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The product may have been altered since this document was published.
We reserve the right to change the technical data, design and scope of supply.
Generally the information provided and agreements made when processing the individual quotations and orders are binding.
The original operating instructions were written in German.
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<td>15.2</td>
<td>Technical data for position transmitter equipment</td>
<td>61</td>
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1 Introduction

This technical file contains detailed descriptions on the safe and proper installation, connection, commissioning and monitoring of the product.

It also includes safety instructions and general information about the product.

This technical file is intended solely for specially trained and authorized personnel.

1.1 Validity

This technical file is valid for the TAPMOTION® MD-III product.

Drawings and illustrations in this technical file are provided for reference only. For specific details please refer to drawings submitted with each individual customer order.

1.2 Manufacturer

This product is manufactured by:

Reinhausen Manufacturing Inc.
2549 North 9th Avenue, 38343 Humboldt, Tennessee, USA
Tel.: +1 731 784 7681
Fax: +1 731 784 7682

Further information on the product and copies of this technical file are available from this address if required.

1.3 Subject to change without notice

The information contained in this technical file comprises the technical specifications approved at the time of printing. Significant modifications will be included in a new edition of the technical file.

The document number and version number of this technical file are shown in the footer.

1.4 Completeness

This technical file is incomplete without the supporting documentation.
1 Introduction

1.5 Supporting documents

The following documents also apply in addition to this technical file:

- Technical data and drawings which are provided upon order confirmation and delivery

Also observe generally valid legislation, standards, and guidelines as well as specifications on accident prevention and environmental protection in the respective country of use.

1.6 Safekeeping

This technical file and all supporting documents must be kept ready at hand and accessible for future use at all times.

1.7 Notation conventions

This section contains an overview of the symbols and textual emphasis used.

1.7.1 Symbols

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>🛠️</td>
<td>Wrench size</td>
</tr>
<tr>
<td>🔄</td>
<td>Tightening torque</td>
</tr>
<tr>
<td>🧧</td>
<td>Number and type of fastening materials used</td>
</tr>
<tr>
<td>💧</td>
<td>Fill with oil</td>
</tr>
<tr>
<td>🪝</td>
<td>Cut open, cut through</td>
</tr>
<tr>
<td>🧼</td>
<td>Clean</td>
</tr>
<tr>
<td>👀</td>
<td>Visual inspection</td>
</tr>
<tr>
<td>🧠</td>
<td>Use your hand</td>
</tr>
<tr>
<td>🔪</td>
<td>Adapter ring</td>
</tr>
<tr>
<td>Symbol</td>
<td>Meaning</td>
</tr>
<tr>
<td>--------</td>
<td>--------------------------------</td>
</tr>
<tr>
<td>![Symbol]</td>
<td>Apply a coat of paint</td>
</tr>
<tr>
<td>![Symbol]</td>
<td>Use a file</td>
</tr>
<tr>
<td>![Symbol]</td>
<td>Grease</td>
</tr>
<tr>
<td>![Symbol]</td>
<td>Coupling bolt</td>
</tr>
<tr>
<td>![Symbol]</td>
<td>Use a ruler</td>
</tr>
<tr>
<td>![Symbol]</td>
<td>Use a saw</td>
</tr>
<tr>
<td>![Symbol]</td>
<td>Hose clip</td>
</tr>
<tr>
<td>![Symbol]</td>
<td>Wire eyelet, safety wire</td>
</tr>
<tr>
<td>![Symbol]</td>
<td>Use a screwdriver</td>
</tr>
</tbody>
</table>

Table 1: Symbols

1.7.2 Information system

Information is designed to simplify and improve understanding of particular procedures. In this technical file it is laid out as follows:

Important information.

1.7.3 Hazard communication system

Warnings in this technical file are displayed as follows.

1.7.3.1 Warning relating to section

Warnings relating to sections refer to entire chapters or sections, sub-sections or several paragraphs within this technical file. Warnings relating to sections use the following format:
1 Introduction

1.7.3.2 Embedded warning information

Embedded warnings refer to a particular part within a section. These warnings apply to smaller units of information than the warnings relating to sections. Embedded warnings use the following format:

⚠️ DANGER! Instruction for avoiding a dangerous situation.

1.7.3.3 Signal words and pictograms

The following signal words are used:

<table>
<thead>
<tr>
<th>Signal word</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>DANGER</td>
<td>Indicates a hazardous situation which, if not avoided, will result in death or serious injury.</td>
</tr>
<tr>
<td>WARNING</td>
<td>Indicates a hazardous situation which, if not avoided, could result in death or serious injury.</td>
</tr>
<tr>
<td>CAUTION</td>
<td>Indicates a hazardous situation which, if not avoided, could result in injury.</td>
</tr>
<tr>
<td>NOTICE</td>
<td>Indicates measures to be taken to prevent damage to property.</td>
</tr>
</tbody>
</table>

Table 2: Signal words in warning notices

Pictograms warn of dangers:

<table>
<thead>
<tr>
<th>Pictogram</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>🚸</td>
<td>Warning of a danger point</td>
</tr>
<tr>
<td>⚡️</td>
<td>Warning of dangerous electrical voltage</td>
</tr>
<tr>
<td>Pictogram</td>
<td>Meaning</td>
</tr>
<tr>
<td>----------</td>
<td>-------------------------</td>
</tr>
<tr>
<td><img src="image1.png" alt="Pictogram" /></td>
<td>Warning of combustible substances</td>
</tr>
<tr>
<td><img src="image2.png" alt="Pictogram" /></td>
<td>Warning of danger of tipping</td>
</tr>
</tbody>
</table>

Table 3: Pictograms used in warning notices
2 Safety

2.1 General safety information

The technical file contains detailed descriptions on the safe and proper installation, connection, commissioning and monitoring of the product.

- Read this technical file through carefully to familiarize yourself with the product.
- Particular attention should be paid to the information given in this chapter.

2.2 Appropriate use

The product and associated equipment and special tools supplied with it comply with the relevant legislation, regulations and standards, particularly health and safety requirements, applicable at the time of delivery.

If used as intended and in compliance with the specified requirements and conditions in this technical file as well as the warning notices in this technical file and attached to the product, then the product does not present any hazards to people, property or the environment. This applies throughout the product’s entire life, from delivery through installation and operation to disassembly and disposal.

The operational quality assurance system ensures a consistently high quality standard, particularly in regard to the observance of health and safety requirements.

The following is considered appropriate use

- Only operate the product in accordance with this technical file and the agreed delivery conditions and technical data
- Use the equipment and special tools supplied solely for the intended purpose and in accordance with the specifications of this technical file
- Use the product only with the transformer specified in the order
- The serial numbers of the on-load tap-changer and drive must match.

2.3 Inappropriate use

Use is considered to be inappropriate if the product is used other than as described in the Appropriate use section.

Reinhausen Manufacturing does not accept liability for damage resulting from unauthorized or inappropriate changes to the product. Inappropriate changes to the product without consultation with Reinhausen Manufacturing can lead to personal injury, damage to property and operational disruption.
2.4 Personnel qualification

The product is designed solely for use in electrical energy systems and facilities operated by appropriately trained staff. This staff comprises people who are familiar with the installation, assembly, commissioning and operation of such products.

