## Contents

1. **General** ......................................................................................................................................................................................... 5
   1.1 Safety Instructions .............................................................................................................................................................................. 5
   1.2 Specified Application ....................................................................................................................................................................... 5

2. **Design/Types** .................................................................................................................................................................................. 6

3. **Shipment** ....................................................................................................................................................................................... 7

4. **Installation of the tap-changer for cover mounting** .................................................................................................................. 8
   4.1 Mounting flange ................................................................................................................................................................................. 8
   4.2 Attaching the on-load tap-changer head to the transformer tank ............................................................................................ 8

5. **Installation of the tap-changer into a bell-type tank** .................................................................................................................. 9
   5.1 Installing the on-load tap-changer in the supporting structure ................................................................................................. 9
   5.2 Preparation .................................................................................................................................................................................... 10
   5.3 Attaching the bell-type cover .................................................................................................................................................... 12

6. **Connecting the tap winding and the tap-changer take-off terminal** ....................................................................................... 14
   6.1 Connecting the tap selector terminals ........................................................................................................................................ 14
   6.2 Connecting the tap-changer take-off terminal .......................................................................................................................... 15

7. **Transformer ratio test** .................................................................................................................................................................. 15

8. **Drying procedure and filling with oil** ..................................................................................................................................... 16
   8.1 Drying procedure .......................................................................................................................................................................... 16
   8.1.1 Vacuum-drying ........................................................................................................................................................................ 16
      8.1.1.1 Vacuum-drying in the autoclave ..................................................................................................................................... 16
      8.1.1.2 Vacuum-drying in the transformer tank .......................................................................................................................... 16
   8.1.2 Vapour-phase drying .................................................................................................................................................................. 16
      8.1.2.1 Vapour-phase drying in the autoclave ................................................................................................................................ 17
      8.1.2.2 Vapour-phase drying in the transformer tank .................................................................................................................. 17
   8.1.3 Operating the on-load tap-changer ..................................................................................................................................... 17
   8.2 Oil filling ....................................................................................................................................................................................... 17

9. **Pipe connections** ............................................................................................................................................................................. 18
   9.1 Pipe connection R for protective relay RS 2001 ........................................................................................................................... 18
   9.2 Pipe connection S for suction pipe .......................................................................................................................................... 18
   9.3 Pipe connection Q ......................................................................................................................................................................... 18
   9.4 Connection E2 .............................................................................................................................................................................. 18
## Contents

10 Mounting the motor drive unit, the bevel gear and the drive shaft ................................................................. 19
  10.1 Mounting the motor drive unit .................................................................................................................. 19
  10.2 Mounting the bevel gear ....................................................................................................................... 19
  10.3 Mounting the drive shaft ....................................................................................................................... 19

11 Putting the tap-changer into operation at the transformer manufacturer ............................................................... 21
  11.1 Operational tests ................................................................................................................................... 21
  11.2 Complete oil filling ............................................................................................................................. 21
  11.3 Ground connections ............................................................................................................................ 22
  11.4 Electrical tests on the transformer ....................................................................................................... 22

12 Transport to the installation site .................................................................................................................... 22

13 Putting into service at the operating site .......................................................................................................... 23

14 Monitoring during service .................................................................................................................................. 23

15 Failures ............................................................................................................................................................. 24

16 Maintenance .................................................................................................................................................... 24

17 Appendix ....................................................................................................................................................... 26

### NOTE

The data described in these Operating Instructions may vary in detail from the design delivered. We reserve the right to make alterations without notice.
1  General

1.1  Safety Instructions
All personnel involved in installing, commissioning, operating, maintenance or repair of the equipment must:
- be suitably qualified and
- strictly observe these Operating Instructions.

Improper operation or misuse can lead to
- a reduction in the efficiency of the equipment,
- damage to the equipment and property of the user and
- serious or fatal injury.

Safety instructions in this manual are presented in three different forms to emphasize important information.

⚠️ WARNING
This information indicates particular danger to life and health. Disregarding such a warning can lead to serious or fatal injury.

⚠️ CAUTION
This information indicates particular danger to the equipment or other property of the user. Serious or fatal injury cannot be excluded.

⚠️ NOTE
This notes give important information on specific subjects.

1.2  Specified Application

⚠️ CAUTION
The on-load tap-changer may only be used with the transformer specified in the order.
Installation, electrical connection and commissioning of the on-load tap-changer must only be carried out by qualified, skilled personnel and only in accordance with these Operating Instructions.

It is the responsibility of the user to ensure that the on-load tap-changer is used for the specified application only. For safety reasons, any unauthorised work such as installation, alteration, electrical connection, commissioning or modification to the on-load tap-changer equipment is forbidden without first consulting MR!

The trouble-free operation of the drive, on-load tap-changer and transformer may be put at risk.

⚠️ WARNING
All relevant fire protection regulations must be strictly observed.
The on-load tap-changer consists of the diverter switch with the tap selector mounted underneath (fig. 1). The diverter switch is installed in its own oil compartment.

The on-load tap-changer is attached to the transformer cover by means of the tap-changer head.

If required, the tap selector may be equipped with a change-over selector. For the standard version, models without change-over selector are available up to 14 and with change-over selector up to 27 operating positions.

The design of the on-load tap-changer and the designation of its main parts are shown in installation drawing 893900 (see section 17).

The Operating Instructions contain all information regarding the following tap-changer models, which are available with and without change-over selector.

