ON-LOAD
TAP CHANGER
TYPE RM
Operating Instructions
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**Please note:**

Drawings and illustrations contained herein may differ in detail from the tap changer equipment delivered. They are for reference only and are subject to change without notice.
1. GENERAL

The tap changer consists of the diverter switch with the tap selector attached underneath (fig. 1).
The diverter switch is installed in its own oil compartment.
The tap changer is attached to the transformer cover by means of the tap changer head.
If required, the tap selector is equipped with a change-over selector. Tap changer models without change-over selector are available up to a maximum of 18 and with change-over selector up to a maximum of 35 operating positions.
The design and the designation of the most important parts of the tap changer can be understood from installation drawing 897 597 in section 15.
The Operating Instructions apply to all standard models of the tap changer variants specified below, which are available with and without change-over selector:

**Three-phase tap changer:**
RM III 600 (fig. 1)

**Single-phase tap changers:**
RM I 601, RM I 1201, RM I 1502

All single-phase tap changers are also available as a tap changer group 3 x RM I 601, 3 x RM I 1201 or 3 x RM I 1502 with a common motor drive.

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**WARNING:**
The on-load tap changer is to be used only with the transformer specified in the tap changer order.

Installation, electrical connection and putting into service of the on-load tap changer must be carried out exclusively by qualified, skilled personnel and in accordance with these Operating Instructions.
Do not alter or modify the equipment without consulting MR beforehand.
Disregard of these Operating Instructions and improperly performed work during installation, electrical connection and putting into service of the on-load tap changer may put at risk the trouble-free operation of motor drive unit, tap changer and transformer and could result in personal injury and damage of property.
2. SHIPMENT

Tap changer and motor drive are shipped in the adjustment position. The tap changer is packed in two parts – diverter switch and tap selector – and is well protected against moisture. Both the diverter switch and the tap selector are blocked in the adjustment position.

The tap changer equipment is shipped as follows:

Diverter switch oil compartment with tap changer head and built-in diverter switch unit (max. weight approx. 210 kg), fig. 2.

Tap selector (max. weight approx. 190 kg), fig. 3.

Motor drive unit MA 7 (approx. 90 kg), fig. 4, or MA 9 (approx. 60 kg).

Drive shaft with coupling parts and bevel gear (max. weight approx. 210 kg), fig. 5.

Protective relay RS 2001 (3.5 kg), fig. 6.

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.

Please note: In general, drive shaft, bevel gear and protective relay are packed with the tap changer.
3. INSTALLATION OF THE ON-LOAD TAP CHANGER FOR COVER MOUNTING

3.1 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. 7 and drawing 893 899, section 15).

To position the studs (M12, max. length = 45 mm) we recommend the use of a drilling template (see fig. 8 and dwg. 890 183 in the appendix). If requested, the drilling template will be supplied with the first installation of a tap changer type RM free of charge.

3.2 Attachment of the tap changer head to the transformer cover

The diverter switch oil compartment is lowered through the cover aperture (= mounting flange) of the transformer and is bolted by the tap changer head to the mounting flange. Then, the tap selector is fastened to the diverter switch oil compartment (see section 3.3).

Proceed as follows:

1. Place the diverter switch oil compartment on a level surface.
2. Clean sealing surfaces of mounting flange and tap changer head.
3. Put an oil-resistant gasket on the mounting flange.
4. Lift the diverter switch oil compartment by hooking up the tap changer head and carefully lower the oil compartment into the opening of the mounting flange.
   Make sure not to damage the screening rings (with $U_{m} \geq 170$ kV only).
5. Check the installation position of the tap changer head.
    Attach the tap changer head to the mounting flange with nuts.

Remove now the blocking plate from the coupling of the oil compartment bottom (fig. 9).

3.3 Assembly of diverter switch oil compartment and tap selector

The tap selector is raised to the diverter switch oil compartment and connected to it. At the same time the mechanical coupling for the tap selector drive has to be produced.

Finally, the tap selector connecting leads are connected to the diverter switch oil compartment.

Proceed as follows:

1. Place the tap selector on a level surface. Get ready 2 hex. head screws M10 x 110/ w.s. 17, with lock nuts and lock washers and 2 hexagonal screws M10 x 80 with spring washers.

Remove now the blocking strip from the tap selector coupling (fig. 10). The coupling must not be turned afterwards.