2.5 Operator’s duty of care

To prevent accidents, disruptions and damage as well as unacceptable adverse effects on the environment, those responsible for transport, installation, operation, maintenance and disposal of the product or parts of the product must ensure the following:

▪ All warning and hazard notices are complied with.
▪ Personnel are instructed regularly in all relevant aspects of operational safety, the operating instructions and particularly the safety instructions contained therein.
▪ Regulations and operating instructions for safe working as well as the relevant instructions for staff procedures in the case of accidents and fires are kept on hand at all times and are displayed in the workplace where applicable.
▪ The product is only used when in a sound operational condition and safety equipment in particular is checked regularly for operational reliability.
▪ Only replacement parts, lubricants and auxiliary materials which are authorized by the manufacturer are used.
▪ The specified operating conditions and requirements of the installation location are complied with.
▪ All necessary devices and personal protective equipment for the specific activity are made available.
▪ The prescribed maintenance intervals and the relevant regulations are complied with.
▪ Installation, electrical connection and commissioning of the product may only be carried out by qualified and trained personnel in accordance with this technical file.
▪ The operator must ensure appropriate use of the product.

2.6 Personal protective equipment

Personal protective equipment must be worn during work to minimize risks to health.

▪ Always wear the personal protective equipment required for the job at hand.
▪ Follow information about personal protective equipment provided in the work area.
Always wear

<table>
<thead>
<tr>
<th>Protective clothing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Close-fitting work clothing with a low breaking strength, with tight sleeves and with no protruding parts. It mainly serves to protect the wearer against being caught by moving machine parts. Do not wear any rings, necklaces or other jewelry.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Safety shoes</th>
</tr>
</thead>
<tbody>
<tr>
<td>To protect against falling heavy objects and slipping on slippery surfaces.</td>
</tr>
</tbody>
</table>

Table 4: Personal protective equipment to be worn at all times

Wear the following in special environments

<table>
<thead>
<tr>
<th>Special personal protective equipment is needed in special environments. The choice of equipment depends on the circumstances.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety glasses</td>
</tr>
<tr>
<td>To protect the eyes from flying parts and splashing liquids.</td>
</tr>
</tbody>
</table>

| Hard hat |
| To protect from falling and flying parts and materials. |

| Hearing protection |
| To protect from hearing damage. |

Table 5: Personal protective equipment to be worn in special environments

2.7 Protective devices in the motor-drive unit

The following protective devices are fitted in the motor-drive unit:

- End stop device (mechanical and electric)
- Device protecting against unintentional passage
- Motor protection device
- Protection against accidental contact
• Electronics of monitoring system to monitor the vacuum interrupters in the on-load tap-changer
3 Product description

This chapter contains an overview of the design and function of the motor-drive unit and monitoring system.

3.1 Motor-drive unit

3.1.1 Function description of motor-drive unit

The motor-drive unit adjusts the operating position of on-load tap-changers in regulating transformers to the individual operating requirements.

The tap-change operation is activated by starting the motor-drive unit (a single control impulse triggered, for example, by a voltage regulator of the TAPCON®-series). This operation is always completed regardless of any other control pulses emitted during the tap-change operation. In the standard design, the next tap-change operation can only proceed once all control devices have reached their rest positions.

Behavior in the event of a voltage interruption

Should the voltage be interrupted during an on-load tap-change operation, once the voltage supply returns, the motor-drive unit completes the started on-load tap-change operation.

3.1.2 Performance features

The motor-drive unit is particularly characterized by the following properties:

- Hand crank with interlocking switch
- Protection against accidental contact when doors are open
- Tap position indicator which is clear and easy to read
- TAPCON® 250 voltage regulator can be integrated
- Rapid replacement of the position transmitter modules since the functions of the position transmitter board and position transmitter module are separate
- Panel heater as anti-condensation heater
- Monitoring system to monitor vacuum interrupters in the on-load tap-changer

3.1.3 Scope of delivery

The motor-drive unit is packaged with protection against moisture and is delivered as follows:

- Motor-drive unit with hand crank and hand lamp
- Product documentation
Please note the following:

1. Check the shipment for completeness on the basis of the shipping documents.
2. Store the parts in a dry place until installation.
3. The product must remain in its airtight, protective wrapping and may only be removed immediately before installation.

3.1.4 Design

This chapter contains an overview of the design of the MD-III motor-drive unit.

The actual motor-drive unit equipment and the arrangement of the individual elements may differ from those shown.
3.1.4.1 Indication field

A clear indication field is fitted in the motor-drive unit. Pointer and operations counter are mechanically driven and indicate the tap-change operation sequence of the motor-drive unit. The reset wheel on the operations counter is lead-sealed at the factory.
3.1.4.2 Hand crank lock (optional)

An optional mechanical hand crank lock can be used to block the hand crank in cases where the monitoring system reports a fault or is not ready for operation.

3.1.4.3 Anti-condensation heater

The anti-condensation heater is designed as a panel heater which also acts as the front cover of the swing frame.

The design of the motor-drive unit and panel heater ensures that air circulates inside the motor-drive unit and therefore that there is a constant interior temperature which is always higher than the outside temperature.

3.1.4.4 Swing frame/terminal rail

The swing frame protects all electrical and mechanical parts of the motor-drive unit behind the swing frame against accidental contact.

The terminal rail behind the swing frame facilitates an easy electrical connection of the motor-drive unit. The wiring is easily connected using vertically arranged cap rails with the corresponding installed terminal bars.
3.1.4.5 Position transmitter equipment

The position transmitter equipment is used to remotely indicate the operating position of the on-load tap-changer when idle.

The remote display is available in various versions.

The position transmitter module for connection by the customer is located on the terminal rail.

For more information about the position transmitter equipment, see Installing electrics for motor-drive unit [► 39] section.

3.1.4.6 Transmission gear cover plate

The touch-protected transmission gear cover plate features an opening for the hand crank used in manual mode.

For operation, observe the information provided in the Actuating motor-drive unit with hand crank [► 53] chapter.

3.2 Monitoring system (VIM)

The monitoring system is also known as the VIM module (Vacuum Interrupter Monitoring).

3.2.1 Function description of monitoring system

**WARNING**

Danger of death, severe injury and damage to property!

Danger of death, severe injury and damage to property due to incorrect operation of hand crank and monitoring system!

► Never actuate on-load tap-changer with the hand crank if the transformer is energized. When the hand crank is operated, the monitoring system no longer provides protection so failure of a vacuum interrupter may result in injuries to operating staff and/or damage to the transformer.

► Check the on-load tap-changer when the monitoring system trips during operation.

► Before resetting the monitoring system, always first establish the cause and remedy the fault.

► The monitoring system improves operating reliability, but cannot cover all operating statuses.

There is a high probability that the monitoring system will detect a vacuum interrupter malfunction in the following operating modes:

▪ Electric on-load tap-change operation resulting from manual actuation of the RAISE/LOWER pivot switch
• Electric on-load tap-change operation resulting from automatic activation by a voltage regulator

If the hand crank is operated, the monitoring system does not provide protection.

An optional mechanical hand crank lock can be used to block the hand crank in cases where the monitoring system reports a fault or is not ready for operation.

In the event of an error, the monitoring system triggers the following actions:
- The on-load tap-changer is stopped and returned to its starting position
- The motor protective switch 8-2 is tripped
- Further electrical on-load tap-change operations are blocked
- In designs with an appropriate hand crank lock: Hand crank operations are also blocked
- The error indication on the monitoring circuit board lights up
  – Yellow LED for errors in the signal transmission
  – Red LED for errors in a vacuum interrupter
- Error messages are indicated by illumination of the red Alarm signal lamp (86RL) on the swing frame of the motor-drive unit.

### 3.2.2 Monitoring system design

![Monitoring system (VIM), schematic diagram](image)

Figure 3: Monitoring system (VIM), schematic diagram
The monitoring system evaluates the current signals in the on-load tap-changer. For fail-safe transmission, the current signals are converted into optical signals and transferred via fiber-optic cables. The monitoring system carries out the following checks:

1. After the by-pass switch has opened and before the vacuum interrupter opens, there must be a current signal.
2. Once the vacuum interrupter opens, there must be no current signal present.

