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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 applies to the following types of the protective relay:

▪ RS 2001 (standard design)
▪ RS 2001/V (seals made from Viton)
▪ RS 2001/H (for high oil conservators)
▪ RS 2001/E (increased protection from vibration)
▪ RS 2001/R (extra inspection window)
▪ RS 2003 (design for Canada)
▪ RS 2004 (design for Canada with automatic reset)

1.2 Manufacturer

The product is manufactured by:

Maschinenfabrik Reinhausen GmbH
Falkensteinastraße 8
93059 Regensburg
Tel.: (+49) 9 41/40 90-0
E-mail: sales@reinhausen.com

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

1.3 Completeness

This technical file is incomplete without the supporting documents.

The following documents are considered supporting documents:

▪ Supplements (included in the scope of delivery)
▪ Dimensional drawing (included in the scope of delivery)
▪ Routine test report (included in the scope of 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.
1.4 Safekeeping

Keep this technical file and all supporting documents ready at hand and accessible for future use at all times.

1.5 Notation conventions

1.5.1 Hazard communication system

Warnings in this technical file are displayed as follows.

1.5.1.1 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:

⚠️ WARNING

Type of danger!

Source of the danger and outcome.

► Action

► Action

1.5.1.2 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.

1.5.1.3 Signal words and pictograms

The following signal words are used:

<table>
<thead>
<tr>
<th>Signal word</th>
<th>Definition</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 minor or moderate injury.</td>
</tr>
<tr>
<td>NOTICE</td>
<td>Indicates measures to be taken to prevent damage to property.</td>
</tr>
</tbody>
</table>

Table 1: Signal words in warning notices
Pictograms warn of dangers:

<table>
<thead>
<tr>
<th>Pictogram</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Warning of a danger point" /></td>
<td>Warning of a danger point</td>
</tr>
<tr>
<td><img src="image2.png" alt="Warning of dangerous electrical voltage" /></td>
<td>Warning of dangerous electrical voltage</td>
</tr>
<tr>
<td><img src="image3.png" alt="Warning of combustible substances" /></td>
<td>Warning of combustible substances</td>
</tr>
<tr>
<td><img src="image4.png" alt="Warning of danger of tipping" /></td>
<td>Warning of danger of tipping</td>
</tr>
<tr>
<td><img src="image5.png" alt="Warning of danger of crushing" /></td>
<td>Warning of danger of crushing</td>
</tr>
</tbody>
</table>

Table 2: Pictograms used in warning notices

1.5.2 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.

1.5.3 Instruction system

This technical file contains single-step and multi-step instructions.

Single-step instructions

Instructions which consist of only a single process step are structured as follows:
Aim of action
✓ Requirements (optional).
► Step 1 of 1.
⇨ Result of step (optional).
⇨ Result of action (optional).

Multi-step instructions
Instructions which consist of several process steps are structured as follows:
Aim of action
✓ Requirements (optional).
1. Step 1.
⇨ Result of step (optional).
2. Step 2.
⇨ Result of step (optional).
⇨ Result of action (optional).
2 Safety

- Read this technical file through to familiarize yourself with the product.
- This technical file is a part of the product.
- Read and observe the safety instructions provided in this chapter.
- Read and observe the warnings in this technical file in order to avoid function-related dangers.
- The product is manufactured on the basis of state-of-the-art technology. Nevertheless, risks to life and limb for the user or impairment of the product and other material assets due to the function may arise in the event of improper use.

2.1 Appropriate use

The product is designed solely for use in electrical energy systems and facilities. If used as intended and in compliance with the requirements and conditions specified 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 danger to people, property or the environment. This applies throughout the service life of the product, from delivery, installation and operation to removal and disposal.

The following is considered appropriate use:
- Use the product only with the on-load tap-changer and transformer specified in the order.
- The serial numbers of on-load tap-changer and on-load tap-changer accessories (drive, drive shaft, bevel gear, protective relay, etc.) must match if the on-load tap-changer and on-load tap-changer accessories are supplied as a set for one order.
- Operate the product in accordance with this provided technical file, the agreed delivery conditions and technical data.
- Ensure that all necessary work is performed by qualified personnel only.
- Only use the equipment and special tools included in the scope of delivery for the intended purpose and in accordance with the specifications of this technical document.

2.2 Fundamental safety instructions

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:
Personal protective equipment

Loosely worn or unsuitable clothing increases the danger of becoming trapped or caught up in rotating parts and the danger of getting caught on protruding parts. This poses a danger to life and limb.

- Wear appropriate personal protective equipment such as a helmet, work gloves, etc. for the respective activity.
- Never wear damaged personal protective equipment.
- Never wear rings, necklaces, or other jewelry.
- If you have long hair, wear a hairnet.