2. Put the tap selector on an appropriate lifting device.
3. Raise the tap selector below the diverter switch oil compartment. Take care that tap selector connecting leads clear the oil compartment and remain undamaged.

4. Match the position of the two coupling parts and the attachment points of tap selector suspension and oil compartment bottom.
5. Raise the tap selector to its final height.
6. Bolt the tap selector suspension to the oil compartment bottom (fig. 11):
2 hex. head screws M10 x 110 (wrench size 17) with nuts (self-locking, max. torque 44 Nm) and washers.

2 hex. head screws M10 x 80/w.s. 17 with lock washers, max. torque 44 Nm

7. Connect the tap selector connecting leads to the diverter switch oil compartment:

**OLTC RM III 600 Y**
Attach each of the 6 leads to the oil compartment terminals by:
1 nut M16, w.s. 24, tightening torque (50 + 5) Nm, with lock tab and screening cap (fig. 12).

**OLTC RM I 601**
Attach two leads to the oil compartment terminals by:
1 nut M16, w.s. 24, tightening torque (50 + 5) Nm, with lock tab and screening cap (fig. 12).

**OLTC RM I 1201**
Attach each of the 6 leads to the connecting lugs of the oil compartment by:
1 screw M10, w.s. 17, lock nut and screening cap (fig. 13a, 13b), max. tightening torque 44 Nm.

**OLTC RM I 1502**
Two sectors of the diverter switch are connected in parallel by two connecting rings located at the outside of the diverter switch oil compartment. The tap selector leads are to be connected to these connecting rings.
Attach each of the 6 leads to the connecting rings by:
1 screw M10/w.s. 17, lock nut and screening cap (fig. 14), max. tightening torque 44 Nm.
4. INSTALLATION OF THE TAP CHANGER INTO A BELL-TYPE TANK

To install the on-load tap changer into a transformer with a bell-type tank the 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, dwg. 896 762 in the appendix).

First of all lift the tap changer into the supporting structure and connect it to the tap winding. The 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 (with the diverter switch unit removed) by means of the lifting traverse (see dwg. 890 180 in the appendix) and attach both the tap changer and the 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 3.1.

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

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

IMPORTANT:

- In the supporting structure the tap changer must be suspended in an exactly vertical position.

- The 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 is 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 position after the bell-type cover is set up. By this measure the leads to be connected to the tap changer can be correctly dimensioned in length.

To connect the tap winding and the tap changer take-off terminal follow the instructions according to section 5.

4.1 Assembly of diverter switch oil compartment and tap selector, connection of tap selector connecting leads

The assembly of diverter switch oil compartment and tap selector as well as the connection of the tap selector connecting leads have to be carried out according to section 3.3.

CAUTION:

The connected leads must not exert any force on the tap changer. Moreover there must be sufficient clearance so that it is possible to raise the 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 6 and 7.
4.3 Preparations

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

1. Open the tap changer cover (24 screws M10/w.s. 17, with lock washers).

2. Take care of the cover gasket (round rubber gasket, fig. 15).

3. Remove the position indicator dial (pull off the clip from the shaft end, fig. 16).

Take note of the red-marked area which is in the region of the tap changer head and not covered by the supporting plate of the diverter switch unit (fig. 17).

4. Remove the fixing nuts of the supporting plate (4 nuts M8/w.s. 13, lock washers, fig. 18).

5. Carefully lift the diverter switch unit vertically out of the diverter switch oil compartment (fig. 19).

6. Remove the suction pipe. The pipe connection in the tap changer head has to be withdrawn from the inside (fig. 20). Be careful not to damage the O-rings at the pipe connection.

7. Unscrew the still remaining screw connections in the tap changer head (17 nuts M8/w.s. 13, lock washers), see fig. 21. Lift off the tap changer head from the supporting flange. Take care of the gasket.

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**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 the 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.
4.4 Setting up the bell-type transformer cover

① Before setting up the bell-type transformer cover clean the sealing surface of the oil compartment supporting flange. Put the gasket on the supporting flange (fig. 22). Withdraw the spacer blocks (see section 4.2).

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 of tap changer head, mounting flange). Place an oil-resistant gasket on the mounting flange.

