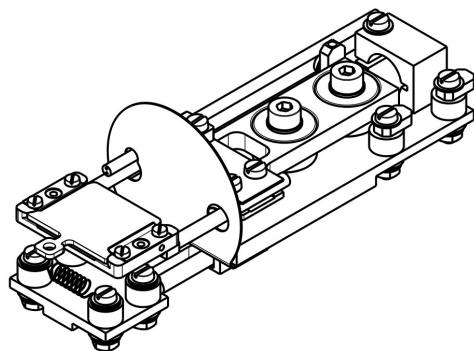
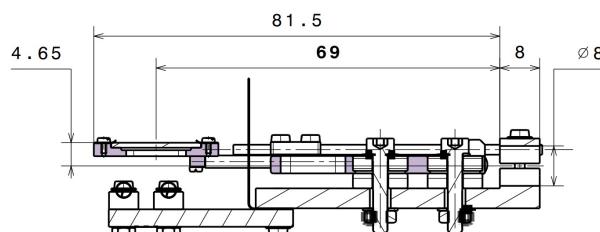
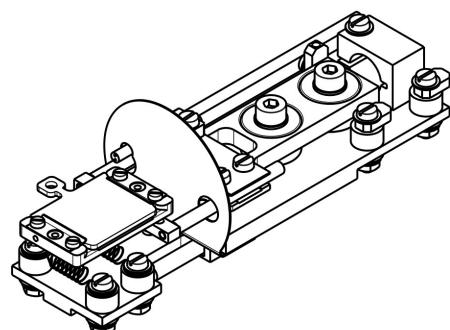
Orientation Sample Plate Receiver:

The following images show all the different ways the base model sample plate receiver can be mounted to the HSOME heating stage. Each mounting position is marked with it's corresponding product code.

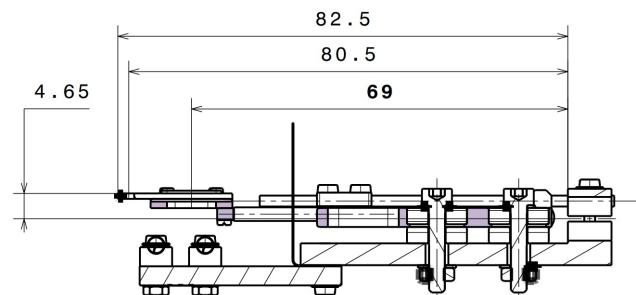
HSEBOM(P)
sample surface parallel to flange,
access from right side



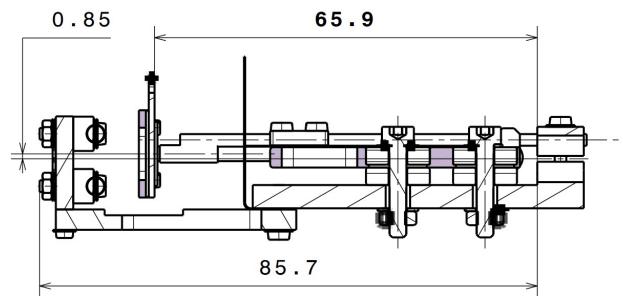
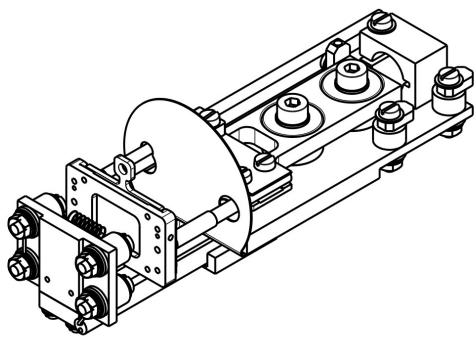
HSEBOM(P)
sample surface parallel to flange,
access from left side



HSEBOM(PS)
sample surface parallel to flange,
access in axis (straight)



HSEBOM(N)
sample surface normal to axis



Caution!

The specification may change if upgrades or accessories are mounted to the main product.

5. Unpacking and Installation

Before unpacking, optically inspect the parcel. If any damage is found, take pictures of the parcel and send them to Ferrovac immediately. Package contents depend on each specific heater configuration or UHV-Suitcase package. Compare content with the delivery note. Any damage or missing items must be reported to Ferrovac **within one week of delivery**.



Caution!