Work area

Untidy and poorly lit work areas can lead to accidents.

- Keep the work area clean and tidy.
- Make sure that the work area is well lit.
- Observe the applicable laws for accident prevention in the relevant country.

Protection against electric shock

If the terminal box cover of the protective relay hangs from the wire on the side of the enclosure, this can lead to damage to the wires. This poses a danger to life and limb.

- Always remove the terminal box cover with wire from the protective relay for any work which involves opening the protective relay.
- Remove the slotted head screw for potential tie-in and remove the terminal box cover with wire.

Working during operation

The product may only be operated in a sound, operational condition. Otherwise it poses a danger to life and limb.

- Regularly check the operational reliability of safety equipment.
- Comply with the inspection work, maintenance work and maintenance intervals described in this technical file.

Explosion protection

Highly flammable or explosive gases, vapors and dusts can cause serious explosions and fire. This increases the danger to life and limb.

- Do not install, operate or perform maintenance work on the product in areas where a risk of explosion is present.
Safety markings

Warning signs and safety information plates are safety markings on the product. They are an important aspect of the safety concept.

▪ Observe all safety markings on the product.
▪ Make sure all safety markings on the product remain intact and legible.
▪ Replace safety markings that are damaged or missing.

Ambient conditions

To ensure reliable and safe operation, the product must only be operated under the ambient conditions specified in the technical data.

▪ Observe the specified operating conditions and requirements for the installation location.

Auxiliary materials and operating materials

Auxiliary materials and operating materials not approved by Maschinenfabrik Reinhausen GmbH can lead to personal injuries, damage to the product and product malfunctions.

▪ Only use conductive and grounded hoses, pipes, and pump equipment that are approved for flammable liquids.
▪ Only use lubricants and auxiliary materials approved by the manufacturer.
▪ Contact Maschinenfabrik Reinhausen GmbH.

Modifications and conversions

Unauthorized or inappropriate changes to the product may lead to personal injury, material damage and operational faults.

▪ Only modify the product after consultation with the manufacturer.

Spare parts

Spare parts not approved by the manufacturer may lead to physical injury, damage to the product and operational faults.

▪ Only use spare parts approved by the manufacturer.
▪ Contact the manufacturer.

2.3 Personnel qualification

The person responsible for assembly, commissioning, operation, maintenance and inspection must ensure that the personnel are sufficiently qualified.
2 Safety

Electrically skilled person

The electrically skilled person has a technical qualification and therefore has the required knowledge and experience, and is also conversant with the applicable standards and regulations. The electrically skilled person is also proficient in the following:

▪ Can identify potential dangers independently and is able to avoid them.
▪ Is able to perform work on electrical systems.
▪ Is specially trained for the working environment in which (s)he works.
▪ Must satisfy the requirements of the applicable statutory regulations for accident prevention.

Electrically trained persons

An electrically trained person receives instruction and guidance from an electrically skilled person in relation to the tasks undertaken and the potential dangers in the event of inappropriate handling as well as the protective devices and safety measures. The electrically trained person works exclusively under the guidance and supervision of an electrically skilled person.

Operator

The operator uses and operates the product in line with this technical file. The operating company provides the operator with instruction and training on the specific tasks and the associated potential dangers arising from improper handling.

Technical Service

We strongly recommend having maintenance, repairs and retrofitting carried out by our Technical Service department. This ensures that all work is performed correctly. If maintenance is not carried out by our Technical Service department, please ensure that the personnel who carry out the maintenance are trained and authorized by Maschinenfabrik Reinhausen GmbH to carry out the work.

Authorized personnel

Authorized personnel are trained by Maschinenfabrik Reinhausen GmbH to carry out special maintenance.

2.4 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.
▪ Never wear damaged personal protective equipment.
▪ Observe information about personal protective equipment provided in the work area.
Protective clothing
Close-fitting work clothing with a low tearing strength, with tight sleeves and with no protruding parts. It mainly serves to protect the wearer against being caught by moving machine parts.

Safety shoes
To protect against falling heavy objects and slipping on slippery surfaces.

Safety glasses
To protect the eyes from flying parts and splashing liquids.

Visor
To protect the face from flying parts and splashing liquids or other dangerous substances.

Hard hat
To protect against falling and flying parts and materials.

Hearing protection
To protect against hearing damage.

Protective gloves
To protect against mechanical, thermal, and electrical hazards.

Table 3: Personal protective equipment

2.5 Drying transformer

2.5.1 Drying transformer in furnace

Observe the following information when drying the transformer in a furnace.