④ Position the tap changer head onto the mounting flange and pay attention to the 2 adjusting bolts (fig. 22) and the marks on the supporting flange and tap changer head (fig. 23). This ensures 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 tap changer slightly by means of the lifting traverse (see fig. 24 and section 15, drawing 890 180). Make sure that all supporting flange studs go easily through the fixing bores of the tap changer head.

⑥ Fasten the tap changer head on the red marked region not covered by the diverter switch supporting plate (fig. 25, see also section 4.3). Use 17 nuts M8 (w.s. 13, max. torque 14 Nm, securing by lock washers). Attach the tap changer head to the mounting flange.

⑦ Remount the suction pipe.
Make sure that the O-rings are correctly seated. The O-rings should be slightly greased before being mounted.

⑧ Reinsert the diverter switch unit.
Make sure that the supporting plate is in its proper position within the tap changer head (the red marked areas must be left free). Attach the supporting plate: 4 nuts M8/w.s. 13, max. torque 14 Nm, secure by lock washers.

⑨ Attach the position indicator dial: push the circlip onto the shaft end. The mounting of the position indicator is possible only in the correct position by means of its coupling pin (fig. 26).

⑩ Close the tap changer head by the cover. Make sure that the round rubber gasket in the cover is in its proper position. Fasten the tap changer cover uniformly by 24 screws M10/w.s. 17, max. torque 34 Nm (fig. 27).
5. CONNECTION OF TAP WINDING AND TAP CHANGER TAKE-OFF LEADS

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

⚠️ ATTENTION:

All connections to the tap changer must be made carefully and secured. The tap selector 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 connection ends of the tap selector leads must be shaped in the form of expansion loops.

In case of single-phase tap changers RM I 1201 and RM I 1502 with several tap selector planes connected in parallel, the tap selector terminals that bear the same designation have to be connected together. This is to avoid overvoltages of contacts connected in parallel.

Bridges, according to dwg. 897 595, for the parallel connection of tap selector planes can be supplied on request (see section 15).

5.1 Connection of tap selector leads

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

The crimped ends of the fine tap selector terminals are provided with a through-hole for M10-screws to allow the tap selector to be connected by means of cable shoes (see fig. 28 and 29).

Screening caps are available on request and also serve to secure the M10-screws (see fig. 29). In this case a lock washer must be placed below each screening cap. The M10-screws and lock washers are not part of the delivery.

⚠️ CAUTION:

Terminal K must on no account be bent or distorted as otherwise the function of the reversing switch will be impaired.

The through-hole in the tap selector terminals in the case of three-phase and single-phase tap changers with only one tap selector plane is positioned vertically. For the ease of bridging, however, the through-holes of tap changers RM I 1201 and RM I 1502 are arranged horizontally at the fine tap selector (see section 15, drawing 897 596).

Reversing switch terminals:

Terminals (+) and (-) of the reversing switch are shaped in the form of lugs with a through-hole for M10-screws (fig. 30). Change-over selector terminal K is an extended fine tap selector terminal (also with through-hole for M10-screws). The part outside the laminated paper bar (fig. 31) here serves as stationary reversing switch contact.
**Coarse tap selector terminals:**
Terminals (+) and (−) of the coarse tap selector are similar to those of the fine tap selector terminals (through-hole for M10-screws always in vertical position, fig. 32). They are attached to the respective laminated paper bars of the coarse tap selector.

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**CAUTION:**
Tap selector take-off leads in the vicinity of the change-over selector (reversing switch or coarse tap selector) must be placed so as to allow sufficient clearance to the movable parts of the change-over selector (reversing switch: fig. 33a, coarse tap selector: fig. 33b). Disregard may cause blocking of the change-over selector.

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5.2 Connection of the tap changer take-off leads
The tap changer take-off lead has to be connected to the connecting ring at the diverter switch oil compartment. The screw connection has to be secured.

**On-load tap changers**
**RM III 600 Y** (star-point connection) and **RM I 601**
A through-bore for M12 screws is provided at three locations on the connecting ring, placed in 120° intervals (fig. 34).

**On-load tap changers**
**RM I 1201** and **RM I 1502**
Three or four through-bores for M12 screws are provided at three locations on the connecting ring, placed at the intervals of 120° (fig. 35).
6. **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 dia. together with a hand wheel or a hand crank may be used.

In case of tap changer combinations 3 x RM I 601 ... 1502 all three tap changer heads have to be linked together by means of the horizontal part of the drive shaft (see section 9).