If one is present, the monitoring system generates an alarm signal.

The monitoring system is also fitted with self-monitoring, which checks the internal circuits. At the input, the electronics are protected by a Zener diode and an interchangeable fuse.

### 3.2.3 Monitoring system displays and controls

![Monitoring system (VIM) displays and controls](image)

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Green TEST push-button</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>Green Power LED</td>
<td>4</td>
</tr>
</tbody>
</table>

The following displays and controls of the monitoring system (Vacuum Interrupter Monitoring VIM) are located behind the motor-drive unit's door:

- The green TEST push-button is used to check the internal circuitry of the monitoring system.
- 1 green LED indicates the control voltage supply present
- 3 red LEDs (1 per phase) indicate when a vacuum interrupter malfunction has been recorded
  - The monitoring system performs this check during every diverter switch operation
- 3 yellow LEDs (1 per phase) indicate the loss of the current transformer signal
  - The monitoring system repeats this check after every 32 tap-change operations
- The red RESET push-button has to be pressed to reactivate the monitoring system after a check
3.2.4 Maintenance mode

When performing test tap-change operations with a de-energized transformer, it may be useful to put the monitoring system into maintenance mode. The integrity test for the fiber-optic cable is suspended in this case.

To switch to maintenance mode, proceed as follows:

1. **DANGER!** Maintenance mode must not be activated if the transformer is energized.
2. Press and hold the RESET push-button for around 6 seconds to disable the verification system for 10 hours.
   - The 3 yellow LEDs on the monitoring circuit board flash slowly
   - At the end of the 10 hours, the yellow LED go out and the unit returns to its normal function
3. You can press the TEST push-button at any time to exit maintenance mode, instead of waiting for the time to expire.

3.2.5 Test function

An error can be simulated by pressing the green TEST push-button, e.g. to check that the on-load tap-changer returns to its starting position during an on-load tap-change operation. The alarm status can be reset by pressing the red RESET push-button. You will find a description of this function in the In-service monitoring system verification section.

3.2.6 Overview of monitoring system operating statuses

In the motor-drive unit, LEDs on the monitoring circuit board and on the swing frame indicate various operating states or events:

<table>
<thead>
<tr>
<th>Operating status</th>
<th>Monitoring display</th>
<th>Swing frame display</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Green LED Power</td>
<td>Yellow LED Fault</td>
</tr>
<tr>
<td>Normal operation</td>
<td>ON</td>
<td>OFF</td>
</tr>
<tr>
<td>Control voltage supply fault</td>
<td>OFF</td>
<td>OFF</td>
</tr>
<tr>
<td>Loss of current transformer signal</td>
<td>ON</td>
<td>ON</td>
</tr>
<tr>
<td>Vacuum interrupter error</td>
<td>ON</td>
<td>OFF</td>
</tr>
<tr>
<td>Maintenance mode</td>
<td>ON</td>
<td>OFF</td>
</tr>
<tr>
<td>Test mode</td>
<td>ON</td>
<td>OFF</td>
</tr>
</tbody>
</table>
4 Packaging, transport and storage

4.1 Packaging

The products are sometimes supplied with a sealed packaging and sometimes also dried depending on what is required.

A sealed packaging surrounds the packaged goods on all sides with plastic foil. Products that have also been dried are identified by a yellow label on the sealed packaging.

The information in the following sections should be applied as appropriate.

4.1.1 Suitability

**NOTICE**

Property damage due to incorrectly stacked crates!

Stacking the crates incorrectly can lead to damage to the packaged goods!

► Only stack up to 2 equally sized crates on top of one another.

The packaging is suitable for undamaged and fully functional means of transportation in compliance with local transportation laws and regulations.

The packaged goods are packed in a stable crate. This crate ensures that the packaged goods are secure when in the intended transportation position and that none of the parts touch the loading surface of the means of transport or touch the ground after unloading.

The packaged goods are stabilized inside the crate to prevent impermissible changes in position.

A sealed packaging surrounds the packaged goods on all sides with plastic foil. The packaged goods are protected from humidity using a desiccant. The plastic foil is bonded after the drying agent is added.

4.1.2 Markings

The packaging bears a signature with instructions for safe transport and correct storage. The following symbols apply to the shipment of non-hazardous goods. Adherence to these symbols is mandatory.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>☔</td>
<td>Protect against moisture</td>
</tr>
<tr>
<td>↑↑</td>
<td>Top</td>
</tr>
<tr>
<td>🥃</td>
<td>Fragile</td>
</tr>
<tr>
<td>🤛</td>
<td>Attach lifting gear here</td>
</tr>
<tr>
<td>⬤</td>
<td>Center of mass</td>
</tr>
</tbody>
</table>

Table 6: Shipping pictograms
4.2 Transportation, receipt and handling of shipments

**WARNING**

Danger of death and damage to property!

- Transport crate only when closed.
- Do not remove the mounting material used in the crate during transport.
- Only trained and appointed persons may select the sling gear and secure the load.
- Do not walk under the hanging load.
- Use means of transport and lifting gear with a sufficient carrying capacity in accordance with the weight stated on the delivery slip.

In addition to oscillation stress and shock stress, jolts must also be expected during transportation. In order to prevent possible damage, avoid dropping, tipping, knocking over and colliding with the product.

If a crate tips over, falls from a certain height (e.g. when slings tear) or experiences an unbroken fall, damage must be expected regardless of the weight.

Every delivered shipment must be checked for the following by the recipient before acceptance (acknowledgment of receipt):

- Completeness based on the delivery slip
- External damage of any type.

The checks must take place after unloading when the crate or transport container can be accessed from all sides.

**Visible damage**

If external transport damage is detected on receipt of the shipment, proceed as follows:

- Immediately record the transport damage found in the shipping documents and have this countersigned by the carrier.
- In the event of severe damage, total loss or high damage costs, immediately notify the sales department at Maschinenfabrik Reinhausen and the relevant insurance company.
- After identifying damage, do not modify the condition of the shipment further and retain the packaging material until an inspection decision has been made by the transport company or the insurance company.
- Record the details of the damage immediately onsite together with the carrier involved. This is essential for any claim for damages!
- Photograph damage to packaging and packaged goods. This also applies to signs of corrosion on the packaged goods due to moisture inside the packaging (rain, snow, condensation).
- **NOTICE!** Be absolutely sure to also check the sealed packaging. If the sealed packaging is damaged, do not under any circumstances install or commission the packaged goods. Either dry the dried packaged goods again as per the operating instructions for the relevant on-load tap-
chamber/off-circuit tap-changer or contact Maschinenfabrik Reinhausen GmbH to agree on how to proceed with drying. If this is not done, the packaged goods may be damaged.

- Name the damaged parts.

**Hidden damage**  When damages are not determined until unpacking after receipt of the shipment (hidden damage), proceed as follows:

- Make the party responsible for the damage liable as soon as possible by telephone and in writing, and prepare a damage report.
- Observe the time periods applicable to such actions in the respective country. Inquire about these in good time.

With hidden damage, it is very hard to make the transportation company (or other responsible party) liable. Any insurance claims for such damages can only be successful if relevant provisions are expressly included in the insurance terms and conditions.

### 4.3 Storage of shipments

**Packaged goods dried by Maschinenfabrik Reinhausen**

Upon receipt of the shipment, immediately remove the packaged goods dried by Maschinenfabrik Reinhausen from the sealed packaging and store air-tight in dry insulating oil until used.

**Non-dried packaged goods**

Non-dried packaged goods but with a functional sealed packaging can be stored outdoors when the following conditions are complied with.