**NOTICE**

Damage to protective relay, on-load tap-changer and transformer!
If the protective relay is dried in a furnace, this may cause damage to the protective relay and restrict its correct function.

► Do not dry protective relay in a furnace.

2.5.2 Drying the transformer in the transformer tank
If drying takes place in the transformer tank, the protective relay can remain fitted during the drying process.
3 Product description

3.1 Scope of delivery

The product is packaged with protection against moisture and is delivered as follows:

- Protective relay
- Technical files

Please note the following:

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

3.2 Function description

The protective relay is looped into the circuit breaker tripping circuit. It is tripped when the specified speed of flow from the on-load tap-changer head to the oil conservator is exceeded due to a fault. The flowing insulating fluid actuates the flap valve which tips over into position OFF. The contact in the dry-reed magnetic switch is thereby actuated, the circuit breakers are tripped, and the transformer is de-energized.

The protective relay is a component of an on-load tap-changer filled with insulating fluid and its properties conform to the respective applicable version of IEC publication 60214-1.

Diverter switch operations at rated switching capacity or at permissible overload will not cause the protective relay to trip.

The protective relay responds to flow, not to gas accumulated in the protective relay. It is not necessary to bleed the protective relay when filling the transformer with insulating fluid. Gas accumulation in the protective relay is normal.
3.3 Design/versions

Front view

Figure 1: Protective relay RS 2001

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Inspection window</td>
</tr>
<tr>
<td>2</td>
<td>Pressure equalization element</td>
</tr>
</tbody>
</table>

Rear view

Figure 2: Protective relay RS 2001

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Dummy plug</td>
</tr>
<tr>
<td>2</td>
<td>Nameplate</td>
</tr>
</tbody>
</table>

The protective relay RS 2001/R has an extra inspection window on the rear.
### View from above

![Diagram of Protective relay RS 2001 with numbered parts](image)

#### Figure 3: Protective relay RS 2001

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Gasket</td>
</tr>
<tr>
<td>2</td>
<td>Potential tie-in</td>
</tr>
<tr>
<td>3</td>
<td>Terminal box cover</td>
</tr>
<tr>
<td>4</td>
<td>Slotted head screw for potential tie-in</td>
</tr>
<tr>
<td>5</td>
<td>OPERATION (reset) test button</td>
</tr>
<tr>
<td>6</td>
<td>Slotted head screw for protective cover</td>
</tr>
<tr>
<td>7</td>
<td>OFF (test tripping) test button</td>
</tr>
<tr>
<td>8</td>
<td>Cable gland</td>
</tr>
<tr>
<td>9</td>
<td>Protective cover</td>
</tr>
<tr>
<td>10</td>
<td>Dummy plug</td>
</tr>
<tr>
<td>11</td>
<td>Connection terminal</td>
</tr>
<tr>
<td>12</td>
<td>Pressure equalization element</td>
</tr>
<tr>
<td>13</td>
<td>Cylinder head screw for protective conductor connection</td>
</tr>
</tbody>
</table>

The protective relays RS 2003 and RS 2004 have a 1/2"-14NPT adapter in place of the cable gland.
3.4 Nameplate

The nameplate is on the back of the protective relay.

![Figure 4: Nameplate](image)

3.5 Safety markings

The following safety markings are used on the product:

![Figure 5: Safety markings overview](image)

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Protective conductor connection</td>
</tr>
<tr>
<td>2</td>
<td>Warning of dangerous electrical voltage</td>
</tr>
<tr>
<td>3</td>
<td>Read the documentation</td>
</tr>
</tbody>
</table>
4 Packaging, transport and storage

4.1 Packaging

The products are sometimes supplied with sealed packaging and sometimes in a dry state, depending on requirements.

Sealed packaging surrounds the packaged goods with plastic foil on all sides.

Products that have also been dried are identified by a yellow label on the sealed packaging. In the dry state, delivery is also possible in a transport container.

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.

► The outer marking on the packaging states if, for example, the on-load tap-changer or selector has been packed upright. Never stack these crates.

► General rule: Do not stack crates above a height of 1.5 m.

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

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

The packaged goods are packed in a sturdy crate. This crate ensures that, when in the intended transportation position, the packaged goods are stabilized to prevent impermissible changes in position, and that none of the parts touch the loading surface of the means of transport or touch the ground after unloading.
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><img src="image" alt="Umbrella" /></td>
<td>Protect against moisture</td>
</tr>
<tr>
<td><img src="image" alt="Up Arrows" /></td>
<td>Top</td>
</tr>
<tr>
<td><img src="image" alt="Fragile Glass" /></td>
<td>Fragile</td>
</tr>
<tr>
<td><img src="image" alt="Lifting Gear" /></td>
<td>Attach lifting gear here</td>
</tr>
<tr>
<td><img src="image" alt="Center of Mass" /></td>
<td>Center of mass</td>
</tr>
</tbody>
</table>

Table 4: Shipping pictograms
4.2 Transportation, receipt and handling of shipments

**WARNING**

Danger of death or severe injury!