- Ensure enough workspace on a clean table for unpacking and inspection
- Some Ferrovac products are shipped under UHV! Sudden uncontrolled venting can cause damage to pumps and valves
- Read manuals carefully before using any device
- Never expose any component of the product/system to physical shock or aggressive chemicals
- CF-Flange knife edges and edge-welded bellows are particularly vulnerable, any damage to these parts may result in a complete failure of the vacuum integrity

5.1. Product Specific Unpacking and Installation Instructions



Caution!

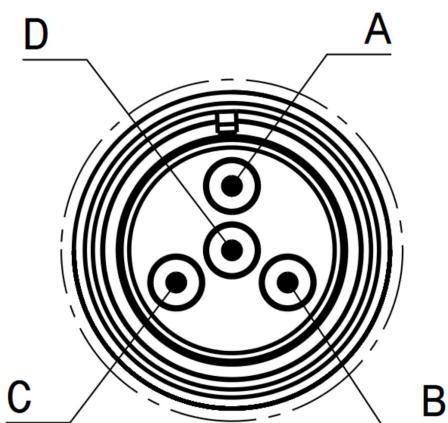
This product is designed for use in a UHV environment and therefore is cleaned to UHV standards.

- Never touch the product with bare hands or unclean gloves.
- Only place the product on adequately clean surfaces and only use clean tools to work on the product.
- Do not leave the product out of a vacuum environment unprotected for a prolonged period of time.

Electrical Connections:

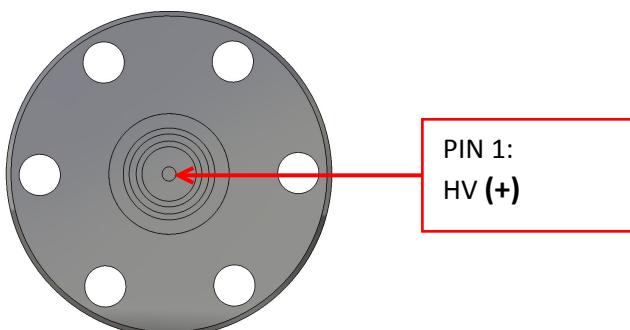
The HSASOM40(EBMD) stage has two electrical feedthroughs, and is shipped with fitting air side connectors for both.

Pin assignment (air side) - MS-type feedthrough DN16CF, 4 pin:

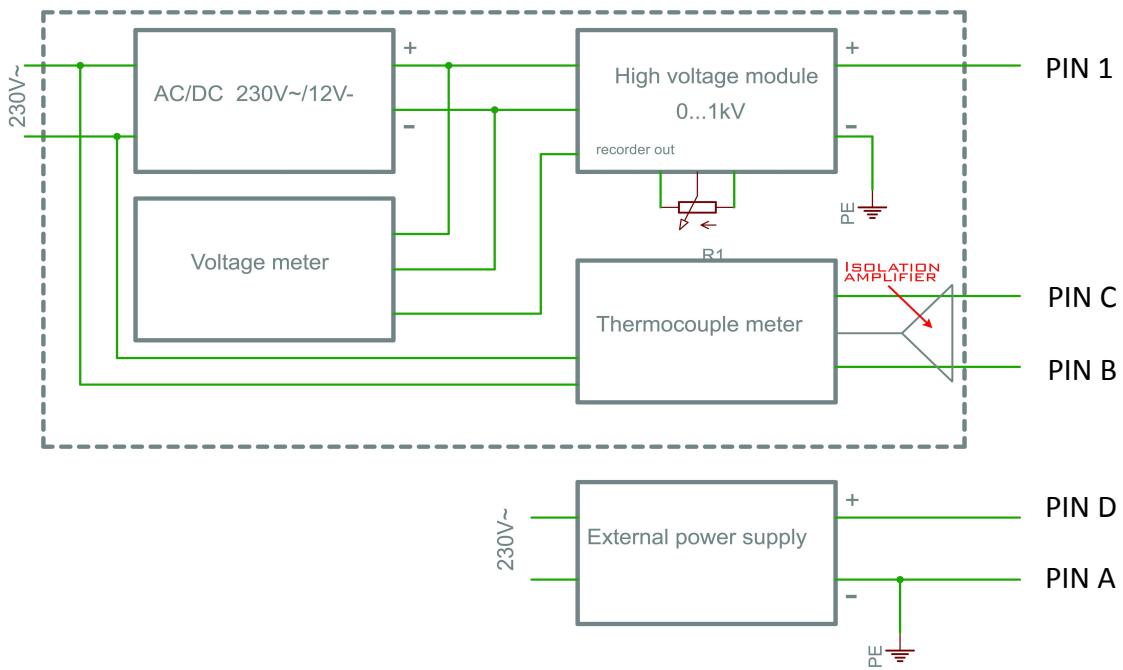


Terminal	Function
A	heater - (GND)
B	if incl.: TC - (Ni-Al)
C	if incl.: TC + (Ni-Cr)
D	heater +

Pin assignment - SHV high voltage feedthrough DN16CF, 1 pin:



Example for connection configuration:



28.03.2012 10:52:01 f=1.84 N:\PROJEKTE\DIV\Beam Heater Control.sch (Sheet: 1/1)



Caution!

All wiring work and other work related to the electrical connections for this product must be done by appropriately qualified personnel.

Thermocouple:

The Type K thermocouple is optionally installed. Since the thermocouple measures the temperature of the sample receptor directly, it is floating at high voltage! The additional pins for the MS-type Plug are provided.



Warning: Potentially Lethal Voltages!

This Product operates at potentially lethal voltages of up to 230VRMS.

Any adjustment, fault finding procedure, installation and maintenance of the product described in this manual must be carried out only by authorized service personnel.

- In case of malfunction, immediately disconnect the unit from the mains power supply
- Do not touch any electrical terminals, connectors or wires
- Report damaged cabling immediately to service personnel
- Always wear electrically isolating safety shoes when performing maintenance

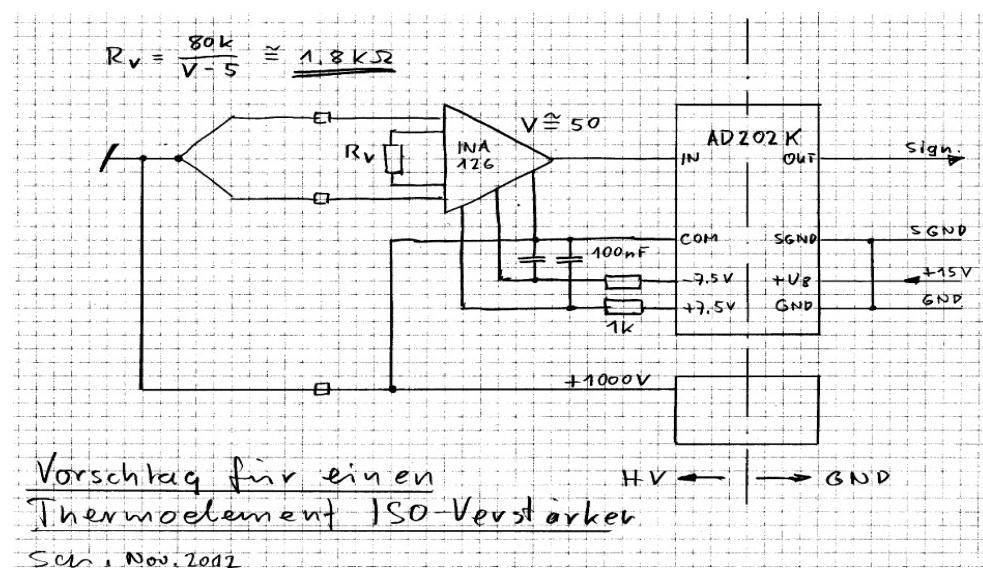
For the electrical connection use a Molybdenum or Tantalum screw for fastening the thermocouple on the sample receptor and pull it through the provided ceramic tube.

To avoid an electrical breakdown at airside, it is mandatory to separate the electrical current galvanically by using an isolation amplifier, such as the AD202K from Analog devices (datasheet below) for example with an internal isolated supply for the input part and an adjustable gain (max. 100).

(datasheet ISO122: <http://pdf1.alldatasheet.com/datasheet-pdf/view/47966/AD/AD202K.html>)

Because the thermocouple is on high voltage at the contact point, an instrumentation amplifier (working as a preamplifier) obtrudes itself. A suitable instrumentation amplifier would be the INA126 from Burr Brown, adjusted with a gain of 50.

See the circuit suggestion below.