**Three-phase tap-changer for neutral application:**
MS III 300 Y

**On-load tap-changer combination (special design for delta connection):**
MS I 301/MS II 302

**Single-phase tap-changer:**
MS I 301

All single-phase tap-changers are also available as a tap-changer group 3 x MS I 301 with a common motor drive.
3 Shipment

On-load tap-changer and motor drive are shipped in the adjustment position.
The on-load tap-changer equipment is shipped as follows (insulating parts are protected against moisture):
Delivery of the tap-changing equipment includes:
Diverter switch oil compartment with tap-changer head and diverter switch unit installed and the tap selector mounted (max. weight approx. 230 kg), fig. 1
Motor drive unit ED 100/200 S (approx. 80 kg), or
Motor drive unit ED 100/200 L (approx. 130 kg), fig. 2.
Drive shaft with coupling parts and bevel gear (max. weight approx. 20 kg), fig. 3.
Protective relay RS 2001 (3.5 kg), fig. 4.

The shipment is to be fully checked against consignment documents. The parts must be stored in a dry place until assembly.
All tap-changer parts must be left wrapped in their airtight protective cover and are to be removed only shortly before installation.

**NOTE**
In general, the drive shafts, the bevel gear and the protective relay are packed with the on-load tap-changer.

**WARNING**
When carrying out any work on the on-load tap-changer, motor drive or components, ensure they are positioned securely.
Otherwise there is a danger that individual devices may tip over accidentally. This can result in serious injury or even fatalities.
Installation of the on-load tap-changer for cover mounting (fig. 5)

4.1 Mounting flange

A mounting flange is necessary in order to mount the tap-changer head to the transformer cover. This mounting flange is to be constructed in accordance with the sealing surface of the tap-changer head (see fig. 6 and drawing 893900, see section 17).

To position the studs (M12, max. length 45 mm) we recommend the use of a drilling template (see fig. 7 and drawing 890183, section 17). If requested, the drilling template will be supplied with the first installation of a tap-changer type MS free of charge.

4.2 Attachment of the tap-changer head to the transformer cover

The on-load tap-changer is lowered through the cover aperture (= mounting flange) of the transformer and bolted by the tap-changer head to the mounting flange.

Proceed as follows:
1. Place the on-load tap-changer on a level surface.
2. Clean the sealing surface of the mounting flange and the tap-changer head.
3. Put an oil resistant gasket on the mounting flange.
4. Lift the on-load tap-changer by hooking up the tap-changer head and carefully lower it into the opening of the mounting flange. Take care not to damage the screening rings (only installed if $U_m \geq 170$ kV).
5. Check installed position of the tap-changer head.
6. Screw the tap-changer head to the mounting flange.
5 Installation of the on-load tap-changer into a bell-type tank (fig. 8)

To install the on-load tap changer into a transformer with a bell-type tank the on-load tap-changer has to be mounted onto a supporting structure. Therefore the on-load tap-changer is equipped with a supporting flange at the diverter switch oil compartment (special design, see section 17, drawing 896762).

First of all, lift the on-load tap-changer into the supporting structure and connect it to the tap winding. For this purpose the on-load tap-changer has to be attached to the supporting structure in such a way that it cannot be displaced.

The supporting flange is provided with bores, so that it can, without further measures, be provisionally secured to the supporting structure. It is advantageous to put spacer blocks temporarily between supporting structure and supporting flange and to remove them before setting up the bell-type cover.

After mounting the bell-type cover raise the on-load tap-changer (diverter switch insert dismounted) by means of the lifting device (see section 17, drawing 890180) and attach both on-load tap-changer and tap-changer head to the bell-type cover.

To attach the tap-changer head to the bell-type cover we recommend the use of a mounting flange as described in section 4.1.

5.1 Installation of the on-load tap-changer into the supporting structure

Lift the on-load tap-changer into the supporting structure. Make sure that the on-load tap-changer is in its proper mounting position and fasten it there safely.

NOTE

- In the supporting structure the on-load tap-changer must be suspended in an exactly vertical position.
- The on-load tap-changer must be mounted so that it need not be lifted by more than 5 to 20 mm to reach its final position after the bell-type cover has been set up.

It is of advantage to install spacer blocks between supporting structure and supporting flange in such a way that the on-load tap-changer is in its envisaged final position after the bell-type cover is set up. By this measure the leads to be connected to the on-load tap-changer can be correctly dimensioned in length. Remove the spacer blocks after connecting the leads.

To connect the tap winding and the tap-changer take-off terminal follow the instructions according to section 6.

CAUTION

Make sure, that the connected leads do not exert any force or pressure on the on-load tap-changer. This can tension the tap selector and thus impair its function. Moreover, there must be sufficient clearance, so that it is possible to raise the on-load tap-changer to its final installation position after the bell-type tank has been mounted.

Drying procedure and transformer ratio test are to be performed in accordance with sections 7 and 8.
5.2 Preparation

Before setting up the bell-type tank, the tap-changer head must be separated from the on-load tap-changer.

1. For this purpose, open the cover of the on-load tap-changer head (24 screws M10 / w.s.17, with locking washers).
2. Make sure not to damage the cover gasket (O-ring gasket, fig. 9).
3. Remove the position indicator dial (pull off the clip from the shaft end, fig. 10). Take note of the red-marked areas in the tap-changer head not covered by the supporting plate of the diverter switch insert (fig. 11).
4. Remove the fixing nuts of the supporting plate (5 nuts M8 / w.s.13, locking washers, fig. 12).
5. Lift the diverter switch insert carefully out of the diverter switch oil compartment (fig. 13).

