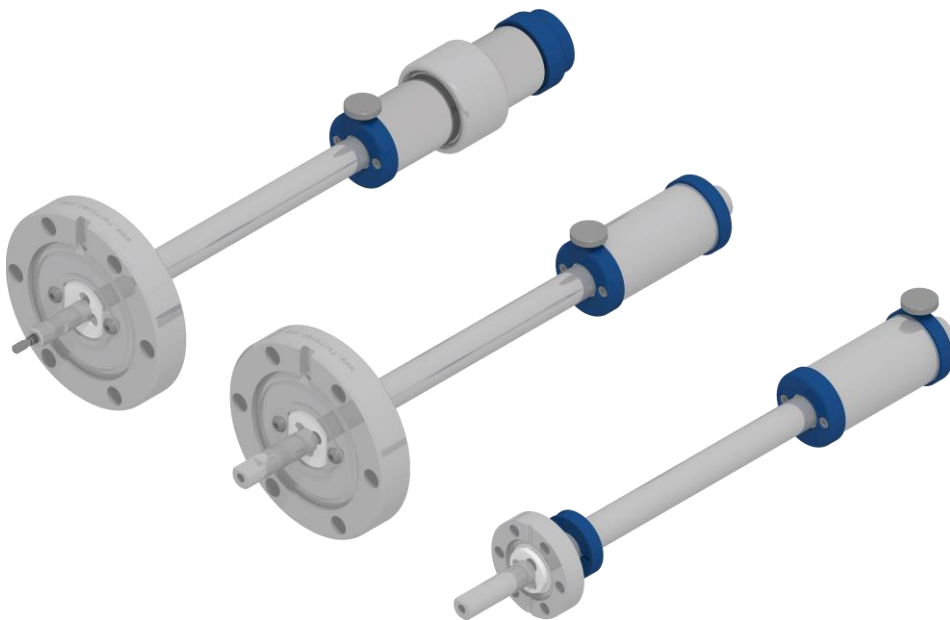


FERROVAC
ULTRA HIGH VACUUM TECHNOLOGY

MD16/MD40/MDG40
Linear Rotary Feedthroughs



User Manual

65828 Revision B

February, 2026

Ferrovac AG
Thurgauerstrasse 72
CH-8050 Zürich

www.ferrovac.com

**Important!**

It is the sole responsibility of all users, service engineers and technicians to read the user manual carefully and keep it in a safe place, accessible by all users. Read and strictly follow all safety instructions before using the product described in this document. Ferrovac declines all responsibility and liability for any damage or injuries resulting from incorrect use, non-designated use, adjusting, controlling, altering, or re-programming of the product.

Warranty

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

Warranty limitations

This warranty does not apply to defects resulting from the following:

- Failure to observe 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 replaces all other warranties, whether implied or expressed, including any implied warranty of merchantability or fitness for a particular use. The remedies provided herein are the buyer's sole and exclusive remedies.

Ferrovac AG and its employees shall not be liable for any direct, indirect, incidental, consequential, or special damages arising from the use of its products, even if Ferrovac AG has been advised of the possibility of such damages. Excluded damages may include, but are not limited to, costs of removal and installation, losses due to injury, or property damage.

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1. General Information

This manual covers crucial details regarding the installation, operation and maintenance of your MD16/MD40/MDG40. It also includes essential safety instructions, maintenance procedures, guidelines for identifying faults, and methods for correcting identified issues.

The described product adheres to relevant technical standards and guidelines during its manufacturing. The information provided in this document reflects the product's state at the time of printing and is subject to technical modifications without prior notice. Ferrovac does not guarantee the absolute accuracy or completeness of the contents of this publication. Figures and images included are for reference purposes and may not be binding. Product names used are for identification and might be trademarks of their respective companies.



Important: Read Manuals First!



Before using the product or any related equipment, please thoroughly read all safety instructions and pertinent manuals.

1.1. Designated Use

The **MD16, MD40, and MDG40** are magnetically driven feedthroughs specifically designed for the **transmission of linear and/or rotary motion** into ultra-high vacuum (UHV) environments.

The product is designed for:

- **Sample Transfer:** Moving samples between vacuum chambers (e.g., from load-lock to main chamber).
- **Positioning:** Precise alignment of sample holders, storage platforms, or mechanical components inside UHV systems.
- **Actuation:** operation of internal mechanical devices under vacuum conditions.

The actuation may be performed manually or by approved Ferrovac motorization units.

Operational Requirements:

- **Installation:** Must be mounted on compatible CF flanges using appropriate metal gaskets.
- **Limits:** Must be operated strictly within the specified pressure, temperature, and torque limits (see Technical Specifications).
- **Personnel:** Installation and operation must be performed exclusively by personnel trained in vacuum technology and the handling of delicate scientific equipment.
- **Compliance:** Usage must strictly follow this manual & all referenced technical documentation.