Power Supplies:

Power supplies are not included in the standard version of the HSASOM40(EBMD) heating stage.

Below you can find information about which power supplies we recommend for this product:

Recommended high voltage power supply:

The CE marked HV supply should have a DC voltage range from 0-1500V positive polarity with a recommended power of 600W. An adjustable current limit should be provided and an accurate reading of the output current with 1mA resolution.



Warning: Potentially Lethal Voltages!

Any high voltage supply with a high power output can cause a potentially lethal electric shock if operated by unqualified personnel!

Recommended low voltage power supply:

The CE marked low voltage DC power supply (conventional lab PSU) should have a voltage range from 0-30V with a recommended power of 100W. An adjustable current limit should be provided and a reading of the output current.

The negative output of the power supply must be connected to earth potential.

6. Operation

6.1. Operating the heating stage

- Mount the heating stage to a UHV chamber and pump down to a working pressure of about $1*10E-9$ mbar.
- Establish electrical connections to the power supplies or control unit.
- The operation power for the high voltage and filament are displayed in charts at chapter 6.3.
- Increase the high voltage slowly up to desired voltage while observing the vacuum gauge.
No pressure increase and no voltage breakdown should be observed.
- Turn on the filament power supply in current limited mode and slowly increase the filament current. While slowly increasing the filament current, check for emission current on the HV-supply current display and keep an eye on the chamber pressure.



Caution!

Do not operate the heating stage in a pressure above $1*10E-6$ mbars!

- Measure the temperature by using a thermocouple, if one has been installed.



Caution!

The typically used thermocouple Type K operates only up to temperatures of $\sim 1300^{\circ}\text{C}$. This is the limited operating temperature.

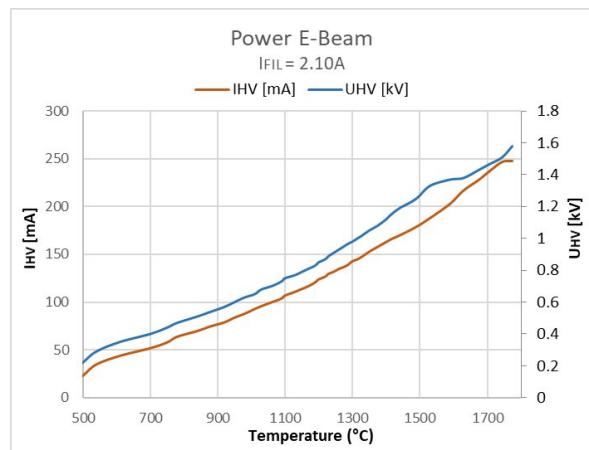
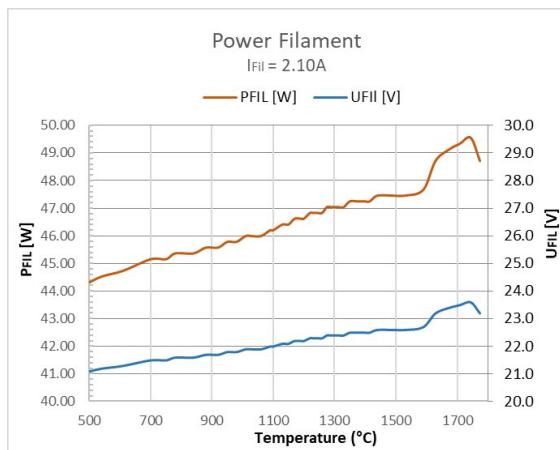
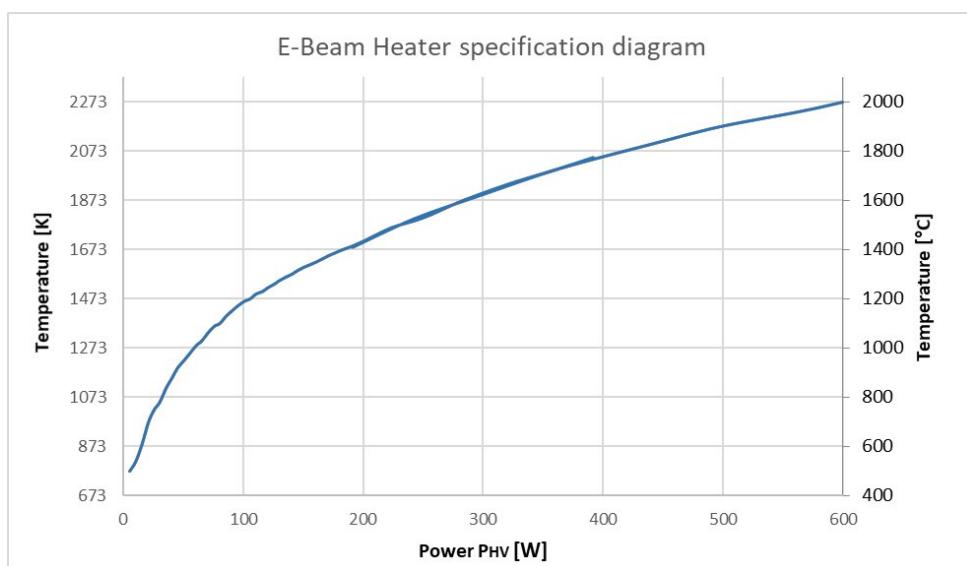
- Hold the filament current at the wanted heating temperature.
- For higher operating temperatures, the thermocouple should be dismounted consequently. In this case it is recommended to use a Pyrometer for temperature measurement.