6. Remove the suction pipe. Pull out the connecting piece in the tap-changer head to the inside (fig. 14). Do not lose the O-rings of the connecting piece.

7. Loosen the remaining screw connections on the tap-changer head (17 nuts M8/ w.s.13, locking washers), see fig. 15. Lift off the tap-changer head from the supporting flange.

**CAUTION**

Under all circumstances avoid dropping any parts into the diverter switch oil compartment. Otherwise there is the risk that the diverter switch blocks and both on-load tap-changer and transformer are damaged. Therefore, make sure that the number of small parts is complete when disassembling and reinstalling. Count them to be sure.
5.3 Setting up the bell-type transformer cover

1. Before setting up the bell-type transformer cover clean the sealing surface of the supporting flange. Place the O-ring on the supporting flange (fig. 16). Withdraw the spacer blocks (see section 5.1).

2. Lift the bell-type cover over the transformer active part and set up the bell-type cover.

3. Before mounting the tap-changer head, clean the sealing surfaces (bottom surface of the tap-changer head, mounting flange). Put an oil-resistant gasket on the mounting flange.

4. Place the tap-changer head on the mounting flange. Take note of the two adjusting bolts (fig. 16) and the markings at the supporting flange and tap-changer head (fig. 17), which ensure assembly in the correct position. Depending on the final height adjustment leave a clearance of 5 to 20 mm between tap-changer head and supporting flange.

5. Lift the on-load tap-changer slightly by means of the lifting traverse (see fig. 18 and section 17, dwg. 890180). Make sure, that all studs of the supporting-flange are easily guided through the bore holes on the tap-changer head.
6. Attach the tap-changer head in the red marked area not covered by the supporting plate of the diverter switch insert (fig. 19, also refer to section 5.2). Fixation by 17 nuts M8 / w.s.13, torque 20 Nm, secure by locking washers. Attach the tap-changer head to the mounting flange.

7. Reinstall the suction pipe. Check proper seat of the O-rings. Grease them slightly before mounting.

8. Remount the diverter switch insert with great care. Make sure that the supporting plate is correctly placed in the tap-changer head (red marked areas must be left free). Attachment of the supporting plate: by 5 nuts M8 / w.s.13, torque 20 Nm, secure by locking washers.

9. Attachment of the position indication dial: Slip the clip onto the shaft end. The coupling pin ensures installation of the position indication dial in its correct position (fig. 20).

10. Close the tap-changer head with the cover. Make sure that the O-ring gasket in the cover is placed properly. Fasten the cover of the on-load tap-changer head equally by 24 screws M10 / w.s. 17, torque 34 Nm (fig. 21).
6 Connecting the tap winding and the tap-changer take-off terminal

The connection of the tap winding and the tap-changer take-off lead has to be carried out according to the connection diagram supplied with the particular tap-changer equipment.

CAUTION

Carry out all connections carefully and secure them. The connecting leads must be assembled in such a way as to allow all leads to be connected to the tap selector without tension. If necessary, the lead ends must be shaped in form of expansion loops.

6.1 Connecting the tap selector terminals

The tap selector terminals are indicated on the tap selector bars.

The crimped ends of the tap selector terminals are provided with a through-hole for M8 screws, so that the tap leads can be connected by means of cable shoes (see fig. 22).

CAUTION

Make sure that the K terminal is not bent or distorted in any way, as this could impair the function of the reversing switch.
6 Connecting the tap winding and the tap-changer take-off terminal

7 Transformer ratio test

6.2 Connecting the tap-changer take-off terminal

The tap-changer take-off lead is to be connected to the take-off terminal of the diverter switch oil compartment (through-holes for M10-screws, fig. 23). Secure the screw connection (see fig. 24).

CAUTION

Place the tap selector take-off leads in the vicinity of the change-over selector (reversing switch or coarse tap selector) so as to allow sufficient clearance to the movable parts of the change-over selector. Otherwise the change-over selector may be blocked.

7 Transformer ratio test

We recommend to carry out ratio testing before drying of the transformer.

To operate the drive shaft in the tap-changer head a short tube of 25 mm nominal width with a screwed-in coupling bolt of 12 mm diameter together with a hand wheel or a hand crank may be used.

In case of tap-changer group 3 x MS I 301 and tap-changer combination MS I 301 / MS II 302 all tap-changer heads have to be linked together by means of the horizontal part of the drive shaft (see section 10).

If the on-load tap-changer is equipped with a motor drive ED, 16.5 drive shaft revolutions are required for one tap-change operation. The diverter switch action can be heard distinctly. When operating the change-over selector a higher torque is required. The end positions, which are to be inferred from the connection diagram supplied with the delivery, must never be overrun. Therefore always check the attained operation position through the inspection glass in the cover of the on-load tap-changer head (fig. 25). Keep the number of tap-change operations without oil to a minimum.

After the transformer ratio test the on-load tap-changer has to be set back to the adjustment position (see the connection diagram delivered with the equipment).

NOTE

If the transformer is to be vapor-phase dried in its own tank, open the kerosene drain plug (see section 8.1.2).
8 Drying procedure and filling with oil

8.1 Drying procedure

As precondition for MR's guarantee of the dielectric properties of the on-load tap-changer a minimum drying treatment must be carried out according to the following instructions (either according to 8.1.1 oder 8.1.2).