1.2. Non-Designated Use

Any use deviating from the intended application described above is considered non-designated. Ferrovac assumes no liability for damages resulting from improper use; the risk is borne solely by the operator.

Non-designated use includes, but is not limited to:

- **Boundary Violations:** Operation outside the specified vacuum, temperature, or mechanical load ranges.
- **Structural Misuse:** Use as a structural support, load-bearing element, or handle in atmospheric pressure environments.
- **Mechanical Abuse:** Application of excessive torque, axial force, or mechanical overloading beyond the design limits.
- **Unauthorized Modifications:** Any structural or functional changes without prior written approval from Ferrovac.
- **Third-Party Integration:** Use of non-approved motor drives or control systems.
- **Safety Negligence:** Operation with damaged components, compromised vacuum seals, or in disregard of the safety instructions provided.

2. Terms and Symbols

Symbol	Term	Meaning
	Caution!	Risk of injury or damage to equipment when not observed
	Warning!	Risk of severe injury, danger to life and risk of damage when not observed
	Important!	Important information for safe operation of the equipment
	Information!	Useful information, hints, and clues
	First Read Manual!	Mandatory study of all relevant manuals



3. General Safety Information

Carefully review the safety instructions before using the product detailed in this manual and any associated instrumentation. Adhere strictly to all safety precautions.

Familiarize yourself with this manual to operate the product correctly. Store this manual near the product and inform all users of its location. Ensure this manual is passed on when transferring the product to third parties.

The responsible body refers to individuals or a group accountable for the proper use and maintenance of the product within its specifications. This entity must ensure adequate training for users.

Operators must use the product for its intended purpose and receive training in electrical safety, handling cryogenic liquids (if applicable), and using scientific instruments safely. They must be protected from electric shock and other hazardous situations.

Maintenance Personnel perform routine tasks to maintain the product's operating condition, such as adjusting line voltage or replacing consumables, following procedures outlined in this manual.

Service Personnel are qualified to work on live circuits, handle cryogenic liquids (if applicable), conduct fault finding, and perform repairs. Only fully trained service personnel qualified to manage potentially lethal voltages should perform servicing and repairs.

Shock hazard: Hazardous voltages are considered present when voltage levels exceed 30 V RMS, 42.2 V peak, or 60 VDC, according to the American National Standards Institute. Assume the presence of hazardous voltages in any unknown circuitry as a safety precaution.



Important: Ambient conditions and environment!

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

- Room temperature should range between 15°C and 35°C.
- Humidity should range between 30% and 75%.
- Altitudes up to 2000m are acceptable.
- Pollution Degree 2 environments are suitable.



3.1. Specific Safety Precautions for MD16/MD40/MDG40

The products detailed in this manual should only be operated by qualified personnel who are aware of potential shock hazards and well-versed in the necessary precautions to prevent injury.

3.2. Bakeout



Caution: Check upon Bake-out!



- Remove non-bakeable components such as motors, encoders, electric and electronic devices, non-bakeable cables, tools, plastic caps, tissues etc. from the bake-out area!
- Ensure that there are no flammable liquids and no other highly flammable materials near the bake-out area!
- Verify vacuum conditions before and during bake-out.
- Do not start a bake-out while pressure is higher than 1E-6mbar.
- Through proper temperature control, ascertain that the maximum baking temperature of the product is never exceeded.
- Heating and cooling rate should not exceed 100 °C per hour.
- After reaching the nominal bakeout temperature (typically 150°C), recheck that the pumping system is running normally and that the pressure does not increase above 1E-5 mbar.

All UHV manipulators including the MD16/MD40/MDG40 are bakeable up to 200°C. Do **not** remove the magnetic coupling for the bakeout procedure. In order to minimize evolution of residual gas, it is helpful to move the coupling back and forth during cooldown of the UHV system after bakeout.

4. About

This type of magnetically driven manipulator can be used as a small transfer arm for short and intermediate distances in UHV Systems. For example: It is perfectly suitable for sample transfer from a load lock into the main chamber. Single shaft linear/rotary feedthroughs can serve for carrying a movable sample storage platform or a stack of receptacles. If used with a port aligner and one of our key adapters, they may also be used to tighten a screw or engage a sample locking mechanism at a specific position. Dual shaft linear/rotary feedthroughs can be equipped with one of our pincer grips. The fine adjustable magnetic coupling allows a precise control of their opening and closing by turning a knurled screw.