6.2. Shutting the heating stage down

- Switch off the filament current by decreasing the current slowly by the control unit.
- Switch off the high voltage the same way.

6.3. Operation Power Overview

- The following test has been conducted with a HSASOME(PS) constellation and a Tantalum flag style sample plate.
- The temperature measured is after 30 seconds of applying the high voltage. Due to the heat transfer delay at powers below 150 W, the maximal achievable temperature is expected to be 50-100K higher than displayed.
- The temperature is measured by the Heitronics KT 19.01 radiation thermometer (so called pyrometer). Temperature could only be read above 500°C.

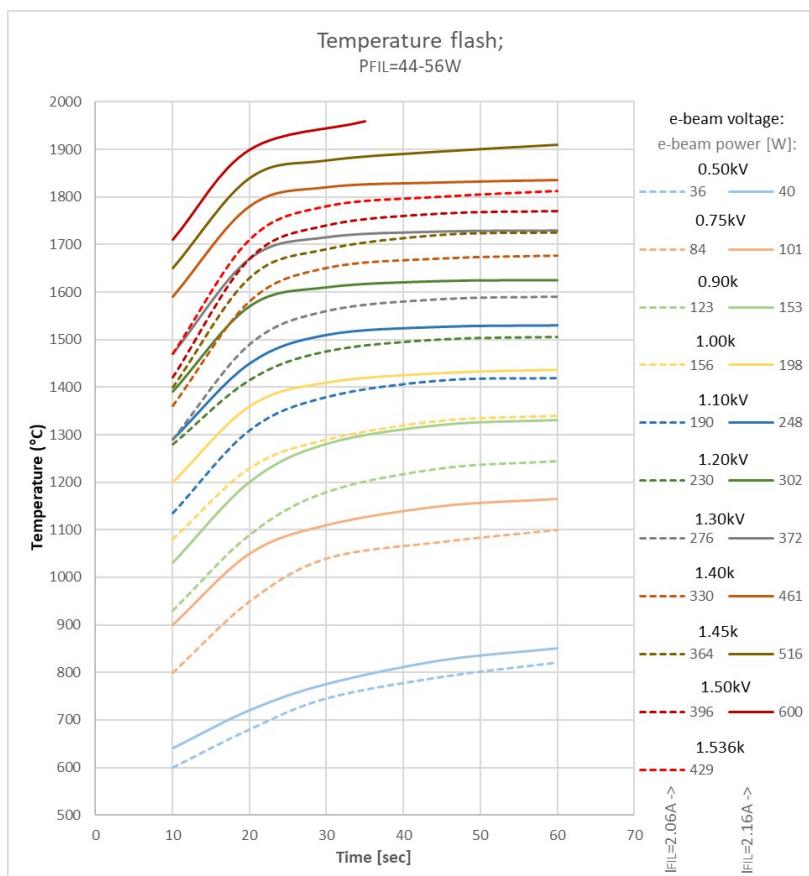


- Following is the table of raw data from the measurement series.