8.1.1 Vacuum-drying

8.1.1.1 Drying in the vacuum autoclave

NOTE
When drying the transformer in the autoclave the cover of the on-load tap-changer head must be removed.

- Heating up
  the on-load tap-changer in air of atmospheric pressure
  with a temperature rise of approx. 10 K to a final
  temperature of not more than 110 °C.
- Preparatory drying
  in circulating air at 110 °C max. applied to the on-load
  tap-changer for a duration of 20 hours.
- Vacuum drying
  at a temperature of 110 °C max. applied to the on-load
  tap-changer and a residual pressure of not more than
  10⁻³ bar for a duration of at least 50 hours.

8.1.1.2 Drying in the transformer tank

NOTE
If the transformer is to be dried in its own tank, the interior of the diverter switch oil compartment must be connected to vacuum by a connecting pipe, as the cover of the on-load tap-changer head remains closed during the entire drying process.

The cover of the on-load tap-changer head is vacuum-proof.

To ensure sufficient drying of the interior of the oil compartment and the incorporated diverter switch unit, a short by-pass tube of 25 mm nominal width must be connected between the transformer tank and a connecting flange at the tap-changer head that leads directly into the diverter switch oil compartment.

Connect the by-pass tube either between flanges E2 and Q or flanges E2 and R at the tap-changer head (for position of connecting flanges of the tap-changer head see section 9 and section 17, drawing 893899).

Procedure, temperature, pressure and duration of the drying process are described in section 8.1.1.1.

8.1.2 Vapor-phase drying

NOTE
Before starting the drying procedure, the kerosene drain plug in the oil compartment bottom (fig. 26) must be opened to drain the kerosene condensate from the oil compartment.

The kerosene drain plug has a hexagon socket and is easily accessible between oil compartment bottom and tap selector gear and can be unscrewed from outside. The kerosene drain plug has a plastic coating on the end of its thread and can only be screwed through this coating by applying a lot of pressure (fig. 26).

NOTE
Turn the kerosene drain plug only to the point of increased force.

When vapor-phase drying the transformer in its own tank (see section 8.1.2.2) the kerosene drain plug, in general, is not accessible from outside and can only be opened from inside the oil compartment.

In this case the diverter switch unit must be removed, the kerosene drain plug unscrewed with an extended socket wrench (see section 17, dwg. 890182) and the diverter switch unit reinstalled.

CAUTION
Close the kerosene drain plug again after the drying procedure to ensure that no oil can flow between the diverter switch oil compartment and the transformer tank!
8.1.2.1 Vapor-phase drying in the vacuum autoclave

**NOTE**

When drying the transformer in the vacuum autoclave the cover of the on-load tap-changer head must be removed and stored outside the autoclave.

- Heating up
  by admitting the kerosene vapor at a temperature of about 90 °C. Keep this temperature constant for about 3 to 4 hours.

- Drying
  by increasing the kerosene vapor temperature by about 10 K per hour to the desired final temperature, but not more than 125 °C applied to the on-load tap-changer. The duration of the drying procedure is normally the same as that of the transformer.

8.1.2.2 Vapour-phase drying in the transformer tank

If the transformer is to be dried in its own tank, the cover of the on-load tap-changer head remains closed during the entire drying process. The cover of the on-load tap-changer head is vacuum-proof. To ensure sufficient drying of the interior of the diverter switch oil compartment and of the diverter switch unit, it is necessary to connect a common tube of at least 50 mm nominal width between the kerosene vapor lead and at least two pipe connections of the tap-changer head leading into the diverter switch oil compartment.

For this purpose use flanges R and Q for on-load tap-changer type MS. (For position of pipe connections at the tap-changer head see section 9 and section 17, drawing 893899).

Procedure, temperature and duration of the drying process are described in section 8.1.2.1.

8.1.3 Operating the on-load tap-changer

**CAUTION**

Do not operate the on-load tap-changer after drying without prior wetting with oil as this will damage bearings and gaskets.

The on-load tap-changer must not be operated before the diverter switch oil compartment has been filled with oil and the tap selector has been completely immersed in transformer oil.

8.2 Filling with oil

Close the tap-changer head by lowering the cover. Tighten all 24 bolts M10/ w.s.17 on the cover uniformly (torque 35 Nm).

Under vacuum, fill the on-load tap-changer and transformer simultaneously with new transformer oil.

To fill with oil, use the connection S or R on the tap-changer head. To apply a vacuum to the transformer and oil compartment simultaneously, install a connection pipe between the connection E2 and Q.

**CAUTION**

The oil compartment and its associated oil conservator must be filled with new insulating oil for transformers according to IEC 60 296 (Specification for unused mineral insulating oils for transformers and switchgear) and IEC 60422 (Supervision and maintenance guide for mineral insulating oils in electrical equipment). For dielectric strength limit values see section 16/table II. The use of any other oils may put the trouble-free operation of the on-load tap-changer and the transformer at risk.
The tap-changer head is provided with 3 pipe connections for different purposes. After loosening the thrust collar (4 bolts M10 / w.s. 17) these pipe connections can be freely swivelled (see fig. 27 and section 17, drawing 893899). Torque: 34 Nm.

**NOTE**
Functionally speaking, pipe connections Q and R are interchangeable so that either the protective relay RS 2001 could be connected to Q or the oil filter plant could be connected to R.