4.1. Overview

An illustrated overview with a few examples of linear/rotary feedthroughs is given:

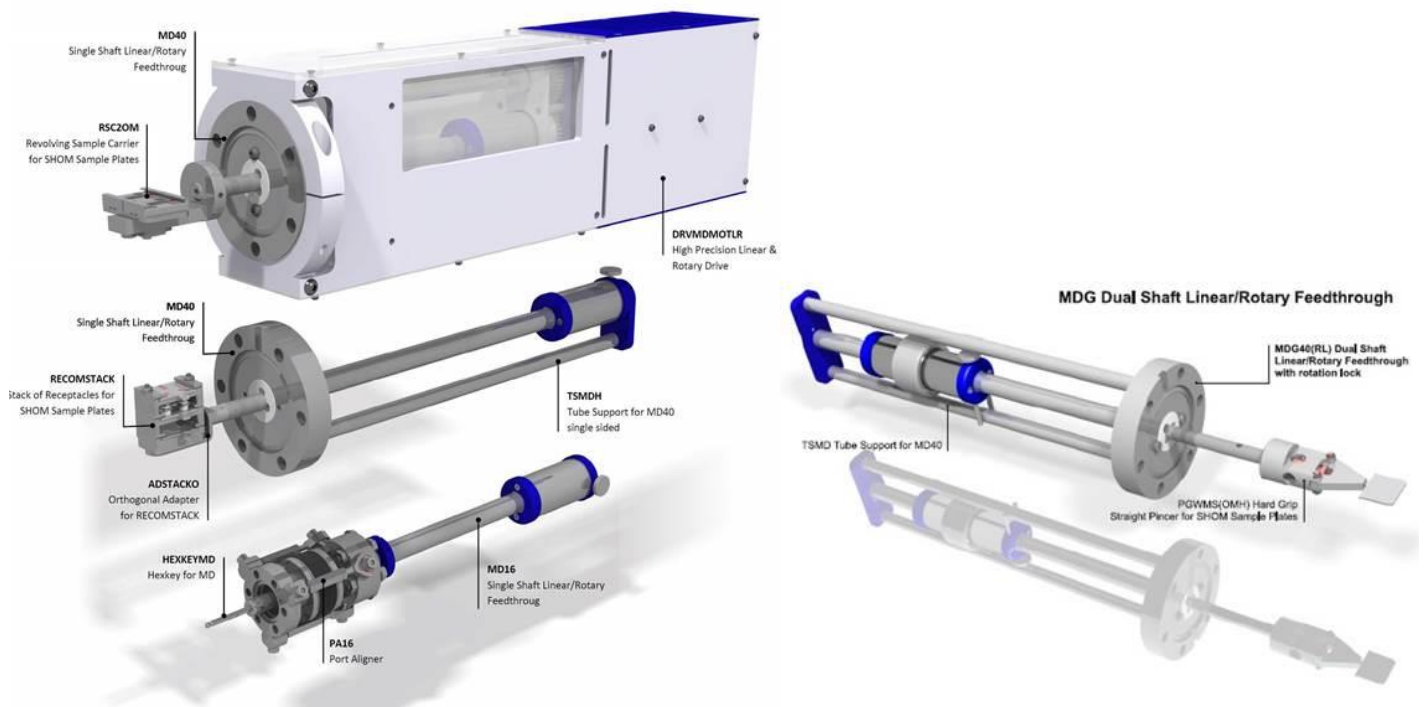


Figure 1: Left hand side, top down: MD40 with revolving sample carrier and high precision drive, MD40 with stack of receptacles and tube support, MD16 with port aligner and hexkey. Right hand side: MDG40 with pincer grip and tube support with rotation lock

5. Specifications



Important: Subject to Variation in Specifications!

The specifications provided in this manual are accurate at the time of printing. Installation of options or accessories may alter these specifications.

- Flange type: DN16CF or DN40CF (model dependent)
- Typical ultimate pressure: down to 1×10^{-11} mbar (system dependent)
- Helium leak rate: $\leq 1 \times 10^{-9}$ mbar·l/s
- Maximum bakeout temperature: 200 °C
- Linear stroke: linear travel (configuration dependent)
- Rotational movement: continuous rotation (or specify limit if applicable)
- Maximum transmissible torque: *according to model specification*
 - MD40 & MD16: 0.5 Nm
 - MD40HT & MD16HT: 1.0 Nm
 - MDG40: 0.4 Nm
- Maximum linear force: *according to model specification*
 - MD40 & MD16: 30 N
 - MD40HT & MD16HT: 60 N
 - MDG40: 23 N