In case of motor drive MA 7, 16.5 drive shaft revolutions are required for one tap change operation, and in case of motor drive MA 9 one drive shaft revolution is required. 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 operating position through the inspection glass in the tap changer cover (fig. 36).

Keep the number of tap change operations without oil to a minimum. After the transformer ratio test the 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 7.1.2).

7. **DRYING PROCEDURE AND FILLING WITH OIL**

7.1 Drying procedure

As precondition for our guarantee of the dielectric properties of the tap changer a minimum drying treatment must be carried out according to the following instructions (as per section 7.1.1 or 7.1.2):

7.1.1 Vacuum-drying

7.1.1.1 Drying in the vacuum autoclave

*When drying the transformer in the autoclave the tap changer cover must be removed.*

- Heating up the tap changer in air of atmospheric pressure with a temperature rise of approx. 10 °C per hour to a final temperature of at most 110 °C.
- Preparatory drying in circulating air at 110 °C max. applied to the tap changer for a duration of 20 hours.
- Vacuum drying a temperature of 110°C max. applied to the tap changer and a residual pressure of at most $10^{-3}$ bar for a duration of at least 50 hours.

7.1.1.2 Drying in the transformer tank

*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 tap changer cover remains closed during the entire drying process.*

The tap changer head cover is vacuum-proof.

7.1.2 Vapor-phase drying process

*Before starting the drying procedure, the kerosene drain plug in the oil compartment bottom (fig. 37) 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 its thread and can only be unscrewed completely with major force.
When drying the transformer in its own tank (see section 7.1.2.2) 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 15, dwg. 890 182) and the diverter switch unit reinstalled.

**CAUTION:**
The kerosene drain plug must be closed again after the drying process to ensure that no oil from the diverter switch oil compartment can flow into the transformer tank!

### 7.1.2.1 Vapor-phase drying in the vacuum autoclave

When drying the transformer in the autoclave the tap changer cover must be removed.

- **Heating up**
  - by admitting the kerosene vapor at a temperature of about 90 °C.
  - Keep this temperature constant for 3 to 4 hours.
- **Drying**
  - by increasing the kerosene vapor temperature by about 10 °C per hour to the desired final temperature, but at most to 125 °C applied to the tap changer.

The duration of the drying procedure is normally the same as that of the transformer.

### 7.1.2.2 Drying in the transformer tank

If the transformer is to be dried in its own tank, the tap changer cover remains closed during the entire drying process. The tap changer head cover 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 Q and R for tap changer type RM. (For position of pipe connections see section 8 and drawing 893 899 in section 15.)

Procedure, temperature and duration of the drying process are described in section 7.1.2.1.

### 7.1.3 Operating the OLTC

**WARNING:**

Do not operate the tap changer after drying without oil wetting, otherwise bearings and gaskets will be damaged.

The 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.

### 7.2 Filling with oil

Close the tap changer head by the cover. Tighten all 24 cover bolts M10, wrench size 17, equally (max. torque 34 Nm).

Tap changer and transformer are simultaneously filled with new transformer oil under vacuum.

**CAUTION:**
The tap changer oil compartment and the associated oil conservator must be filled only with new mineral insulating oil for transformers according to IEC 296. The use of other oils puts at risk the trouble-free operation of tap changer and transformer.

When filling the tap changer with oil, pipe connections S or R on the tap changer head is to be used. To apply vacuum to the tap changer a by-pass tube between connections E2 and Q is to be installed in order to evacuate both diverter switch oil compartment and transformer tank simultaneously.

### 8. PIPE CONNECTIONS

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. 38 and dwg. 893 899 in section 15).

#### 8.1 Pipe connection R for protective relay RS 2001

The mounting of the protective relay RS 2001 (see section 15, dim.dwg. 892 608) is pursuant to our Operating Instructions No. 59.

**Please note:**

- **The stamped-on serial number must be the same as that of the tap changer.**
- **The protective relay must be mounted in horizontal position and as near to the tap changer head as possible.**
- **The directional arrow on the protective relay should point towards the oil conservator in the mounted state.**
- **The pipe extending to the oil conservator must have an inclination of at least 2%.**

#### 8.2 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.

#### 8.3 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.
8.4 Connection flange $E_2$

In general, this flange 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.