Danger of death or serious injuries due to tipping or falling load.
- Only transport the crate when closed.
- Do not remove the securing material used in the crate during transport.
- If the product is delivered on a pallet, secure it sufficiently.
- Only trained and authorized persons may select the sling gear and secure the load.
- Do not walk under the suspended 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, 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 is subject to 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 found upon receipt of the shipment, proceed as follows:
- Immediately record the identified transport damage 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 manufacturer 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 on site 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!** Damage to packaged goods due to damaged sealed packaging. If the product is delivered in sealed packaging, check the sealed packaging immediately. If the sealed packaging is damaged, do not under
any circumstances install or commission the packaged goods. Either re-
dry the dried packaged goods as per the operating instructions, or contact
the manufacturer to agree on how to proceed.

• Identify the damaged parts.

### Hidden damage

When damages are not determined until unpacking after receipt of the ship-
ment (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 insur-
ance 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 fluid until used if the packaged goods were not sup-
plied in insulating fluid.

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

4.4 Unpacking shipments and checking for transportation damages

- **NOTICE!** Damage to packaged goods due to ineffectively sealed packaging. Transport the packaged crate to the place where the packaged goods are to be installed. Do not open the sealed packaging until just before installation.

- **WARNING!** Serious injuries and damage to the packaged goods due to the packaged goods tipping out. Place the packaged goods in an upright crate and protect it from tipping out.

- Unpack the packaged goods and check the condition.
- Check the completeness of the accessories kit using the delivery slip.
5 Mounting

This chapter describes how to install and connect the protective relay.

5.1 Installing protective relay in piping and connecting

⚠️ WARNING

Danger of explosion!

Explosive gases in the protective relay can deflagrate or explode and result in severe injury or death.

► Wait 15 minutes after switching off the transformer before beginning further work on the protective relay so that the gases can dissipate.

► Ensure that there are no ignition sources such as naked flames, hot surfaces or sparks (e.g. caused by the build-up of static charge) in the immediate surroundings and that none occur.

► De-energize all auxiliary circuits before beginning work.

► Do not operate any electrical devices during the work (e.g. risk of sparks from impact wrench).

Always perform all transformer tests with the protective relay attached and connected.

5.1.1 Electrical protection

⚠️ NOTICE

Damage to the connection cable!

Damage to the connection cable due to incorrect connection.

► When routing the cable, observe the manufacturer specifications.

► Avoid impermissibly tight bending radii and kinking.

You may only connect the protective relay to circuits with an external overcurrent protection device and an all-pole isolating device, enabling the equipment to be fully de-energized if required (service, maintenance etc.).

Suitable equipment includes isolating devices in accordance with IEC 60947-1 and IEC 60947-3 (e.g. circuit breakers). Observe the properties of the relevant circuits (voltage, maximum currents) when selecting the circuit breaker type. In addition, observe the following:

▪ It must be easy for the operator to access the isolating device

▪ The isolating device must be labeled for the device and circuits to be isolated

▪ The isolating device may not be a part of the power line

▪ The isolating device may not interrupt the main protective conductor
The isolating device is to be rated such that the permissible disconnect times for protection against electric shock are complied with in accordance with the requirements of DIN VDE 0100-410, depending on the type of ground connection.

The function of the circuit breaker tripping circuit (supply line to the circuit breaker coil) must remain guaranteed at all times, even in the event of the isolating device tripping.

### 5.1.2 Checking function of protective relay

Check the function of the protective relay before installing it in piping between on-load tap-changer head and oil conservator. The associated contact positions for checking electrical continuity are shown in the dimensional drawing provided.

1. Loosen the three screws on the terminal box cover and lift off the terminal box cover.

![Figure 6: Terminal box cover](image)
2. Remove the slotted head screw for potential tie-in and remove the terminal box cover with wire.

![Figure 7: Terminal box cover](image)

**NOTICE**

**Damage to protective relay!**

Damage to protective relay resulting from improper operation.

► Never press both test buttons at the same time.

3. Press OFF test button.

► Flap valve is inclined. Line marker appears in the middle of the inspection window.

![Figure 8: OFF position](image)
4. Press OPERATION test button.
   ⇑ Flap valve is vertical.