5.1. Naming Conventions and List of Elements

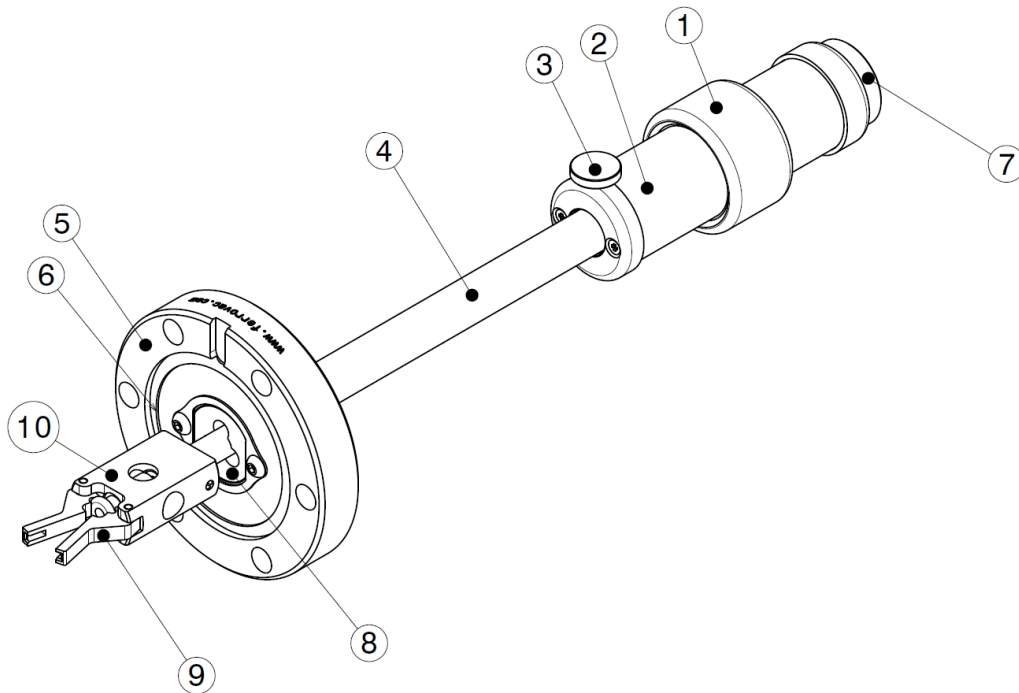


Figure 2: MDG40-PGWMS(OM) Naming Conventions

MDG40 nomenclature. The models MD16/MD40 are not equipped with pincer grips or fine adjusters.

List of Elements:

- | | |
|---------------------------------------|---------------------------------|
| 1. Fine Adjuster | 7. Blue Stop Ring (not visible) |
| 2. Actuator (outer magnetic coupling) | 8. Front Slide Bearing |
| 3. Lock Screw | 9. Jaws |
| 4. Tube | 10. Pincer Grip |
| 5. DN40CF Flange | |
| 6. Knife Edge | |

5.2. Dimensions

The technical dimensions of the product are subject to the specific model configuration. Detailed dimensions are provided in the official technical drawings provided by Ferrovac.

These documents are available upon request or can be downloaded from our website

Naming Key Dimensions:

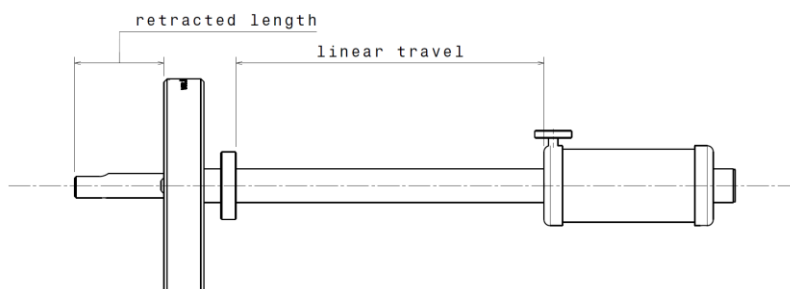


Figure 3: MD40 Naming Key Dimensions

5.3. Facility/System requirements

The MD16, MD40 and MDG40 feedthroughs do not require electrical power, compressed air, process gases or external media supply for operation.

Environmental Conditions

The product is intended for installation in research or industrial vacuum systems under the following conditions:

- Indoor installation only
- Operation within the specified temperature and pressure limits
- Integration into UHV-compatible systems
- Installation in environments free from excessive vibration or mechanical shock

Refer to the Technical Specifications for detailed pressure and temperature limits.

Mandatory Infrastructure

The following infrastructure must be available at the installation site:

- A compatible CF flange interface
- Appropriate metal sealing gaskets
- Suitable mounting hardware and torque tools
- A vacuum system capable of achieving the required UHV pressure range
- Bakeout capability of the vacuum system if UHV operation is intended

No electrical supply, compressed air, nitrogen gas or cryogenic media are required for the manual versions of the product.

If optional motorization units are used, refer to the respective motor unit manual for additional infrastructure requirements.