### 9.1 Pipe connection R for protective relay RS 2001
The mounting of the protective relay RS 2001 (see section 17, dimension drawing 899084) is pursuant to our Operating Instructions No. 59.

**NOTE**
The stamped-on serial number of protective relay and on-load tap-changer must be identical.
The protective relay must be installed as close as possible to the tap changer head in a horizontal position.
The arrow on the installed protective relay must point to the oil conservator.
The pipe leading to the oil conservator must have an inclination of at least 2 %.

### 9.2 Pipe connection S for suction pipe
This is the connection for the feeding pipe of a stationary oil filter unit. If no oil filter is used, a pipe must be connected which ends with a drain cock at the side of the transformer tank at operating height.

### 9.3 Pipe connection Q (special design, required only with oil filter unit)
This pipe connection serves for the connection of the oil return pipe of a stationary oil filter unit. If no oil filter is connected, a dummy plug is mounted instead of the pipe connection.

### 9.4 Connection E2
This connection is closed by a dummy plug. It leads into the oil chamber of the transformer tank directly beneath the tap-changer head and can, in case of need, be connected to an accumulating tube for the Buchholz relay.
10 Mounting the motor drive unit, the bevel gear and the drive shaft

10.1 Mounting the motor drive unit (see section 17, dwg. 898801, 898802)

Detailed mounting instructions can be found in our Operating Instructions no. 138 for the Motor Drive Unit ED.

**NOTE**

The stamped-on serial number of bevel gear and on-load tap-changer must be identical (nameplate).

Motor drive unit and on-load tap-changer must be in the same operating position. This adjustment position is indicated in the tap-changer connection diagram supplied with the equipment.

The motor drive unit must be mounted at the provided place on the transformer tank in a vertical position and protected against excessive transformer vibrations.

10.2 Mounting the bevel gear

The bevel gear is to be attached to a support on the transformer cover by 2 bolts (through-holes 18 mm diameter, see section 17, drawing 892916).

**NOTE**

The stamped-on serial number of bevel gear and on-load tap-changer must be identical.

The horizontal shaft end of the bevel gear must be in proper alignment with the shaft end of the upper gear unit on the tap-changer head.

After loosening the thrust collar (6 bolts M8/w.s.13) the upper gear unit can be freely swivelled (fig. 28).

When having adjusted the upper gear unit, tighten the thrust collar, torque 15 Nm).

The bolts are to be secured.

In case of bevel gears and diverting gears in special design and intermediate bearings of the vertical or horizontal drive shaft, the above instructions apply analogously.

10.3 Mounting the drive shaft (square tube)

The drive shaft must be mounted according to our Operating Instructions No. 42.

The drive shaft is the mechanical connection between the motor drive and the tap-changer head. The diverting from the vertical to the horizontal direction takes place through the bevel gear.

Accordingly, when mounting, the vertical drive shaft is to be attached between motor drive unit and bevel gear, whereas the horizontal drive shaft is to be attached between bevel gear and tap-changer head.

The drive shaft itself consists of a square tube and is to be connected on both ends to the end of either the drive shaft or the driven shaft of the respective implement by two coupling brackets and one coupling bolt.

**NOTE**

When installing the drive shaft, make sure that the shaft ends to be connected are exactly aligned.

Square tubes, coupling brackets, coupling bolts, crews, nuts and lock tabs are corrosion-resistant.

The square tube and the guard plate which serves as foot step protection for the horizontal drive shaft at the transformer cover, are supplied in oversize (various standard lengths). These parts must be cut to the required size before mounting to the transformer.

Finally, balancing of the lag of the motor drive relative to the diverter switch action of the on-load tap-changer must be performed (according to Operating Instructions no. 138 for the Motor Drive Unit ED).
Mounting the motor drive unit, the bevel gear and the drive shaft

Tap-changer group 3 x MS I 301 and tap-changer combination MS I 301 / MS II 302

This procedure is also recommended for all other models of on-load tap-changer type MS.

Due to the special arrangement of the tap-changer phases in three or two columns, the tap-changer heads must be coupled to each other above the tank cover. Since turning of the upper gear unit will initiate a switching action, make sure that the exact adjustment position of the diverter switch is regained after the alignment of the gear units.

Proceed as follows:

1. Check that the operating positions of all on-load tap-changers are identical (inspection window in the tap-changer head). Each of the single-phase tap-changers must be in the adjustment position.

2. Turn the upper gear units of the tap-changer heads into the desired mounting position and fix them there (screw-tighten thrust collars and tab-lock the screws).

   Take note of the arrow on the drive shaft flange below the punched serial number. The direction of the arrow indicates the rotation sense when turning the hand crank of the motor drive clockwise.

3. In order to reduce the difference in time between operation of the individual poles, turn the shaft ends against the direction of the arrow so that all single-phase on-load tap-changers are separately operated by one step, and until the diverter switch unit just operates. Check coincidence of position at all on-load tap-changer heads.

4. Mount the horizontal drive shaft between the tap-changer heads.

5. Return the whole tap-changer set, that is all single-phase tap-changers together, into the adjustment position. The adjustment position must be reached by turning the drive shaft in the direction of the arrow.

   Check simultaneous operation of all diverter switches. Check coincidence of positions at all tap-changer heads.