Figure 9: OPERATION position

5. Position the wire for the terminal box cover and affix using the slotted head screw.

Figure 10: Terminal box cover
5 Mounting

6. Attach the terminal box cover and secure with screws.

Figure 11: Terminal box cover

5.1.3 Installing protective relay in piping

Ensure the following for installation and proper function of the protective relay:

1. Ensure that there are no foreign bodies in the piping or in the oil conservator.
2. Install protective relay such that it can be easily accessed for subsequent maintenance work.
3. Install protective relay with good support and free from vibrations.
4. The test buttons must be at the top.
5. The interior diameter of the piping must be at least 25 mm.
6. The magnetic field strength (bushings, busbars etc.) must be < 20 kA/m. Higher field strengths have a negative effect on the function of the protective relay.
7. The piping from the protective relay to the oil conservator must be routed with an inclination of at least 2% (1.2°) to ensure the switching gases can escape freely.
8. The protective relay is intended for a horizontal operating position in close proximity to the on-load tap-changer head. A positive inclination of up to 5° from horizontal is permitted in the direction to the conservator. An inclination of up to 5° from vertical to either side is permitted.

Figure 12: Protective relay installation
9. The reference arrow on the terminal box cover must point toward the on-load tap-changer's oil conservator.

Figure 13: Reference arrow pointing towards the on-load tap-changer's oil conservator
10. Install a stop-cock with a nominal width of at least 25 mm between the protective relay and oil conservator.

![Figure 14: Stop-cock](image)

### 5.1.4 Making the electrical connections for the protective relay

The protective relay's dry-reed magnetic switching tubes are supplied in the standard version as either NC or NO contacts. Other contact combinations can be supplied as special versions and are shown in the dimensional drawing provided.

**WARNING**

Risk of death or severe injury!

Risk of death or severe injury due to improper electrical connection of the protective relay.

► Loop the protective relay into the tripping circuit of the circuit breakers of the transformer to be protected so that the transformer is immediately de-energized by the circuit breakers when the protective relay is tripped.

► Systems which only generate an alarm message are not permitted.

![Figure 15: Tapped hole](image1)

2. Seal open tapped hole with dummy plug.

![Figure 16: Sealed with dummy plug](image2)

3. Loosen the three screws on the terminal box cover and lift off the terminal box cover.

![Figure 17: Terminal box cover](image3)
4. Take off the slotted head screw for potential tie-in and remove the terminal box cover with wire.

Figure 18: Terminal box cover

5. Remove screw for the protective cover and take off the protective cover.

Figure 19: Protective cover

6. Guide cable through cable gland and into protective relay. Ensure that the cable gland is well connected and sealed.

Figure 20: Cable bushing
7. Connect the electric cables to the connection terminals in accordance with the connection diagram on the dimensional drawing.

Figure 21: Electrical cables

8. Connect protective conductor to cylinder head screw.

Figure 22: Protective conductor
9. Insert the protective cover and secure using the screw.

Figure 23: Protective cover

10. Position the wire for the terminal box cover and affix using the slotted head screw.

Figure 24: Terminal box cover
11. Attach the terminal box cover and secure with screws.

Figure 25: Terminal box cover
5.2 Checking protective relay


- Check that the protective relay is functioning correctly before commissioning the transformer:
  1. Ground the transformer on the high-voltage side and low-voltage side. Ensure that the grounding for work connection on the transformer is not removed during testing.
  2. Ensure that the transformer remains de-energized during testing.
  3. Deactivate the automatic fire extinguishing device.
  4. Loosen the three screws on the terminal box cover and lift off the terminal box cover.
  5. Remove the slotted head screw for potential tie-in and remove the terminal box cover with wire.
  6. Press OFF test button.
  7. Leave the transformer's danger zone.
  8. Ensure that the transformer's circuit breaker cannot be closed.
     - Passive protection test
  9. Press OPERATION test button.
  10. Leave the transformer's danger zone.
  11. Close the transformer's circuit breaker with isolating switches open and the transformer grounded on all sides.
  12. Press OFF test button.
  13. Ensure that the transformer's circuit breaker is open.
     - Active protection test
  14. Press OPERATION test button to reset the protective relay.
  15. Position the wire for the terminal box cover and affix using the slotted head screw.
  16. Attach the terminal box cover and secure with screws.

5.2.2 Checking protective relay (RS 2004)

- Check that the protective relay is functioning correctly before commissioning the transformer:
  1. Ensure that the flap valve is in the OPERATION position.
  2. Leave the transformer's danger zone.
  3. Close the transformer's circuit breaker with isolating switches open and the transformer grounded on all sides.
  4. Press OFF test button.
  5. Ensure that the transformer's circuit breaker is open.
     - Active protection test
6 Commissioning

Once you have checked that the protective device is working correctly, you can continue by commissioning the transformer. To do so, follow the description provided in the operating instructions for the on-load tap-changer.
7 Operation

The following chapter describes how to operate the protective relay.