When selecting and setting up the storage location, ensure the following:

- Protect stored goods against moisture (flooding, water from melting snow and ice), dirt, pests such as rats, mice, termites and so on, and against unauthorized access.
- Store the crates on timber beams and planks as a protection against rising damp and for better ventilation.
- Ensure sufficient carrying capacity of the ground.
- Keep entrance paths free.
- Check stored goods at regular intervals. Also take appropriate action after storms, heavy rain or snow and so on.

Protect the packaging foil from direct sunlight so that it does not disintegrate under the influence of UV rays, which would cause the packaging to lose its sealing function.

If the product is installed more than 6 months after delivery, suitable measures must be taken without delay. The following measures can be used:

- Correctly regenerate the drying agent and restore the sealed packaging.
4 Packaging, transport and storage

- Unpack the packed goods and store in suitable storage space (well ventilated, as dust-free as possible, humidity < 50 % where possible).

4.4 Unpacking shipments and checking for transportation damages

- **NOTICE!** Transport the packaged crate to the place where installation will take place. Do not open the sealed packaging until just before installation. If this is not done, damage to the packaged goods may occur due to ineffectively sealed packaging.

- **WARNING!** When unpacking, check the condition of the packaged goods. Secure packaged goods in an upright crate from tipping out. If this is not done, the packaged goods may be damaged and serious injuries may result.

- Check completeness of supplementary parts on the basis of the delivery slip.

4.5 Things to note when putting back into storage

**NOTICE**

**Damage caused by storage in unheated buildings or outdoors**

If the on-load tap-changer and drive are to be stored in unheated buildings or outdoors:

- Fill on-load tap-changer tank with clean, dry oil and refill gas space with dry nitrogen to a maximum pressure of 0.275 bar (4 psi).
- Weather-proof outside of tank and terminal board.
- Heat drive by connecting the built-in space heater to power.
5 Fitting motor-drive unit

5.1 Preparatory work

**WARNING**

The motor-drive unit may be started by accident if the motor protective switch is not tripped!
Risk of injury from starting the motor-drive unit by accident!
▶ Trip motor protective switch before starting to fit the drive shafts!

**NOTICE**

Damage to on-load tap-changer and motor-drive unit due to incorrect operation!

The on-load tap-changer and motor-drive unit are shipped on separate pallets in the neutral position. Prior to assembly check the serial numbers of the on-load tap-changer and motor-drive unit to ensure they belong together.

If the on-load tap-changer and motor-drive unit are not connected, mechanical damage will result from both the drive shaft of the on-load tap-changer turning and the output shaft of the motor-drive unit turning!

✓ Prior to shipment the on-load tap-changer is locked in the neutral position by a cotter pin. This cotter pin is inserted through the hub and drive shaft extension on the bottom of the tank. It may only be removed just before assembly. Keep the cotter pin.

▶ Check the neutral position on the on-load tap-changer and motor-drive unit as described below.

▶ Only join shafts that have been perfectly aligned.

▶ If you detect deviations, contact Reinhausen Manufacturing.
Checking neutral position

Check the on-load tap-changer's neutral position with the door open as follows:

1. Both change-over selector contacts are in the top position.

Figure 5: Change-over selector contacts
2. The adjustment markings on the by-pass switch are aligned to one another.

Figure 8: Adjustment markings on the by-pass

Check the motor-drive unit’s neutral position as follows:

1. The tap position indicator 1 is at neutral.
2. The pointer on the the tap-change indicator 3 is in the mid-position of the area marked in gray.

Figure 7: Indication field
Assembly variants

When assembling the motor-drive unit, a distinction is made between 2 variants:

1. Standard assembly means that the motor-drive unit is fitted directly beneath and secured to the on-load tap-changer.
2. Offset assembly (assembly on the floor) means that there is a gap between the motor-drive unit and the on-load tap-changer beneath which it is fitted and that the motor-drive unit is secured to the transformer on the main tank. This variant requires a mounting support on the main transformer tank, which is provided by the transformer manufacturer.

5.2 Fitting motor-drive unit to on-load tap-changer

With the standard assembly, the motor-drive unit is fitted directly beneath and secured to the on-load tap-changer.

Figure 8: Standard assembly
To do so, proceed as follows:

1. Secure the two assembly plates supplied to the brackets below the on-load tap-changer oil compartment using the relevant fastening materials. Tightening torque: 60 ft·lb (80 Nm).

Figure 9: Fitting assembly plates on on-load tap-changer

2. Move motor-drive unit into position and align.

3. Insert shims between brackets on motor-drive unit housing and assembly plates in order to correctly align the drive shaft and prevent any clearance.
4. Connect assembly plates with brackets on top of motor-drive unit housing. Tightening torque: 60 ft·lb (80 Nm).

![Figure 10: Fitting assembly plates on motor-drive unit](image)

**Fitting drive shaft**

The drive shaft is the mechanical connection between the motor-drive unit and the on-load tap-changer. It consists of a square tube and is connected at both ends to the motor-drive unit and on-load tap-changer with 2 coupling brackets and 1 coupling bolt each. If the standard assembly is selected, the square shaft is supplied in the length required.

When assembling the drive shaft, proceed as follows:

1. Ensure that the shaft ends to be connected are correctly aligned. The motor-drive unit and on-load tap-changer unit must remain exactly in the assembly position during the entire drive shaft assembly process.

2. Prior to assembly, grease coupling bolts, coupling brackets and ball heads, e.g. with ISOFLEX TOPAS L32 or Shell 6432.

3. Loosely screw together coupling part and slide onto square tube until stop is reached.
4. Insert coupling bolt into shaft end on motor-drive unit. Slide square tube with coupling part on to coupling bolt.

5. Secure vertical drive shaft to drive. Tightening torque of screws: 7 ft·lb (9 Nm).

Figure 11: Mounting drive shaft
6. Secure drive shaft with coupling bolts and coupling brackets on shaft end of on-load tap-changer. Set a unilateral axial clearance of 0.12“ (3 mm) between the coupling bolt and upper coupling piece. Tightening torque of screws: 7 ft·lb (9 Nm).

![Figure 12: Setting axial clearance](image)

7. Connect protective covers supplied to form a protective tube.

8. Fasten protective tube with relevant hose clips to drive's bearing collar and to on-load tap-changer's adapter.

**After assembling the drive shaft:**

1. A pre-assembled connection cable for the monitoring system is led out on the left side of the motor-drive unit housing. Plug the connector on this connection cable into the bushing on the underside of the on-load tap-changer.

2. Establish grounding connection between motor-drive unit housing and transformer tank.

The square shaft, coupling lugs, pins and locking washers are made from corrosion-resistant steel. Despite this, these parts should be painted/coated together with the transformer tank after assembly.
5.3 Fitting motor-drive unit to transformer tank

If the motor-drive unit is supplied in the version for offset assembly, the drive housing is fitted on the main tank of the transformer. The on-load tap-changer and motor-drive unit are connected by a longer drive shaft in this instance. The length of the drive shaft depends on the order specification (maximum length 98.4” (2,500 mm)).

This assembly variant requires a mounting support, provided by the transformer manufacturer, for securing to the main tank on the transformer. Proceed as follows:

1. Attach mounting support to rear of drive housing.

![Figure 13: Rear of motor-drive unit](image)

2. Move motor-drive unit into position and align.
3. Fasten motor-drive unit to transformer's main tank using mounting support. Use shims on mounting support so that the drive shaft can be aligned correctly.

**Fitting drive shaft**

The drive shaft is the mechanical connection between the motor-drive unit and the on-load tap-changer. It consists of a square tube and is connected at both ends to the motor-drive unit and on-load tap-changer with 2 coupling brackets and 1 coupling bolt each.
The square shaft is supplied longer than required. During assembly it has to be cut to the desired length. Proceed as follows:

1. Ensure that the shaft ends to be connected are correctly aligned. The motor-drive unit and on-load tap-changer unit must remain exactly in the assembly position during the entire drive shaft assembly process.
   - The deviation from the vertical must not exceed 2 °.