9.1 Mounting the motor drive unit (see section 15, dwg. 895 660 and 893 381)

You may find comprehensive mounting instructions in our Operating Instructions No. 40 for motor drive unit MA 7 or No. 80 for motor drive unit MA 9.

Please note:

- The serial numbers of motor drive unit and tap changer must be identical (rating plate).

- Motor drive unit and 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.

9.2 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 dia., see section 15, drawing 892 916).

Please note:

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

- The horizontal drive shaft 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. 39).

- When having adjusted the upper gear unit, tighten the thrust collar (max. torque 15 Nm). The bolts are to be tab-locked.

9.3 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 respective implement by two coupling brackets and one coupling bolt.

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

Square tubes, coupling brackets, coupling bolts, screws, nuts and lock tabs are made of stainless steel.

We recommend, however, to apply the same outside coating to these parts as to the transformer tank.

The square tubes 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.

Finally, balancing of the tap changer relative to the lag of the motor drive unit must be checked according to Operating Instructions No. 40 for MA 7 and No. 80 for MA 9.

Tap changer combination 3 x RM I 601...1502

Due to the particular 3-column design the tap changer heads have to be coupled above the transformer cover. As turning of the upper gear units initiates the switching operation, make sure, that the diverter switches remain in their exact adjustment position even when having adjusted the gear units.
Proceed as follows:

1. Check that all tap changers are in the same operating position (inspection window on the tap changer cover). Each single-phase tap changer must be in its adjustment position.

2. Turn the upper gear units of the tap changer heads to the desired installation position and fix them there (tighten the thrust collars and tablock).

   Take note of the **arrow on the drive shaft flange** below the stamped-on serial number. The arrow indicates the rotation sense when turning the hand crank of the motor drive clockwise. It has to be identical on all gear units.

3. Operate each single-phase tap changer separately by one step by turning the shaft ends **counterclockwise** until the diverter switch operates once.

   Check coincidence of positions on all 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 is reached by turning the drive shaft in **clockwise** direction.

   **Check simultaneous operation of all diverter switch units.**

   **Check coincidence of position of all tap changer heads and the motor drive unit.**

6. Mount the **vertical** drive shaft.
10. PUTTING THE TAP CHANGER INTO OPERATION AT THE TRANSFORMER MANUFACTURER

10.1 Operational tests
Before applying voltage to the transformer some test operations must be carried out to check the mechanical functions of tap changer and motor drive.

For these test operations the tap changer has to be run through the entire operating cycle.

Make sure that in each operating position the indications of motor drive and tap changer (inspection window in the tap changer head) read the same position.

A coupling fault between tap changer and motor drive unit exists, if tap changer and motor drive unit show different operating position. Misalignment of coupling between tap changer and motor drive unit leads to severe damage of tap changer and transformer, if operation is continued.

Check, in both end positions, the automatic switching off and the function of the electrical and mechanical end position limitation (see Operating Instructions No. 40 for motor drive unit MA 7 or No. 80 for motor drive unit MA 9).

10.2 Final oil filling
Fill up the tap changer completely with transformer oil via the oil conservator.

In this connection bleed:

- The tap changer head via the bleeder valve in the tap changer cover ($E_1$):
- Open the screw cap M30/w.s.36, lift the valve tappet by means of a screwdriver (fig. 40).
- The suction pipe (S) via the bleeder screw at the connecting elbow: cap nut M16 (w.s. 22, max. torque 9 Nm), slotted bleeder screw M6 (max. torque 2 Nm, fig. 41).

![ATTENTION:]
Make sure that the suction pipe has been bled completely.
The insulation capability of the tap changer to ground is otherwise significantly impaired.

10.3 Ground connections
Connect the ground screws of the tap changer head (2 screws M12 with nuts, w.s. 19, max. torque 60 Nm, fig. 42) to the transformer cover.

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

10.4 Electrical transformer tests
After the aforementioned steps the electrical tests necessary for acceptance 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 tap changer is uncoupled.](image)

To remount the motor drive unit follow the instructions according to section 9.1. and 9.3.

**IMPORTANT:** 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 oil.

Install this by-pass tube at the tap changer head between pipe connections E2 and Q of the tap changer head.

For short stand-by periods of 2 to 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 the switching oil of the 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.

Before putting the transformer into service, operational tests of tap changer and motor drive have to be performed according to section 10.1.

At the same time check the function of the protective relay.