7.1 Tripping the protective relay and re-commissioning the transformer

**WARNING**
Danger of explosion!

Explosive gases in the protective relay can deflagrate or explode and result in severe injury or death.

- Wait 15 minutes after switching off the transformer before beginning further work on the protective relay so that the gases can dissipate.
- Ensure that there are no ignition sources such as naked flames, hot surfaces or sparks (e.g. caused by the build-up of static charge) in the immediate surroundings and that none occur.
- De-energize all auxiliary circuits before beginning work.
- Do not operate any electrical devices during the work (e.g. risk of sparks from impact wrench).

**WARNING**
Danger of death or severe injury!

Danger of severe injury or death if on-load tap-changer and transformer are insufficiently tested.

- Be sure to contact Maschinenfabrik Reinhausen to check on-load tap-changer and transformer if the protective relay has tripped.
- Only use the equipment again when you are sure there is no damage to the on-load tap-changer or transformer.

When the circuit breakers have been tripped by the protective relay, proceed as follows:

1. Establish time of tripping.
2. Determine operating position of on-load tap-changer.
3. As a precaution, block the motor-drive unit by tripping the motor protective switch to prevent the on-load tap-changer from being actuated by remote control.
4. Check the on-load tap-changer head cover. If insulating fluid is leaking, close the oil conservator stop valve immediately.
5. Check whether the flap valve of the protective relay is in the OFF or OPERATION position.

7.1.1 Flap valve in OPERATION position

If the flap valve is in the OPERATION position, there may be a fault in the tripping circuit. Check the tripping circuit in this case. If you are not able to clarify why the protective relay tripped, be sure to contact Maschinenfabrik Reinhausen to check the on-load tap-changer.
7.1.2 Flap valve in OFF position

Note that protective relay RS 2004 features an automatic reset mechanism which means that the flap valve does not remain in the OFF position after tripping. If the protective relay RS 2004 has not tripped due to an error in the tripping circuit, also proceed as described below for RS 2004.

If the flap valve is in the OFF position, proceed as follows:
1. Ensure that the transformer is not started up under any circumstances.
2. Contact and inform Maschinenfabrik Reinhausen of the following:
   - Serial number of protective relay and on-load tap-changer
   - What was the load of the transformer at the instant of tripping?
   - Was the on-load tap-changer moved immediately before or during tripping?
   - Did any other protective devices of the transformer respond at the instant of tripping?
   - Were switching operations in the network being carried out at the instant of tripping?
   - Were overvoltages registered at the instant of tripping?
3. Take further action in agreement with Maschinenfabrik Reinhausen.

7.1.3 Re-commissioning the transformer

Once the reason for the protective relay tripping has been established and remedied, you can re-commission the transformer:
1. Check the protective relay [Section 5.2.1, Page 36].
2. Commission the transformer.
8 Maintenance

**Electric shock!**

An energized transformer could cause death or serious injuries.

- Switch off transformer on high and low-voltage side.
- Lock transformer to prevent unintentional restart.
- Ensure that 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.

**DANGER**

**Electric shock!**

Working on the on-load tap-changer when on-load tap-changer components are energized can lead to death or serious injuries.

- De-energize all auxiliary circuits, such as the tap-change supervisory device, pressure relief device, pressure monitoring device.
- Make sure that everything is de-energized.

**WARNING**

**Danger of explosion!**

Explosive gases in the oil compartment of the on-load tap-changer, transformer, pipe system, oil conservator and at the dehydrating breather opening can deflagrate or explode and result in severe injury or death.

- Ensure that there are no ignition sources such as naked flames, hot surfaces or sparks (e.g. caused by the build-up of static charge) in the transformer's immediate surroundings and that none occur.
- Do not operate any electrical devices (e.g. risk of sparks from impact wrench).
- Only use conductive and grounded hoses, pipes, and pump equipment that are approved for flammable liquids.

**NOTICE**

**Damage to motor-drive unit!**

Damage to the motor-drive unit due to condensate in protective housing of motor-drive unit.

- Always keep protective housing of the motor-drive unit tightly closed.
- In the event of operation interruptions of more than 2 weeks, connect and operate the anti-condensation heater in the motor-drive unit. If this is not possible, e.g. during transportation, place a sufficient amount of desiccant in the protective housing.
8.1 Inspection

Protective relay monitoring is limited to a function test.

<table>
<thead>
<tr>
<th>Interval</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annually</td>
<td>Check that the protective relay functions correctly.</td>
</tr>
</tbody>
</table>

Table 5: Inspection plan
9 Disposal

For disposal, observe the national requirements applicable in the country of use.