2. Determine dimension A between tap changer and shaft end of drive.

3. Cut square shaft to dimension A-0.35" (A-9 mm) and remove burrs.

4. Prior to assembly, grease coupling bolts, coupling brackets and ball heads, e.g. with ISOFLEX TOPAS L32 or Shell 6432.

5. Loosely screw together coupling part and slide onto square tube until stop is reached.

6. Insert coupling bolt into shaft end on motor-drive unit. Slide square tube with coupling part on to coupling bolt.
7. Secure vertical drive shaft to drive. Tightening torque of screws: 7 ft·lb (9 Nm).

Figure 15: Mounting drive shaft
8. Secure drive shaft with coupling bolts and coupling brackets on shaft end of on-load tap-changer. Set a unilateral axial clearance of 0.12" (3 mm) between the coupling bolt and upper coupling piece. Tightening torque of screws: 7 ft·lb (9 Nm).

![Figure 16: Setting axial clearance](image)

9. Shorten protective covers supplied if necessary, deburr and connect to form a protective tube.

10. Fasten protective tube with relevant hose clips to drive's bearing collar and to on-load tap-changer's adapter.

**After assembling the drive shaft:**

1. A pre-assembled connection cable for the monitoring system is led out on the left side of the motor-drive unit housing. Plug the connector on this connection cable into the bushing on the underside of the on-load tap-changer.

2. Take suitable protective measures to ensure that this cable cannot be damaged.

3. Establish grounding connection between motor-drive unit housing and transformer tank.

The square shaft, coupling lugs, pins and locking washers are made from corrosion-resistant steel. Despite this, these parts should be painted/coated together with the transformer tank after assembly.
5 Fitting motor-drive unit

5.4 Installing electrics for motor-drive unit

**WARNING**

Danger of death or severe injury!

An energized transformer and energized on-load tap-changer components could cause death or serious injuries when installing the electrics!

- Adherence to the following safety precautions is mandatory.

The drive may only be connected to circuits which have an external all-pole disconnection device so that the equipment can be fully de-energized if required (service, maintenance etc.).

Suitable equipment includes disconnection devices in accordance with IEC 60947-1 and IEC60947-3 (e.g. non-automatic circuit-breaker). When stating the circuit breaker type, note the properties of the relevant circuits (voltage, maximum currents). The following should also be noted during installation:

- It must be easy for the operator to access the disconnecting device
- The disconnecting device must be labeled for the motor-drive unit and the circuits to be disconnected.
- The disconnecting device must not be part of the power line
- The disconnecting device must not interrupt the main grounding conductor

Unless otherwise specified, the connections for the supply current circuits must have a conductor cross-section of at least 1.5 mm² (16 AWG).

**NOTICE**

Damage to the on-load tap-changer and motor-drive unit!

Damage to on-load tap-changer and motor-drive unit due to incorrect use of position transmitter equipment!

- Only circuits stated in the chapter Technical data for position transmitter equipment [→ 61] may be connected to the position transmitter module connections.
- The switchover point of the position transmitter equipment in the motor-drive unit is not the same as the switchover point of the diverter switch. This depends on the type of diverter switch. This fact should be noted when project planning the locking circuits between the motor-drive unit and external equipment (e.g. transformer circuit breaker).
- For external monitoring, locking and control purposes, it is not therefore the position transmitter equipment but the "Tap changer in operation" position transit contact shown in the connection diagram that should be used.

To electrically connect the motor-drive unit proceed as follows:

1. Switch off voltage supply.
2. Lock voltage supply to prevent unintentional restart.
3. Make sure everything is de-energized.
4. Visibly ground and short circuit motor-drive unit.
5 Fitting motor-drive unit

5. Cover or cordon off adjacent energized parts.
6. Connect motor-drive unit following connection diagrams provided in the document pocket. Note the supply voltage stated in the connection diagram.
7. Connect main grounding conductor to grounding conductor terminal on terminal bar X1 (minimum connection cross-section 14 AWG (2.5 mm²)).
8. Once the electrical connections are complete, ensure protection against accidental contact. To do this, close swing frame and check that transmission gear cover plate is fastened correctly.
9. **WARNING!** Never start up motor-drive unit without transmission gear cover plate.
10. Close motor-drive unit doors.
11. To connect the monitoring system, plug cable connector of motor-drive unit into the bushing on the underside of the on-load tap-changer oil compartment.
6 Checks after assembly

Please contact Reinhausen Manufacturing if any aspect of the tests is not clear.

6.1 Preparations

**WARNING**

Danger of death and damage to property!

Danger of death and damage to property due to electrical voltage!

► The relevant safety instructions must be observed.

► Ensure that the motor-drive unit and on-load tap-changer are correctly coupled in accordance with instructions in the Fitting motor-drive unit [► 27] chapter.

► Ensure that the motor-drive unit is connected in accordance with the connection diagrams provided.

► Provide protection against accidental contact before energizing the drive. The transmission gear cover plate must be fitted and the swing frame closed.

Perform the checks described above before filling the on-load tap-changer with oil.

6.2 Electrical test operations

**NOTICE**

Damage to motor-drive unit!

Too many tap-change operations in succession will damage the motor!

► Perform no more than 120 tap-change operations in succession to avoid damaging the motor.

**NOTICE**

Damage to the on-load tap-changer!

Performing too many operations without complete oil filling will damage the on-load tap-changer!

► Do not perform more than 120 tap-change operations on the on-load tap-changer without oil before drying.

With electric on-load tap-changer actuation, the pointer on the tap-change indicator remains in the gray area.
To perform tap-change operation tests and check the limit position locks, proceed as follows:

1. Switch on motor protective switch 8-2.
   - The green Power LED on the monitoring circuit board lights up.

2. Ensure that the hand crank is in the storage bracket.

3. On the monitoring system, press and hold the red RESET push-button for approx. 5 seconds (three yellow LEDs flash slowly) to activate maintenance mode and deactivate the verification system for 10 hours.
   - At the end of the 10 hours, the LEDs go out and the unit automatically returns to normal function. Instead of waiting for the specified time to expire, you can also press the green TEST push-button to exit maintenance mode prematurely.

4. Switch the on-load tap-changer one step in the LOWER direction (16L) using the RAISE/LOWER rotary switch. Check movement of tap position indicator.
   - The drive starts up and remains in the gray area of the tap-change indicator.

5. Switch further in the same direction and stop in the lowest position (display showing 16L).

6. Place one hand on the motor protective switch and again move the RAISE/LOWER rotary button in the LOWER direction.
   - The drive must not start up. If it does, switch off the motor protective switch straight away because either the limit switch timing or the connections aren’t right.

7. **CAUTION!** Do not turn hand crank with force. Switch off motor protective switch, insert hand crank and move on-load tap-changer in the LOWER direction.
   - Mechanical blocking should occur after around 2.5 hand crank revolutions. This can be clearly felt on the hand crank.

8. Fit hand crank in bracket. Switch on motor protective switch and move on-load tap-changer back into adjustment position (display shows N) by moving the RAISE/LOWER rotary switch.

To check the second limit position lock, proceed as follows:

1. Move on-load tap-changer another step in the RAISE direction (16R) and repeat the verification process described above for the other switching direction
   - The drive starts up and remains in the gray area of the tap-change indicator after every switching operation.
   - If the guide lever on the hand crank is raised, the on-load tap-changer must not start up.
   - Once the limit position is reached (display shows 16R), the drive must not start up when the RAISE/LOWER rotary switch is moved.
   - When the hand crank is moved in the limit position, mechanical blocking occurs after around 2.5 revolutions.
6 Checks after assembly

2. Return the on-load tap-changer to its adjustment position (display shows N).
3. Fit hand crank in bracket and close drive housing.
4. Exit maintenance mode by pressing the green TEST push-button on the monitoring system.