aimed	Filament				E-Beam				Temperature	
	PHV [W]	U _{Fil} [V]	I _{Fil} [A]	P _{Fil} [W]	R _{Fil} [Ω]	U _{HV} [kV]	I _{HV} [mA]	P _{HV} [W]	R _{HV} [Ω]	T [°C]
10	21.2	2.10	44.52	10.10	0.29	35	10.2	8286	540	813
20	21.5	2.10	45.15	10.24	0.4	52	20.8	7692	700	973
30	21.6	2.10	45.36	10.29	0.47	64	30.1	7344	780	1053
40	21.7	2.10	45.57	10.33	0.54	75	40.5	7200	880	1153
50	21.8	2.10	45.78	10.38	0.6	84	50.4	7143	950	1223
60	21.9	2.10	45.99	10.43	0.65	93	60.5	6989	1010	1283
70	21.9	2.10	45.99	10.43	0.7	100	70.0	7000	1060	1333
80	22.0	2.10	46.20	10.48	0.75	107	80.3	7009	1100	1373
90	22.1	2.10	46.41	10.52	0.79	114	90.1	6930	1150	1423
100	22.2	2.10	46.62	10.57	0.83	121	100.4	6860	1190	1463
110	22.3	2.10	46.83	10.62	0.87	127	110.5	6850	1220	1493
120	22.3	2.10	46.83	10.62	0.91	132	120.1	6894	1245	1518
130	22.4	2.10	47.04	10.67	0.95	137	130.2	6934	1275	1548
140	22.4	2.10	47.04	10.67	0.98	143	140.1	6853	1300	1573
150	22.4	2.10	47.04	10.67	1.02	148	151.0	6892	1330	1603
160	22.5	2.10	47.25	10.71	1.05	153	160.7	6863	1350	1623
170	22.5	2.10	47.25	10.71	1.08	158	170.6	6835	1375	1648
180	22.5	2.10	47.25	10.71	1.12	163	182.6	6871	1400	1673
190	22.5	2.10	47.25	10.71	1.15	166	190.9	6928	1415	1688
200	22.6	2.10	47.46	10.76	1.19	170	202.3	7000	1440	1713
225	22.6	2.10	47.46	10.76	1.25	179	223.8	6983	1490	1763
250	22.6	2.10	47.46	10.76	1.33	188	250.0	7074	1530	1803
275	22.7	2.10	47.67	10.81	1.37	203	278.1	6749	1590	1863
300	23.2	2.10	48.72	11.05	1.38	217	299.5	6359	1630	1903
325	23.4	2.10	49.14	11.14	1.43	228	326.0	6272	1675	1948
350	23.5	2.10	49.35	11.19	1.47	238	349.9	6176	1710	1983
375	23.6	2.10	49.56	11.24	1.51	247	373.0	6113	1745	2018
390	23.2	2.10	48.72	11.05	1.58	248	391.8	6371	1775	2048
191	24.6	2.16	53.14	11.39	1.00	191	191.0	5236	1410	1683
242	25.1	2.16	54.22	11.62	1.10	220	242.0	5000	1525	1798
300	25.4	2.16	54.86	11.76	1.20	250	300.0	4800	1625	1898
364	25.7	2.16	55.51	11.90	1.30	280	364.0	4643	1730	2003
441	26.1	2.16	56.38	12.08	1.40	315	441.0	4444	1830	2103
497.35	26.4	2.16	57.02	12.22	1.45	343	497.4	4227	1900	2173
562.4	27.0	2.16	58.32	12.50	1.48	380	562.4	3895	1960	2233
600	27.0	2.16	58.32	12.50	1.50	400	600.0	3750	2000	2273

6.3.1. Operation of flash cycles

- For flash operations the high voltage can be chosen from the displayed chart. First the filament current is set as required. Subsequently the high voltage is turned on with the required voltage directly.
- Two different filament currents are compared. Because of the difference of the free electrons, the power of the e-beam is significantly higher at the same voltage.
- Because with higher temperature of the filament and constant current source, the power of the filament is increasing. This results also in a power increase of the e-beam. The specified e-beam power (legend) is the power required at peak temperature (after 60 seconds).



- Following is the table of raw data of the flash cycle series.