6. Unpacking

The linear/rotary feedthroughs are shipped cleaned and prepared for installation in UHV systems.

Before unpacking, visually inspect the parcel for transport damage. If damage is detected, document it photographically and notify Ferrovac immediately.

Verify the completeness of delivery against the delivery note or invoice. Any transport damage or missing items must be reported within one week of delivery.



Caution: Special Requirements for the Working Environment!

The feedthrough is a precision UHV component and must be handled in a clean environment.

Before unpacking and handling:

- Ensure the workspace is clean, dry and free of dust.
- Provide a sufficiently large and stable working surface.
- Use powder-free cleanroom gloves.
- Use clean tools free of grease or contaminants.
- Avoid contact with oils, fingerprints or particulate contamination.
- Do not use aggressive cleaning agents or strong solvents such as acetone on sealing surfaces.

To protect sealing surfaces and sensitive components:

- Clean the working surface and cover it with clean aluminium foil or lint-free material.
- Never strike or impact the CF knife edge.
- Protect the component from mechanical shock.
- Do not bend the tube or shaft.

Permanent magnets are integrated into the coupling system. Avoid strong impacts, as magnetic materials are brittle and may fracture under shock loading.



7. Installation



Caution: Safeguard CF Knife Edges and Bellows!

The exposed knife edges of UHV flanges, along with bellows, are exceptionally vulnerable to mechanical damage, easily acquiring dents or scratches upon contact with metallic surfaces like hand tools commonly used during vacuum system assembly. Damage to CF-knife edges or bellows may result in leaks. Ferrovac disclaims all warranty for damages or leaks caused by mishandling of UHV components.

Mounting the MDXXX

In delicate situations, the mounting procedure exposes the feedthrough to the risk of being damaged. Please follow the warning notes and the illustrated instruction.

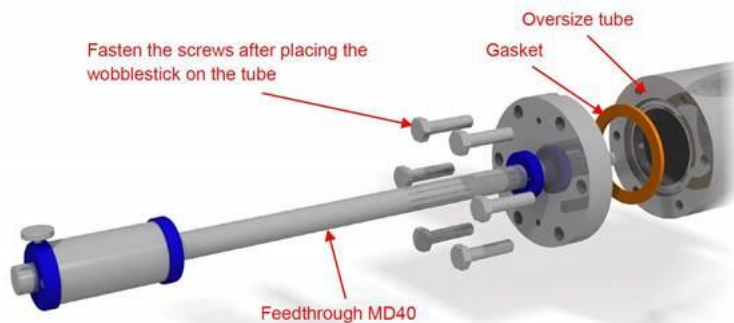


Figure 4: Mounting arrangement, screws used: M6x20 hex-headed or cylindrical-hex (Allen)

7.1. Tube Support

Especially linear/rotary feedthroughs with longer travel ranges require special care to be taken to protect the tube unit from accidental bending.

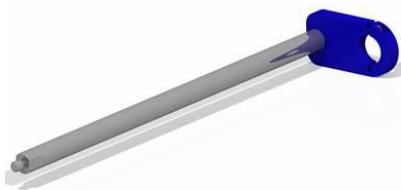


Figure 5: Single sided tube support TSMDH

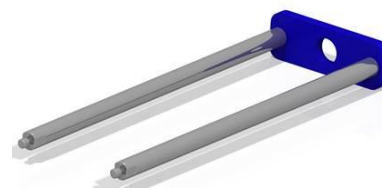


Figure 6: Tube support TSM

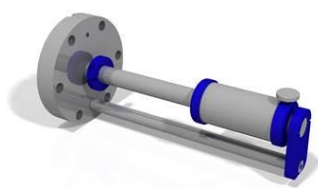


Figure 7: Feedthrough with single sided tube support MD40(Y0)-TSMDH

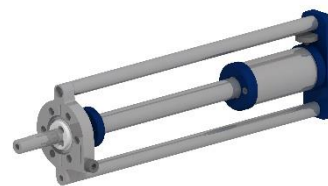


Figure 8: Feedthrough with tube support MD16-ADCF16TS-TSM



8. Operation

These operational procedures ensure the safe use of your product. Please follow all instructions carefully. If you have any doubts or do not fully understand the operating instructions, please contact Ferrovac for further guidance.

Before operating the feedthrough, ensure clear visual access to the sample transfer area or to the mechanical interface where motion is transmitted inside the vacuum system. Direct observation of the moving components is strongly recommended during operation.

Movement of the outer magnetic coupling directly transmits linear and/or rotary motion into the UHV system. The transmission of force occurs without mechanical contact through the vacuum boundary.

Under normal operating conditions, only minimal force should be required. Ferrovac manipulators are designed for smooth and precise operation. If noticeable resistance occurs, stop immediately and inspect the system for misalignment, obstruction, or mechanical damage before continuing.