6.3 Testing monitoring system

![Monitoring system displays and control elements](image)

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Green TEST push-button</td>
</tr>
<tr>
<td>2</td>
<td>Green Power LED</td>
</tr>
</tbody>
</table>

**Tripping test**

For the tripping test, open the on-load tap-changer oil compartment and motor-drive unit doors. Three insulating material plates are arranged vertically next to one another in the front of the on-load tap-changer oil compartment. The vacuum interrupters are each mounted on the front of the insulating material plates.

1. Switch off motor protective switch 8-2 in the motor-drive unit
2. Connect external source of power to busbar connection P2 and fixed contact A of one of the vacuum interrupter assemblies, e.g. left phase
   - The power source must be able to produce a current of at least 20 A
3. Switch on motor protective switch 8-2

4. On the monitoring system, press and hold the red RESET push-button for approx. 5 seconds (three yellow LEDs flash slowly) to activate maintenance mode and deactivate the testing system for 10 hours
   - At the end of the 10 hours, the LEDs go out and the unit automatically returns to normal function.
   - Instead of waiting for the specified time to expire, you can also press the green TEST push-button to exit maintenance mode prematurely

5. Switch on input voltage at power source and slowly increase until a primary current of around 20 A flows through the current transformer.

6. Start motor-drive unit by moving RAISE/LOWER pivot switch in one direction
   - A red LED on the monitoring system and the Alarm signal lamp (86RL) on the swing frame light up
   - The drive stops and goes back to its starting position

7. Check the blocking:
   - The drive cannot now be moved in either direction

8. Reset monitoring system by pressing the RESET push-button
   - All red alarm displays go out.

9. Perform same test procedure with the vacuum interrupter assemblies of the center and right phases.

10. Reset monitoring system by pressing RESET push-button.

11. Close motor-drive unit and on-load tap-changer oil compartment doors.
Tighten nuts on access door to on-load tap-changer to a maximum tightening torque of 11 ft·lb (15 Nm).
7 Drying procedure

NOTICE

Damage to drive and on-load tap-changer!

If the drive is dried in an autoclave, the drive and on-load tap-changer may be damaged.

► Do not dry drive in an autoclave.
► Remove the drive if the transformer is dried in an autoclave.
► If the transformer is dried in its own tank, the drive can remain in place.

Also observe the information about drying provided in the on-load tap-changer's operating instructions.
8 Commissioning at the transformer manufacturer's site

**8 Commissioning at the transformer manufacturer's site**

**WARNING**

**Danger of death or severe injury!**

Danger of death or severe injury from explosive gases in the on-load tap-changer, in the pipework system, at the dehydrating breather opening and from flying parts and hot oil splashing!

► Make sure that only trained technicians perform work on the transformer.

► Use suitable personal protective equipment/clothing.

► Ensure that there are no naked flames, hot surfaces or sparks (for example caused by static charging) in the immediate surroundings and that none occur.

► Only use conductive and grounded hoses, pipes, and pump equipment that are approved for flammable liquids.

► Ensure that the oil compartment of the on-load tap-changer is correctly filled with oil as per the instructions.

► Ensure that all the on-load tap-changer's safety equipment is ready for use.

► Keep away from the danger area during the transformer test.

► Observe applicable fire protection regulations.

**WARNING**

**Danger of death and damage to property!**

Danger of death and damage to property due to incorrect operation during commissioning!

► Only start up transformer if the functions described in the Checks after assembly chapter are satisfied.

► Only actuate on-load tap-changer with the hand crank if the transformer is de-energized and the motor protective switch switched off.

► Otherwise damage to the transformer and/or personal injury may result if any of the vacuum interrupters fails to interrupt.

► During operation, if the monitoring system trips, do not reset until the on-load tap-changer has been inspected and the cause of the problem corrected.

► Contact Reinhausen Manufacturing for assistance if needed.
8 Commissioning at the transformer manufacturer's site

8.1 High-voltage tests on the transformer

**WARNING**

**Danger of death or severe injury!**

Danger of death or severe injury from explosive gases in the on-load tap-changer, in the pipework system, at the dehydrating breather opening and from flying parts and hot oil splashing!

► Make sure that only trained technicians perform work on the transformer.

► Use suitable personal protective equipment/clothing.

► Ensure that there are no naked flames, hot surfaces or sparks (for example caused by static charging) in the immediate surroundings and that none occur.

► Only use conductive and grounded hoses, pipes, and pump equipment that are approved for flammable liquids.

► Ensure that the oil compartment of the on-load tap-changer is correctly filled with oil as per the instructions.

► Ensure that all the on-load tap-changer's safety equipment is ready for use.

► Keep away from the danger area during the transformer test.

► Observe applicable fire protection regulations.

Perform the high voltage tests on the transformer to check joint operation of the transformer and on-load tap-changer and to rule out irregularities or malfunctions.

It is essential that you ensure only trained, instructed expert personnel who are familiar with and comply with the pertinent safety and technical regulations, who are aware of the potential risks, and who consistently use the occupational safety equipment provided to prevent injury and property damage are assigned to perform such a transformer test.

Note the following points before undertaking high voltage tests on the transformer:

- Ensure that the ground connections on the motor-drive protective housing and protective housing fastening are free of paint.
- Only perform high voltage test if motor-drive unit door is closed.
- Disconnect external connections to electronic components in the motor-drive unit to prevent damage from overvoltage.
- When connecting the motor-drive unit's supply voltage, only use the holes in the protective housing base intended for lead insertion.
- Guide all ground connecting leads to one central connection point (establishment of suitable reference earth).
- Disconnect all electronic components before the high voltage test. Before a wiring dielectric test, remove all devices with a withstand voltage of < 1,000 V.
- Leads used for testing must be removed before the high voltage test, as these function as antennas.
• Wherever possible, route the measurement and data leads separately from the energy cables.

Contact the manufacturer if you have any questions about possible sources of danger.

8.2 Dielectric tests on transformer wiring

Note the following points for dielectric tests on the transformer wiring:

The motor-drive unit is put through dielectric tests before delivery.

► Before the dielectric test for the transformer wiring, disconnect drive from the section to be tested to rule out increased component loading for those components fitted in the motor-drive unit.
9 Transporting transformer to installation site

**WARNING**

Danger of death or severe injury from explosive gases in the on-load tap-changer, in the pipework system, at the dehydrating breather opening and from flying parts and hot oil splashing!

- Ensure that there are no naked flames, hot surfaces or sparks (for example caused by static charging) in the immediate surroundings and that none occur.

9.1 Transport with removed drive

Proceed as follows to transport the transformer with removed drive:

1. Before disassembly, ensure that the tap position indicator on the motor-drive unit is in Neutral.

2. **NOTICE!** If the on-load tap-changer and motor-drive unit are not connected, mechanical damage will result from both the drive shaft of the on-load tap-changer turning and the output shaft of the motor-drive unit turning.

3. Remove motor-drive unit.

4. Do not actuate the motor-drive unit while the on-load tap-changer is not coupled.

5. Do not actuate an on-load tap-changer which is not coupled and secure drive shaft to prevent twisting. Use the cotter pin provided.

6. Transport the drive to the installation site in the delivery packaging.

7. Fit drive and drive shaft at operating site as described in operating instructions.
10 Commissioning motor-drive unit at the operating site

**WARNING**

Danger of death and damage to property!