If you have any questions about disassembly and disposal, please contact Maschinenfabrik Reinhausen GmbH's Technical Service department.
10 Technical data for protective relay

The technical data for the protective relay RS 2001 is listed in the following. In accordance with DIN EN 60255-1, operational accuracy = base accuracy

<table>
<thead>
<tr>
<th>Housing</th>
<th>Outdoor model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Degree of protection</td>
<td>IP66</td>
</tr>
<tr>
<td>Relay actuation</td>
<td>Flap valve with aperture</td>
</tr>
<tr>
<td>Weight</td>
<td>approx. 3.5 kg</td>
</tr>
<tr>
<td>Oil flow speed of available types when tripping (oil temperature 20 °C)</td>
<td>0.65 ± 0.15 m/s 1.20 ± 0.20 m/s 3.00 ± 0.40 m/s 4.80 ± 0.60 m/s</td>
</tr>
</tbody>
</table>

Table 6: General technical data

Tripping circuit

The protective relay can be supplied with either a normally open (NO) or a normally closed (NC) dry-reed magnetic switch (see dimensional drawing supplied). Other contact combinations are available as a special version.

Electrical data for normally closed (NC) dry-reed magnetic switch

<table>
<thead>
<tr>
<th>Electrical data</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>DC switching capacity</td>
<td>1.2 W…200 W</td>
</tr>
<tr>
<td>AC switching capacity</td>
<td>1.2 VA…400 VA</td>
</tr>
<tr>
<td>Switching voltage AC/DC</td>
<td>24 V…250 V</td>
</tr>
<tr>
<td>Switched current AC/DC</td>
<td>4.8 mA…2 A</td>
</tr>
</tbody>
</table>

Table 7: Electrical data

Switching capacity (switching load on an off)

| Minimum switched current AC/DC (lowest voltage) | 50 mA (at 24 V) |
| Minimum switched current AC/DC (highest voltage) | 4.8 mA (at 250 V) |
| Maximum switched current DC (highest current) | 1.6 A (at 125 V with L/R = 40 ms) |
| Maximum switched current DC (highest voltage) | 0.9 A (at 250 V with L/R = 40 ms) |
| Maximum switched current AC (highest current) | 2 A (at 125 V with cos φ = 0.6) |
| Maximum switched current AC (highest voltage) | 1.6 A (at 250 V with cos φ = 0.6) |
| Switching operations | 1,000 cycles |

Table 8: Switching capacity (switching load on an off)
### Dielectric strength

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC dielectric strength between all voltage-carrying connections and the</td>
<td>2,500 V, 50 Hz, test duration 1 minute</td>
</tr>
<tr>
<td>grounded parts</td>
<td></td>
</tr>
<tr>
<td>AC dielectric strength between the opened contacts</td>
<td>2,000 V, 50 Hz, test duration 1 minute</td>
</tr>
</tbody>
</table>

Table 9: Dielectric strength

### Electrical data for normally open (NO) dry-reed magnetic switch

#### Electrical data

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>DC switching capacity</td>
<td>1.2 W…250 W</td>
</tr>
<tr>
<td>AC switching capacity (50 Hz)</td>
<td>1.2 VA…400 VA</td>
</tr>
<tr>
<td>Switching voltage AC/DC</td>
<td>24 V…250 V</td>
</tr>
<tr>
<td>Switched current AC/DC</td>
<td>4.8 mA…2 A</td>
</tr>
</tbody>
</table>

Table 10: Electrical data

#### Switching capacity (switching load on an off)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum switched current AC/DC</td>
<td>50 mA (at 24 V)</td>
</tr>
<tr>
<td>(lowest voltage)</td>
<td></td>
</tr>
<tr>
<td>Minimum switched current AC/DC</td>
<td>4.8 mA (at 250 V)</td>
</tr>
<tr>
<td>(highest voltage)</td>
<td></td>
</tr>
<tr>
<td>Maximum switched current DC</td>
<td>2 A (at 125 V with L/R = 40 ms)</td>
</tr>
<tr>
<td>(highest current)</td>
<td></td>
</tr>
<tr>
<td>Maximum switched current DC</td>
<td>1 A (at 250 V with L/R = 40 ms)</td>
</tr>
<tr>
<td>(highest voltage)</td>
<td></td>
</tr>
<tr>
<td>Maximum switched current AC</td>
<td>2 A (at 125 V with cos φ = 0.6)</td>
</tr>
<tr>
<td>(highest current)</td>
<td></td>
</tr>
<tr>
<td>Maximum switched current AC</td>
<td>1.6 A (at 250 V with cos φ = 0.6)</td>
</tr>
<tr>
<td>(highest voltage)</td>
<td></td>
</tr>
<tr>
<td>Switching operations</td>
<td>1,000 cycles</td>
</tr>
</tbody>
</table>