6. Mount the vertical drive shaft.
11 Putting the on-load tap-changer into operation at the transformer manufacturer

11.1 Operational tests
Before applying voltage to the transformer, some test operations must be carried out to check the mechanical functions of on-load tap-changer and motor drive.
For these test operations the on-load tap-changer has to be run through the entire operating cycle.
Make sure that in each operating position the indications of motor drive and on-load tap-changer (inspection window in the tap-changer head) read the same position.

⚠️ CAUTION
A coupling fault between on-load tap-changer and motor drive unit exists, if on-load tap-changer and motor drive unit show a different operating position. Misalignment of coupling between on-load tap-changer and motor drive unit leads to severe damage of on-load tap-changer and transformer if operation is continued. The transformer may not be put into operation.

Check that the automatic switch-off is working in both end positions and check the function of the electrical and mechanical end position limits (see Operating Instructions no. 138 for the motor drive unit ED).

11.2 Final oil filling
Fill up and bleed the on-load tap-changer completely via the oil conservator with transformer oil according to IEC 60 296 and IEC 60 422.
In this connection bleed:
- The tap-changer head via the bleeder valve in the tap-changer head cover (E1):
  Open the screw cap M30/w.s.36, lift the valve tappet by means of a screwdriver, replace the screw cap and fix it, torque 10 Nm (fig. 29).
- The suction pipe (S) via the bleeder screw at the connecting ellbow: cap nut M16/w.s.22, torque 10 Nm, slotted bleeder screw M6, max. torque 2 Nm (fig. 30).

⚠️ CAUTION
Make sure that the suction pipe has been bled completely. The insulation capability of the on-load tap-changer to ground is otherwise significantly impaired.
11.3 Ground connections
Connect the ground screws of the tap-changer head (2 screws M12 / w.s.19 with nuts, torque 60 Nm, fig. 31) to the transformer cover.

Connect the ground screw M12 / w.s.19 (torque 60 Nm) of the motor drive housing to the transformer tank.

11.4 Electrical transformer tests
After the afore-mentioned steps the electrical tests necessary for acceptance of the transformer can now be performed.

If the motor drive unit is to be demounted for transport of the transformer to the installation site, move the motor drive into the adjustment position and then uncouple.

CAUTION
Do not operate the motor drive while the on-load tap-changer is uncoupled.

NOTE
If the transformer is filled with oil but stored or transported without oil conservator, a by-pass tube must be installed between the interior of the diverter switch oil compartment and the transformer tank to equalise the pressure caused by the expansion of the oil.

Install this by-pass tube at the tap-changer head between the connection E2 and one of the free connections R, S or Q of the tap-changer head.

For short stand-by periods between 2 and 4 weeks without oil conservator, it is also sufficient to lower the oil level by approx. 5 litres.

If the transformer is to be completely emptied, drain also the switching oil of the on-load tap-changer completely.

The interior of the diverter switch oil compartment should be conserved and protected in the same way as the transformer, e.g. by filling with nitrogen.

In the case of a longer stand-by period, the heater of the motor drive unit must be connected and put into operation.
13 Putting into service at the operating site

Before putting the transformer into service operational tests of on-load tap-changer and motor drive have to be performed according to section 11.1. At the same time check the function of the protective relay.

Loop in signaling contact for undershooting the minimum oil level in the on-load tap-changer oil conservator in the on-load tap-changer tripping circuit.

Make sure that the connected circuit breakers operate when test button »OFF« of the protective relay is pressed. Be sure that they energize the transformer only after the protective relay has been brought to position »IN SERVICE« by pressing the other test button.

When having energized the transformer, tap-change operations under load can be performed. The switching gas accumulating under the cover of the on-load tap-changer head will cause minor oil displacement or escape via the oil conservator.

14 Monitoring during service

NOTE

Damage to the on-load tap-changer due to not enough oil in the oil conservator of the on-load tap-changer!
Actuation of the on-load tap-changer with too little oil in the on-load tap-changer’s oil conservator may cause damage to the on-load tap-changer!
Make sure that the contact for signaling the falling below the minimum oil level in the on-load tap-changer’s oil conservator was looped through to the tripping circuit of the circuit-breaker and that the circuit-breaker will immediately de-energize the transformer when the oil has fallen below this minimum oil level in the oil conservator.

Monitoring the on-load tap-changer and motor drive unit is limited to regular visual inspections of the tap-changer head, protective relay and motor drive unit. These can be carried out at the same time as the usual control inspections on the transformer.

Pay particular attention to the following:

- sealing points of the tap-changer head, protective relay and, if applicable, connected pipes must be oil-proof,
- sealing of the protective housing of the motor drive unit,
- trouble-free functioning of the built-in electrical heating in the protective housing of the motor drive unit,
- silicagel breather must be in perfect condition
- function test of the protective relay according to Operating Instructions no. 59.

The insulating oil in the transformer should be monitored by the user according to the relevant regulations (also see section 16).
### WARNING

If the protective relay is triggered, the on-load tap-changer and transformer must be thoroughly checked. This involves withdrawing the diverter switch insert and checking it according to the Inspection Instructions. For more details of the protective relay RS 2001, follow the Operating Instructions no. 59. This applies analogously when other protective devices e.g. the pressure relief device trip in the on-load tap-changer. Only operate the equipment again when you are sure there is no damage to the on-load tap-changer or to the transformer. Operating the transformer without prior checking is not permitted as serious damage to the on-load tap-changer and the transformer can occur.