Danger of death and damage to property due to electrical voltage!

► The relevant safety instructions must be observed.
► Ensure that the motor-drive unit and on-load tap-changer are correctly coupled in accordance with instructions in the Fitting motor-drive unit [► 27] chapter.
► Ensure that the motor-drive unit is connected in accordance with the connection diagrams provided.
► Provide protection against accidental contact before energizing the drive. The transmission gear cover plate must be fitted and the swing frame closed.

**WARNING**

Danger of death and damage to property!

Danger of death and damage to property due to incorrect operation during commissioning!

► Only start up transformer if the functions described in the Checks after assembly chapter are satisfied.
► Only actuate on-load tap-changer with the hand crank if the transformer is de-energized and the motor protective switch switched off.

☞ Otherwise damage to the transformer and/or personal injury may result if any of the vacuum interrupters fails to interrupt.
► During operation, if the monitoring system trips, do not reset until the on-load tap-changer has been inspected and the cause of the problem corrected.
► Contact Reinhausen Manufacturing for assistance if needed.

**NOTICE**

Damage to the on-load tap-changer and motor-drive unit!

Damage to on-load tap-changer and motor-drive unit due to condensate in the motor-drive unit!

► Always keep protective housing of the motor-drive unit tightly closed.
► If the standstill time before commissioning exceeds 8 weeks or operation is interrupted for longer than 2 weeks, the heater must be connected and turned on to prevent the condensation of moisture inside the protective housing. If this is not possible (e.g. during transportation), place a sufficient amount of dehydrating agent in the protective housing.
NOTICE

Damage to the on-load tap-changer and motor-drive unit!

Damage to on-load tap-changer and motor-drive unit due to incorrect use of position transmitter equipment!

► Only circuits stated in the chapter Technical data for position transmitter equipment [► 61] may be connected to the position transmitter module connections.

► The switchover point of the position transmitter equipment in the motor-drive unit is not the same as the switchover point of the diverter switch. This depends on the type of diverter switch. This fact should be noted when project planning the locking circuits between the motor-drive unit and external equipment (e.g. transformer circuit breaker).

► For external monitoring, locking and control purposes, it is not therefore the position transmitter equipment but the "Tap changer in operation" position transit contact shown in the connection diagram that should be used.

Also follow the commissioning notes provided in the on-load tap-changer's operating instructions.
11 Actuating motor-drive unit with hand crank

**WARNING**

Danger of death and severe injury!

An energized transformer and energized on-load tap-changer components could cause death or serious injuries during hand crank operation!

► Switch off and lock transformer to prevent unintentional restart.
► Make sure everything is de-energized.
► Visibly connect all transformer terminals to ground (grounding leads, grounding disconnectors) and short circuit them.
► Cover or cordon off adjacent energized parts.
► Only actuate the motor-drive unit with the hand crank fitted in the motor-drive unit. Otherwise, there is a risk of serious injury.

◇ The hand crank interlock switch disconnects the motor circuit at two poles. (However, it does not disconnect the control circuit.)

► Only actuate motor-drive unit with hand crank in an emergency. An emergency should be understood to be failure of the motor-drive unit's voltage supply when there is an urgent need to perform a tap change.

► It is essential to complete all started tap changes without changing direction of rotation. The tap change is complete when the pointer is in the mid-position of the area marked in gray on the tap-change indicator.

Proceed as follows to operate the on-load tap-changer with the hand crank:

1. Open doors of motor-drive unit
2. Switch off motor protective switch 8-2
3. Take hand crank out of bracket and place on drive shaft on motor-drive unit
4. Carry out tap-change operation (7.5 hand crank revolutions)
   ◇ The pointer of the tap-change indicator must be in mid-position within the gray field once the on-load tap-changing operation is complete.
5. Take off hand crank and return to bracket
6. Switch on motor protective switch 8-2
7. Close motor-drive unit doors
12 Monitoring during operation

**Warning**

Danger of death or severe injury!

Danger of death or severe injury from explosive gases in the on-load tap-changer, in the pipework system, at the dehydrating breather opening and from flying parts and hot oil splashing!

► Make sure that only trained technicians perform work on the on-load tap-changer and motor-drive unit.
► Use suitable personal protective equipment/clothing.
► Ensure that there are no naked flames, hot surfaces or sparks (for example caused by static charging) in the immediate surroundings and that none occur.
► Ensure that the oil compartment of the on-load tap-changer is correctly filled with oil as per the instructions.
► Ensure that all the on-load tap-changer's safety equipment is ready for use.
► Never actuate on-load tap-changer with the hand crank if the transformer is energized.

Monitoring the on-load tap-changer and motor-drive unit during operation differs for annual checks and occasional visual checks.

If faults occur during operation, please refer to the Fault elimination [► 56] chapter for a remedy.

12.1 Annual check

12.1.1 Checking motor-drive unit

Once a year perform tap-change operation tests and check the mechanical end stops in accordance with the instructions in the Electrical test operations [► 41] chapter.

12.1.2 Checking return to starting position

Check whether the on-load tap-changer goes back to its starting position in the event of an error. Proceed as follows:

1. Use RAISE/LOWER rotary button to perform tap-change operation in any direction and then press the monitoring system's green TEST push-button during the tap-change operation.
   ⇒ An alarm signal is generated, the motor-drive unit stops and returns to its starting position.

2. Press the monitoring system’s red RESET push-button to reset the alarm status.
12 Monitoring during operation

3. Perform tap-change operation in opposite direction and then again press the green TEST push-button during the tap change.
   ⇐ An alarm signal is generated, the motor-drive unit stops and returns to its starting position.

4. Press the red RESET push-button to reset the alarm status.

12.2 Occasional visual checks

As well as the annual checks, perform occasional visual checks. You can combine these visual checks with the usual checks on the transformer.

These visual checks may only be undertaken by trained experts.

Pay particular attention to the following:
- Gaskets of the protective housing of the motor-drive unit
- Correct functioning of the installed electrical heater in the protective housing of the motor-drive unit
- Correct functioning of the protective devices
13 Fault elimination

13.1 General information

**WARNING**

Danger of death or severe injury!
Danger of death or severe injury from explosive gases in the on-load tap-changer, in the pipework system, at the dehydrating breather opening and from flying parts and hot oil splashing!

► Make sure that only trained technicians perform work on the on-load tap-changer and motor-drive unit.
► Use suitable personal protective equipment/clothing.
► Ensure that there are no naked flames, hot surfaces or sparks (for example caused by static charging) in the immediate surroundings and that none occur.
► Ensure that the oil compartment of the on-load tap-changer is correctly filled with oil as per the instructions.
► Ensure that all the on-load tap-changer's safety equipment is ready for use.
► Never actuate on-load tap-changer with the hand crank if the transformer is energized.

**WARNING**

Danger of death due to electrical voltage and danger of damage to on-load tap-changer due to improper resetting after a fault!
During operation, if the monitoring system trips, do not reset until the on-load tap-changer has been inspected and the cause of the problem corrected.

► Only operate on-load tap-changer with the transformer energized if the monitoring system is properly connected and functional.
► If necessary, consult with Reinhausen Manufacturing.

**NOTICE**

Damage to the on-load tap-changer and transformer!
Activation of a protective device may indicate damage! Switching on without checking may result in damage to the on-load tap-changer and transformer!

► Check on-load tap-changer, motor-drive unit and transformer when a protective device has been tripped.
► Do not use the equipment again until you are sure there is no damage to the on-load tap-changer or transformer.