Caution: Do not force a sample transfer!

Never apply excessive force when performing a sample transfer! Ferrovac systems are designed for smooth operation. Unexpectedly strong mechanical resistance of a sample receiver or grabber is indicating a misalignment of the transfer axis or the presence of a damaged part in the transfer system. **If in doubt, ask!**

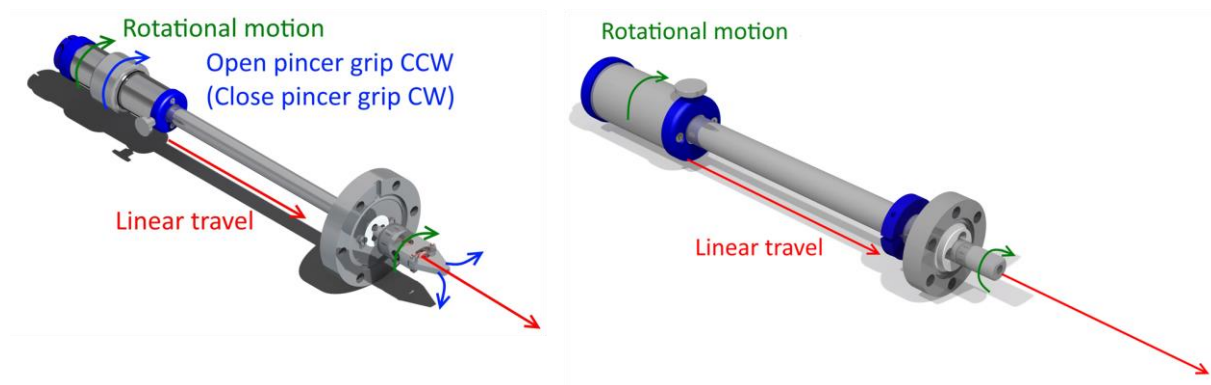


Figure 9: Left hand side: basic handling of the dual shaft linear/rotary feedthrough MDG40 with pincer grip. Right hand side: basic handling of the single shaft linear/rotary feedthrough MD16. The same handling applies to the model MD40



9. Problem solving

9.1. Aligning the magnets



WARNING: Adjustment of Magnetic Coupling

Adjustment or repositioning of the outer magnetic coupling is not part of normal operation and must only be carried out by qualified personnel.

- Improper handling may result in:
- Damage to the magnetic coupling
- Misalignment of internal components
- Loss of vacuum integrity
- Damage to the connected vacuum system or its internal components
- Reduced transmission performance
- Permanent mechanical damage to the feedthrough

Only perform adjustments strictly in accordance with the procedure described below.

- Do not apply excessive force.
- Do not use inappropriate tools.
- Stop immediately if abnormal resistance is detected.

Ferrovac assumes no liability for damage resulting from adjustments performed outside the procedures described in this manual.

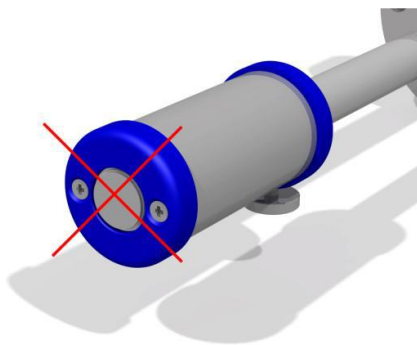


Figure 10: Wrong alignment (fully retracted)

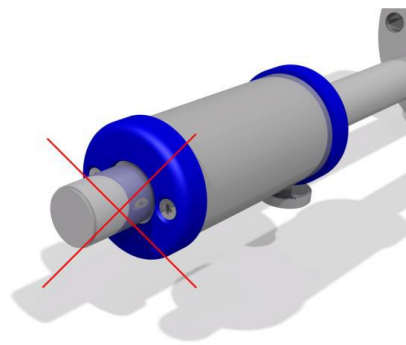


Figure 11: Wrong alignment (fully retracted)

If the specified maximum linear force of 30 N is exceeded during operation (relative displacement between outer and inner magnet assemblies), the magnetic coupling may become misaligned.

The inner and outer magnet assemblies consist of multiple rows of alternately poled permanent magnets. Proper alignment is required to ensure correct magnetic coupling and torque transmission.

When correctly aligned, the rear end of the inner tube protrudes approximately 7 mm from the outer assembly.

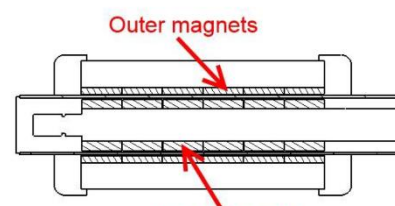


Figure 12: Inner/Outer magnets, correct alignment



Repositioning the Magnet Assemblies

1. Carefully pull the outer magnetic coupling off the tube.
2. Hold the feedthrough shaft firmly using a gloved hand to ensure secure grip.
3. Slowly slide the outer magnetic coupling back onto the tube.