For more serious problems with the on-load tap-changer or motor drive unit, which cannot be rectified easily on site, or if the protective relay is triggered, please inform your authorised MR representative or the transformer manufacturer. Alternatively, contact us directly at Maschinenfabrik Reinhausen GmbH

Technical Service
Postfach 12 03 60
93025 Regensburg
Germany
Phone: (+49) 9 41 / 40 90-0
Fax: (+49) 9 41 / 40 90-501
E-Mail: service@reinhausen.com
16 Maintenance

Maintenance intervals

<table>
<thead>
<tr>
<th>On-load tap-changer</th>
<th>Rated transformer current</th>
<th>Number of switching operations</th>
</tr>
</thead>
<tbody>
<tr>
<td>MS III 300 Y</td>
<td>up to 300 A</td>
<td>100,000</td>
</tr>
<tr>
<td>MS I 301, MS II 302</td>
<td>up to 300 A</td>
<td>100,000</td>
</tr>
</tbody>
</table>

Table 1  Maintenance intervals

If the number of switching operations according to table 1 has not been reached, a maintenance has to be carried out every 7 years.

The scope and type of maintenance are specified in MR's corresponding Maintenance Manual.

If the appropriate preparations are made a proper maintenance can generally be carried out within a day.

**WARNING**

Disregarding the inspection intervals or incomplete/improper maintenance can lead to severe damage on the on-load tap-changer and the transformer.

Generally, we recommend that our Technical Service Department carry out each maintenance. As well as guaranteeing that all work is properly carried out, specific components are also retro-fitted to the latest standard of technology.

If a maintenance is not carried out by our Technical Service Department, please ensure that the personnel carrying out the maintenance are trained by MR or are otherwise suitably qualified to carry out the work. In such a case, we would ask you to forward us a report on the maintenance performed, to complete our maintenance records. For inquiries about spare parts we would ask you to inform us about the serial number (see the name plate on the motor drive unit) and the number of switching operations.

In addition to the maintenance intervals mentioned above, the diverter switch unit of the on-load tap-changer must be replaced after 800,000 tap-change operations.

The tap selector of the on-load tap-changer generally does not require maintenance. In certain cases, for example in industrial transformers where a high number of switching operations is expected, our Technical Service department should be contacted when 1,000,000 switching operations have been carried out.

For on-load tap-changers with more than 15,000 switching operations annually, we recommend the use of our stationary oil filter plant type OF 100 (Operating Instructions no. 18) with a paper filter insert.

Filtering the switching oil means the inspection intervals can be longer (see table 1).

In addition, the limit values for replacement and/or treatment of the diverter switch oil listed in table 2 should be observed.

**CAUTION**

The oil compartment and its associated oil conservator must be filled with new insulating oil for transformers according to IEC 60 296 (Specification for unused mineral insulating oils for transformers and switchgear) and IEC 60 422 (Supervision and maintenance guide for mineral insulating oils in electrical equipment).

For dielectric strength limit values see section 16/table 2. The use of any other oils may put the trouble-free operation of the on-load tap-changer and the transformer at risk.
Limit values for the exchange and/or treatment of the tap-changer oil:

<table>
<thead>
<tr>
<th>On-load tap-changer</th>
<th>Dielectric strength*</th>
</tr>
</thead>
<tbody>
<tr>
<td>MS III 300 Y</td>
<td>30 kV / 2.5 mm (minimum)</td>
</tr>
<tr>
<td>MS I 301, MS II 302</td>
<td>40 kV / 2.5 mm (minimum)</td>
</tr>
</tbody>
</table>

Table 2

*) measured according to IEC 60 156

The temperature of the oil sample at the time of measuring the dielectric strength should be noted. The given values for dielectric strength are valid for oil temperatures of 20 °C ± 5 °C.
<table>
<thead>
<tr>
<th>Description</th>
<th>Page Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>On-load tap-changer type MS, installation drawing (centric drive)</td>
<td>893 900</td>
</tr>
<tr>
<td>Tap-changer head (centric drive)</td>
<td>893 899</td>
</tr>
<tr>
<td>Drilling template for tap-changer head</td>
<td>890 183</td>
</tr>
<tr>
<td>Supporting flange, special design for installation to a bell-type transformer cover</td>
<td>896 762</td>
</tr>
<tr>
<td>Lifting traverse</td>
<td>890 180</td>
</tr>
<tr>
<td>Socket wrench for kerosene drain screw</td>
<td>890 182</td>
</tr>
<tr>
<td>Screwdrivers and spanners for installation and inspection</td>
<td>890 478</td>
</tr>
<tr>
<td>Protective relay RS 2001, dimension drawing</td>
<td>899 084</td>
</tr>
<tr>
<td>Motor drive unit ED-S, protective housing</td>
<td>898 801</td>
</tr>
<tr>
<td>Motor drive unit ED-L, protective housing</td>
<td>898 802</td>
</tr>
<tr>
<td>Bevel gear CD 6400, dimension drawing</td>
<td>892 916</td>
</tr>
</tbody>
</table>
E1 = Bleeding facility for tap-changer head
E2 = Bleeding facility for space under the tap-changer head outside the tap changer oil compartment (same pipe connection as Q, S, R or bleeder screw can be used)
Q = Connection for oil return pipe (only for oil filter)
S = Connection for suction pipe
R = Connection for protective relay (exchangeable with connection Q)
= Ground connection M12
On-load tap-changer OILTAP® MS, M, RM, R
Drilling template for tap-changer head