Table 11: Switching capacity (switching load on an off)

### Dielectric strength

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC dielectric strength between all voltage-carrying connections and the</td>
<td>2,500 V, 50 Hz, test duration 1 minute</td>
</tr>
<tr>
<td>grounded parts</td>
<td></td>
</tr>
<tr>
<td>AC dielectric strength between the opened contacts</td>
<td>2,000 V, 50 Hz, test duration 1 minute</td>
</tr>
</tbody>
</table>

Table 12: Dielectric strength
### Ambient conditions

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Ambient temperature Ta</td>
<td>-40°C…+50°C</td>
</tr>
<tr>
<td>Oil temperature</td>
<td>&lt;130 °C</td>
</tr>
<tr>
<td>Air pressure</td>
<td>Corresponds to 0 m…4,000 m above sea level</td>
</tr>
</tbody>
</table>

Table 13: Ambient conditions
10.1 Protective relay with CO change-over contact as tripping switch

The protective relay can be supplied with a dry-reed magnetic switch, CO change-over (variant 3) (see dimensional drawing supplied).

**Electrical data for CO change-over dry-reed magnetic switch**

<table>
<thead>
<tr>
<th>Electrical data</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>DC switching capacity</td>
<td>1.2 W…150 W</td>
</tr>
<tr>
<td>AC switching capacity (50 Hz)</td>
<td>1.2 VA…200 VA</td>
</tr>
<tr>
<td>Switching voltage AC/DC</td>
<td>24 V…250 V</td>
</tr>
<tr>
<td>Switched current AC/DC</td>
<td>4.8 mA…1 A</td>
</tr>
</tbody>
</table>

Table 14: Electrical data

<table>
<thead>
<tr>
<th>Switching capacity (switching load on an off)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum switched current AC/DC (lowest voltage)</td>
<td>50 mA (at 24 V)</td>
</tr>
<tr>
<td>Minimum switched current AC/DC (highest voltage)</td>
<td>4.8 mA (at 250 V)</td>
</tr>
<tr>
<td>Maximum switched current DC (highest current)</td>
<td>1.0 A (at 150 V with L/R = 40 ms)</td>
</tr>
<tr>
<td>Maximum switched current DC (highest voltage)</td>
<td>0.6 A (at 250 V with L/R = 40 ms)</td>
</tr>
<tr>
<td>Maximum switched current AC (highest current)</td>
<td>1 A (at 200 V with cos φ = 0.6)</td>
</tr>
<tr>
<td>Maximum switched current AC (highest voltage)</td>
<td>0.8 A (at 250 V with cos φ = 0.6)</td>
</tr>
<tr>
<td>Switching operations</td>
<td>1,000 cycles</td>
</tr>
</tbody>
</table>

Table 15: Switching capacity (switching load on an off)

<table>
<thead>
<tr>
<th>Dielectric strength</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>AC dielectric strength between all voltage-carrying connections and the grounded parts</td>
<td>2,500 V, 50 Hz, test duration 1 minute</td>
</tr>
<tr>
<td>AC dielectric strength between the opened contacts</td>
<td>1,150 V, 50 Hz, test duration 1 minute</td>
</tr>
</tbody>
</table>

Table 16: Dielectric strength

10.2 Protective relay with several dry-reed magnetic switches

The protective relay can be supplied with several independent dry-reed magnetic switches. These can be designed as normally open (NO) or normally closed (NC) contacts and are electrically isolated (see dimensional drawing supplied).
Electrical data for normally open (NO) and normally closed (NC) dry-reed magnetic switch

10.3 Tests

Electrical safety

<table>
<thead>
<tr>
<th>IEC 61010-1</th>
<th>Safety requirements for electrical measurement and control and regulation equipment and laboratory instruments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>▪ Overvoltage category III</td>
</tr>
<tr>
<td></td>
<td>▪ Contamination level 2</td>
</tr>
</tbody>
</table>

Table 17: Electrical safety
<table>
<thead>
<tr>
<th><strong>CO</strong></th>
<th><strong>NC</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Change-Over contact</td>
<td>Normally Closed contact</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>IEC</strong></th>
<th><strong>NO</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>The International Electrotechnical Commission (IEC for short) is involved in the preparation and publication of international standards for electrical, electronic and related technologies.</td>
<td>Normally Open contact</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>IP</strong></th>
<th><strong>NPT</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Ingress protection</td>
<td>National Pipe Thread (US thread standard)</td>
</tr>
</tbody>
</table>
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