During Repositioning:

- Each time a row of outer magnets passes over a corresponding inner magnet row, a distinct mechanical “click” can be felt as the magnets engage.
- Due to the eight-fold symmetry of the magnet arrangement, the outer assembly will tend to rotate approximately 1/8 of a full turn per magnet row.
- Apply steady linear force while allowing slight rotational movement to ensure proper alignment.

⚠ Do not apply excessive force.

Repositioning Without Venting the System

- Place one thumb on the rear end of the tube and two fingers around the actuator body.
- Carefully pull back until the outer magnetic coupling reaches the correct position.

If the outer magnetic assembly moves too far off the rear of the tube:

- Carefully reposition it by applying controlled axial force.
- If resistance is encountered, stop immediately.
- Do not apply force against delicate chamber components. Only use structurally stable parts of the vacuum chamber that are designed to withstand mechanical load.

⚠ Improper force application may result in damage to the feedthrough or to internal vacuum components

10. Additional Information

10.1. Return of defective items

Ferrovac products are designed for long service life and maintainability. Whenever technically feasible, spare parts remain available for extended periods after product delivery.

Repair, refurbishment and overhaul services are offered upon request, subject to technical evaluation. This approach supports the responsible use of material resources and helps extend the operational lifetime of vacuum components.

By maintaining and refurbishing existing equipment instead of replacing it, valuable resources can be conserved and lifecycle costs reduced.



Important: No unauthorized return of material!

- Do not return any equipment to our factory without a return of materials authorization (RMA)!
- You are obliged to provide a completed Declaration of Contamination form.
- Note: Parcels will not be opened if the Declaration of Contamination is missing



10.2. Options and accessories

Ferrovac offers a range of accessories and optional components for the MD16, MD40 and MDG40 feedthroughs. These accessories expand the functional capabilities of the system and allow adaptation to specific application requirements.

- Available accessory categories may include:
- Sample handling tools (e.g. forks, grippers, pincer systems)
- In-vacuum tool adapters (e.g. hex keys, socket tools)
- High-torque magnetic couplings
- Motorization units for automated actuation
- Custom interface adapters

Availability and compatibility depend on the specific feedthrough model and configuration.

Technical changes and portfolio extensions may occur without prior notice.

10.3. Factory overhaul

The slide bearings are the only parts of the feedthrough that wear out. A great many bakeout periods can lead to slight deformation of the slide bearings. This can result in reduced motion smoothness and probably higher outgassing rates. We offer a complete factory overhaul for inner and outer bearings and readjustment of any style of pincer grips. Please have a look on our website for more information or contact us directly.

10.4. Declaration of decontamination

In case of returning the feedthrough to Ferrovac GmbH, it is necessary to complete a declaration of contamination and send it to us. Please contact us beforehand. An RMA will be issued and mailed to you.

10.5. Download

This manual can be downloaded from our website. It can be found in the specifications of each listed linear/rotary feedthrough.