13.2 Fault elimination overview

The table below is intended to assist with detecting and, where possible, remedying faults. Contact Reinhausen Manufacturing for assistance if needed.
### Table 7: Fault elimination

<table>
<thead>
<tr>
<th>Error pattern</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>▪ Error signaled on monitoring system by red or yellow LEDs</td>
<td>▪ Have on-load tap-changer and monitoring system checked by trained personnel</td>
</tr>
<tr>
<td>▪ Tripping of motor protective switch in motor-drive unit</td>
<td>▪ Have motor-drive unit and on-load tap-changer checked by trained personnel</td>
</tr>
<tr>
<td>▪ On-load tap-changer not changing tap position (sluggishness, RAISE/LOWER rotary switches not working)</td>
<td>▪ Contact Reinhausen Manufacturing</td>
</tr>
<tr>
<td>▪ No change in voltage on transformer despite change in position on motor-drive unit</td>
<td>▪ Contact Reinhausen Manufacturing</td>
</tr>
<tr>
<td>▪ Noises on drive shaft or motor-drive unit when changing tap position</td>
<td>▪ Check that drive shaft is fitted correctly</td>
</tr>
<tr>
<td></td>
<td>▪ Check that hose clips and guard plates are seated correctly</td>
</tr>
<tr>
<td></td>
<td>▪ Ensure that all components are fastened correctly within motor-drive unit</td>
</tr>
</tbody>
</table>

For detailed information about the monitoring system, please consult the product description for monitoring system (VIM) [► 19] and Checking monitoring system [► 43] chapters.

In the event of faults on the on-load tap-changer and motor-drive unit, which cannot be easily and immediately corrected on site, or if a protective device has been tripped, please inform your authorized Reinhausen Manufacturing representative, the transformer manufacturer or contact us directly at:

Reinhausen Manufacturing Inc.

2549 North 9th Avenue, 38343 Humboldt, Tennessee, USA

Tel.: +1 731 784 7681

Fax: +1 731 784 7682
14 Maintenance

In addition to the annual checks and occasional visual checks, also perform maintenance work whenever a maintenance interval is reached.

Maintenance work on the on-load tap-changer and motor-drive unit may only be undertaken by trained experts. If this route is taken, in addition to the correct performance of all work, certain components will be upgraded to the latest state of technology and manufacturing status.

Contact the Technical Service team at Reinhausen Manufacturing to perform maintenance work:

Reinhausen Manufacturing Inc.
2549 North 9th Avenue, 38343 Humboldt, Tennessee, USA
Tel.: +1 731 784 7681
Fax: +1 731 784 7682

If maintenance is not carried out by our Technical Service department, please ensure that the personnel who carry out the maintenance are trained by MR or are otherwise suitably qualified to carry out the work.

In such cases, we would ask you to forward to us a report on the maintenance performed so we can update our maintenance files. For inquiries about spare parts, please provide the serial number (see name plate on on-load tap-changer and motor-drive unit) and the number of tap-change operations.

14.1 Maintenance intervals

NOTICE

Damage to on-load tap-changer and transformer!

Damage to on-load tap-changer and transformer from non-observance of maintenance intervals and improper maintenance!
- Observe maintenance intervals.
- Ensure complete and proper maintenance.

Perform maintenance after every 500,000 operations.

14.2 Taking on-load tap-changer out of service

1. Switch off and lock transformer to prevent unintentional restart.
2. Make sure everything is de-energized.
3. Visibly connect all transformer terminals to ground (grounding leads, grounding disconnectors) and short circuit them.
4. Cover or cordon off adjacent energized parts.
5. Open motor-drive unit and switch off motor protective switch 8-2.
6. Record the number of operations shown on the on-load tap-changer’s operations counter.

14.3 Maintaining motor-drive unit

After 500,000 tap-change operations, the braking contactor in the motor-drive unit must be replaced. Contact Reinhausen Manufacturing’s Technical Service department.

When maintaining the motor-drive unit, ensure the functions as per the Checks after assembly [► 41] chapter.

14.4 Maintaining monitoring system

When maintaining the on-load tap-changer and motor-drive unit, perform the following checks on the monitoring system:

1. Ensure that the fiber-optic cable is treated with care during maintenance. The bend radius must not fall below 4” (100 mm). Overbending will damage the cable and diminish its ability to carry a light pulse.

2. Ensure monitoring system functions in accordance with the Checks after assembly [► 41] chapter.
## 15 Technical data

### 15.1 Technical data for TAPMOTION® MD-III

The technical data applies to the standard design and may vary depending on the design delivered. Subject to change without prior notice.

<table>
<thead>
<tr>
<th>MD-III motor-drive unit</th>
<th>208 V...240 V</th>
<th>120 V</th>
<th>220 V</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC motor circuit voltage supply</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current</td>
<td>3.8 A...4.7 A</td>
<td>4.5 A</td>
<td>5.9 A</td>
</tr>
<tr>
<td>Frequency</td>
<td>60 Hz</td>
<td>60 Hz</td>
<td>50 Hz</td>
</tr>
<tr>
<td>Speed</td>
<td>1,700 rpm</td>
<td>1,700 rpm</td>
<td>1,400 rpm</td>
</tr>
<tr>
<td>Rotations of the hand crank per tap-change operation</td>
<td></td>
<td></td>
<td>7.5</td>
</tr>
<tr>
<td>Duration of the tap-change operation</td>
<td></td>
<td>approx. 2 s</td>
<td></td>
</tr>
<tr>
<td>Maximum rated torque on the drive shaft</td>
<td></td>
<td>332 ft·lb (450 Nm)</td>
<td></td>
</tr>
<tr>
<td>Maximum number of operating positions</td>
<td></td>
<td>33</td>
<td></td>
</tr>
<tr>
<td>AC control and heating circuit voltage supply</td>
<td>120 V 60 Hz / 110 V 50 Hz</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power consumption of the control circuit (control / operation)</td>
<td></td>
<td>100 VA/25 VA</td>
<td></td>
</tr>
<tr>
<td>Heating output from standard model</td>
<td></td>
<td>50 W</td>
<td></td>
</tr>
<tr>
<td>Additional heater for Arctic model</td>
<td></td>
<td>140 W</td>
<td></td>
</tr>
<tr>
<td>Temperature range (ambient temperature)</td>
<td>- 25 °C...+ 50 °C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature range (ambient temperature) for Arctic model</td>
<td>- 40 °C...+ 50 °C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Protection from foreign objects and water when doors are closed</td>
<td>IP 54 in accordance with DIN EN 60529</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test voltage to ground</td>
<td>2 kV/60 s</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight</td>
<td>Maximum 330 lb (150 kg)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 8: Technical data for TAPMOTION® MD-III
15.2 Technical data for position transmitter equipment

Resistance-type position transmitter module

Standard resistance: 10.0 Ω (0.6 W, +/-1 %) per tap position

The number of desired operating positions determines the number of loaded resistors.

The decisive power loss of the position transmitter module is 0.6 W because in the worst-case scenario only one resistor is energized. The supply voltage should not exceed DC 220 V. If your setup is more demanding, please contact Maschinenfabrik Reinhausen.

Position transmitter module with N/O contact range (break-before-make contact)

AC: 250 V, 0.5 A (resistive loading)
DC: 220 V, 0.2 A (resistive loading)

Minimum voltage level for signal and data processing: 24 V

Position transmitter module with N/O contact range, (make-before-break-type)

AC, DC: 250 V, 0.02 A (resistive loading)
AC, DC: 24 V, 0.20 A (resistive loading)

Minimum voltage level for signal and data processing: 24 V

Position transmitter module with N/O contact range, 10 A (make-before-break-type) for controlling current matching transformer in industrial applications.

AC, DC: 250 V, 10 A (resistive loading)

Position transmitter module, diode matrix

DC: 220 V, 0.2 A (resistive loading)

Minimum voltage level for signal and data processing: 24 V
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