Ifil=2.06A										
Filament		E-Beam				Temperature [°C]				
U _{Fil-E} [V]	P _{Fil} [W]	U _{UHV} [kV]	I _{HV-S} [mA]	I _{HV-E} [mA]	P _{HV} [W]	T _{10s}	T _{20s}	T _{30s}	T _{45s}	T _{60s}
21.7	44.7	0.50	71	71	36	600	680	745	790	820
22.1	45.5	0.75	108	112	84	800	950	1040	1075	1100
22.3	45.9	0.90	129	137	123	930	1090	1180	1230	1245
22.6	46.6	1.00	144	156	156	1080	1230	1290	1330	1340
22.7	46.8	1.10	156	173	190	1135	1310	1380	1415	1420
22.9	47.2	1.20	170	192	230	1280	1415	1475	1500	1505
23.1	47.6	1.30	182	212	276	1290	1490	1560	1585	1590
23.4	48.2	1.40	195	236	330	1360	1580	1650	1670	1676
23.6	48.6	1.45	200	251	364	1400	1630	1690	1720	1725
23.7	48.8	1.50	205	264	396	1420	1670	1740	1765	1770
23.9	49.2	1.537	208	279	429	1470	1710	1780	1800	1812
Ifil=2.16A										
23.6	48.6	0.50	79	80	40	640	720	775	825	850
24.2	49.9	0.75	133	135	101	900	1050	1110	1150	1165
24.4	50.3	0.90	164	170	153	1030	1200	1280	1320	1330
24.9	51.3	1.00	188	198	198	1200	1360	1410	1430	1437
25.1	51.7	1.10	210	225	248	1290	1450	1510	1527	1530
25.5	52.5	1.20	230	252	302	1390	1570	1610	1623	1625
25.9	53.4	1.30	250	286	372	1470	1670	1715	1727	1729
26.4	54.4	1.40	275	329	461	1590	1780	1820	1830	1835
26.8	55.2	1.45	285	356	516	1650	1840	1877	1896	1910
27.2	56.0	1.50	300	400	600	1710	1900	1950		

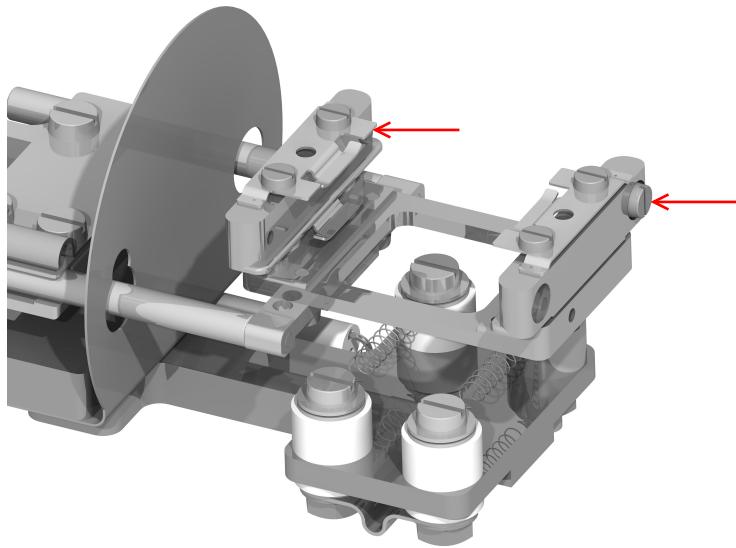
7. Options and Upgrades

7.1. UPGRADEHASAS40EB(+UNISOKU):

Double-Decker Receiver for a SHOM or a UNISOKU Sample Plate, fitting the HSOME Heating Stage

This upgrade can not be used in orientation N, but is compatible with all other orientations.

This upgrade includes a second receiver on top of the flag style sample receiver, made to fit Unisoku sample carriers.



Only one of the two styles of sample carriers can be inserted at any given point.

The Unisoku sample carrier can only be inserted from a predetermined side of the receiver.

Two screws, as shown in the image above, can be adjusted to fine tune the position of the sample carrier on the receiver. The same two screws can also be used to change from which side the sample carrier is inserted into the receiver.

8. Additional Information

8.1. Return of Defective Items

Before any items are returned to the factory, Ferrovac requires a completed declaration of contamination form and will issue a corresponding Return Material Authorization (RMA) number, along with information on how to proceed with the return of defective items.

8.2. Downloads

The latest version of this manual can be downloaded from our website Ferrovac.com. For any suggestions or questions concerning this manual, please don't hesitate to contact us.

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