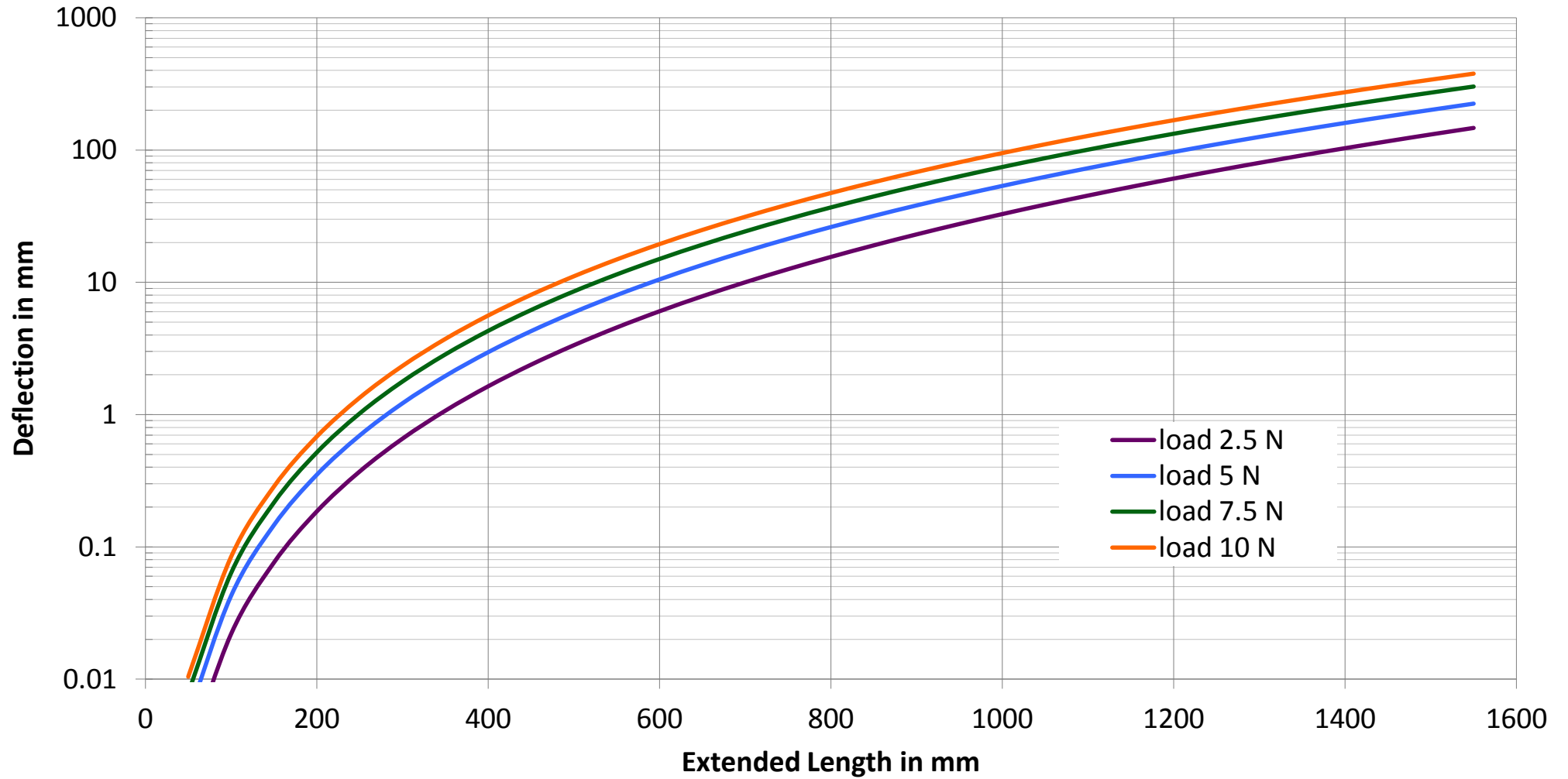
Appendix

The following pages form the appendix and contain supplementary documentation related to the product.

The information provided in this section is for reference purposes only and does not modify or replace the operational instructions defined in this manual.



MD Deflection vs Extended Length at different Loads



RoHS Compliance Declaration

Directive 2011/65/EU ("RoHS Directive")

Legal Requirements

Directive 2011/65/EU of the European Parliament and of the Council on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS Directive) specifies limits for hazardous substances to protect human health and the environment.

Scope

Standard components manufactured by Ferrovac AG, such as UHV hardware (e.g., vacuum chambers, flanges, valves) and laboratory equipment without active electronic functions, do not, to our current understanding, fall directly within the scope of the categories of electrical and electronic equipment listed in Annex I of the RoHS Directive.

However, Ferrovac AG components may be incorporated into Electrical and Electronic Equipment (EEE) that falls under the RoHS Directive. In such cases, the manufacturer of the final product is responsible for ensuring RoHS compliance of the complete device. Ferrovac AG will provide relevant material composition information upon request to support customer compliance efforts.

It should also be noted that the directive does not apply to equipment designed exclusively for research and development and made available on a business-to-business basis (see Article 2(4)(j)).

Declaration

Ferrovac AG is committed to environmental responsibility and, to the best of its knowledge and belief, declares that its standard components – aside from specific exemptions – comply with the substance restrictions set out in RoHS Annex II, based on supplier information.

The following substances are restricted under RoHS:

- Lead (Pb)
- Mercury (Hg)
- Cadmium (Cd)
- Hexavalent chromium (Cr⁶⁺)
- Polybrominated biphenyls (PBB)
- Polybrominated diphenyl ethers (PBDE)
- Phthalates: DEHP, BBP, DBP, DIBP

Exemptions

Certain subcomponents fall under exemptions in RoHS Annex III but still comply with the directive:

- **Exemption 6(c):** "Copper alloy containing up to 4 % lead by weight"
Applies to specific electrical crimp contacts provided by Ferrovac.

Ferrovac AG reserves the right to amend this declaration in response to legal or supply chain changes.

Yours faithfully,

Ferrovac AG
Thurgauerstrasse 72
8050 ZÜRICH
SWITZERLAND

C. Weiss

For and on behalf of Ferrovac AG, 23.05.2025