Marks to be pounded

3 Thickness
On-load tap-changer OILTAP® MS, M, RM, R

Supporting flange, special design for installation to a bell-type transformer cover

O-Ring 44/2 - 5.7
Suction pipe
Drilling hole represented in the sectional plane
Lifting device

Screening ring with $U_{MV}=170$ kV, 245 kV, 300 kV only

Supporting flange
Lifting traverse

$Z =$ Guiding pin

Drive side of the tap selector
On-load tap-changer OILTAP® MS, M, RM, R
Lifting traverse

Sheet steel
St 37 – 2 DIN 17 100
On-load tap-changer OILTAP® MS, M, T, RM, R, G

Socket wrench for kerosene drain screw

<table>
<thead>
<tr>
<th>Socket wrench</th>
<th>Part no. 014 820</th>
<th>Part no. 017 660</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>L = 1350 mm</td>
<td>L = 1860 mm</td>
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<tr>
<td>To be used for on-load tap-changers</td>
<td>Type M (not MD)</td>
<td>Type M III 350 D/600 D</td>
</tr>
<tr>
<td></td>
<td>Type MS</td>
<td>Type T</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Type RM, R</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Type G</td>
</tr>
</tbody>
</table>
### On-load tap-changer OILTAP® MS und M
Screwdrivers and wrenches for installation and inspection

<table>
<thead>
<tr>
<th>Item</th>
<th>Quant.</th>
<th>Designation</th>
<th>Fig.</th>
<th>DIN</th>
<th>Wrench size in mm</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>Double-ended open-jaw wrench</td>
<td>A</td>
<td>895</td>
<td>8 x 10</td>
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<tr>
<td>2</td>
<td>1</td>
<td>Ring and open-jaw wrench</td>
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<td>3113</td>
<td>10</td>
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<tr>
<td>3</td>
<td>1</td>
<td>Double-ended open-jaw wrench</td>
<td>A</td>
<td>895</td>
<td>13 x 17</td>
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<td>1</td>
<td>Double-ended socket wrench</td>
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<td>896</td>
<td>13 x 17</td>
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<tr>
<td>5</td>
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<td>Double-ended open-jaw wrench</td>
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<td>17 x 19</td>
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<td>22 x 24</td>
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<td>7</td>
<td>1</td>
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<td>911</td>
<td>4</td>
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<tr>
<td>8</td>
<td>1</td>
<td>Hexagon socket screw key</td>
<td>D</td>
<td>911</td>
<td>5</td>
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<tr>
<td>9</td>
<td>1</td>
<td>Hexagon socket screw key</td>
<td>D</td>
<td>911</td>
<td>8</td>
</tr>
</tbody>
</table>
The protective relay must be connected in such a way that if it is energized, the power transformer is immediately disconnected by its circuit breakers.

### Variant Key

<table>
<thead>
<tr>
<th>Variants</th>
<th>Relay Designation</th>
<th>Reed switch</th>
<th>Contact positions</th>
<th>Terminal Arrangement</th>
<th>Design</th>
</tr>
</thead>
<tbody>
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<td></td>
</tr>
<tr>
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<td>3.0 - NO</td>
<td></td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
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<td>4.8 - NO</td>
<td></td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
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<td>0.65 - NC</td>
<td>B</td>
<td>1</td>
<td>2</td>
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<tr>
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<td>1.2 - NC</td>
<td></td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3.0 - NC</td>
<td></td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
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<td></td>
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<td></td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
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<td>3</td>
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<td></td>
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<td></td>
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<td>3</td>
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<tr>
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<td>0.65 - 2NO</td>
<td>2A</td>
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<tr>
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<td></td>
</tr>
<tr>
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<td>4</td>
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<td>3.0 - 2NC</td>
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<td>1</td>
<td>4</td>
<td></td>
</tr>
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<td></td>
<td>4.8 - 2NC</td>
<td></td>
<td>1</td>
<td>4</td>
<td></td>
</tr>
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<td>6</td>
<td>0.65 - NO + NC</td>
<td>1A and 1B</td>
<td>1</td>
<td>4</td>
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</tr>
<tr>
<td></td>
<td>1.2 - NO + NC</td>
<td></td>
<td>1</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3.0 - NO + NC</td>
<td></td>
<td>1</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4.8 - NO + NC</td>
<td></td>
<td>1</td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>

*NO - normally open contact, NC - normally closed contact, CO - change-over contact*
Motor drive unit ED-S
Protective housing

**Vertical guard plate with spacing ring**

**Hand crank**

**Wall of transformer tank**

**Shim**

**Attachment of the housing**

The cover can be opened to the left or right depending on the location of the hinge pins.

**Aperture of fixing holes on protective housing** (rear view)

**Aperture in protective housing for cables** (underside view)

* for designs with intermediate gear

* for designs with intermediate gear

3 dummy plates for packing glands

special design for OLTC monitoring
Motor drive unit ED-L
Protective housing

Attachment of protective housing
c. 690 if opened 130°
c. 864 if opened 180°

The cover can be opened to the left or to the right depending on the arrangement of the hinge pins.

Aperture of fixing holes on protective housing (rear view)

Aperture in protective housing for cables (underside view)
Bevel gear CD 6400

Dimension drawing

$e_1 = 205$ for standard design
$e_2 = 215$ for design with ball joint