**IMPORTANT:** The protective relay has to be inserted into the tripping circuit of the circuit breakers, so that on response of the protective relay the transformer is immediately switched off (see Operating Instructions No. 59 for protective relay RS 2001).

Make sure that the circuit breakers switching off the transformer operate when the test button »OFF« is pressed. Be sure that they energize the transformer only after test button »IN SERVICE« of the protective relay has been pressed.

![ATTENTION:
Check that all stop valves between oil conservator and tap changer are open.](image)

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

Supervision of tap changer and motor drive unit is limited to occasional visual checks of tap changer head, protective relay and the motor drive.

**Pay special attention to:**
- oil tightness at the sealing locations of the tap changer head, the protective relay and the pipe connections,
- sealings at the protective housing of the motor drive,
- proper function of the electrical space heater inside the motor drive unit,
- the condition of the control devices in the motor drive unit.

![WARNING:
After a response of the protective relay, do not reset until the tap changer and the transformer have been checked. For this purpose withdraw the diverter switch unit and check it according to our Inspection Instructions. Proceed in detail according to Operating Instructions No. 59 for the protective relay RS 2001.

Before returning to operation, make sure that the cause of the trouble has been corrected and that tap changer and transformer are free of damage. Reconnection of the transformer without prior checking is prohibited and can lead to severe damage of tap changer and transformer.](image)

In case of major faults with tap changer or motor drive which cannot be easily overcome on the spot and in case of a response of the protective relay, please contact the authorized MR representative, the transformer manufacturer or directly

Maschinenfabrik Reinhausen GmbH
Technical Service
Postfach 12 03 60
D-93025 Regensburg
Phone: +49-941-4090-0
Fax: +49-941-4090-501
Telex: 65881
cables: oltc reinhausen
14. INSPECTIONS

IMPORTANT: The tap changing equipment must be inspected at regular intervals to maintain a high level of operating reliability.

The inspection can be carried out by qualified and MR-trained personnel usually within one day, provided it is well prepared and organized.

We strongly recommend to have inspections carried out by our Technical Service. This ensures a professional performance including all the latest updating measures.

If the inspection will not be carried out by MR personnel we recommend to ask us for the necessary spare parts. In this case please indicate the tap changer serial number and the number of tap change operations.

The numbers of tap change operations determining the inspection intervals indicated in table I are figures based on experience with use of usual oil qualities.

The tap selector of the on-load tap changer is generally maintenance-free. In special cases, however, for example in industrial transformers where high numbers of tap change operations are to be expected, our technical service department must be contacted after about 1,000,000 operations.

The diverter switch unit of the tap changer has to be replaced by a new one after not more than about 800,000 operations.

If the number of operations per year exceeds 15 000, we recommend the use of our stationary oil filter unit type 51 with a paper filter insert (see operating instructions No. 18). If the highest voltage for equipment $U_m$ of any tap changer type RM exceeds 245 kV, the use of a stationary oil filter unit type 51 with a combined filter cartridge is obligatory.

Filtering of the switching oil allows the inspection intervals to be extended. Continuous oil filtering also increases the mechanical life of the diverter switch by immediately removing most of the abrasive particles responsible for mechanical wear.

The insulating oils in the transformer are to be monitored by the operator according to the appropriate directions.

If inspections are not carried out by MR personnel, we request a report to supplement our inspection data, so that, in case of need, recommendations for the next inspection can be given.

Standard values for oil testing according to CIGRE report 12-13 (1982) applying to transformer oil at service temperature:

<table>
<thead>
<tr>
<th>On-load tap changer</th>
<th>Water content*</th>
<th>Dielectric strength**</th>
</tr>
</thead>
<tbody>
<tr>
<td>RM III 600 Y</td>
<td>&lt; 40 ppm</td>
<td>&gt; 30 kV/2.5 mm</td>
</tr>
<tr>
<td>RM I 601 ... RM I 1502</td>
<td>&lt; 30 ppm</td>
<td>&gt; 40 kV/2.5 mm</td>
</tr>
</tbody>
</table>

*) measured according to Karl-Fischer method based on IEC Publication 814
**) measured according to DIN VDE 0370 Teil 1

On-load tap changer | Transformer rated current | Number of tap change operations*) without MR oil filter unit | Number of tap change operations*) with MR oil filter unit
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>RM III 600 Y</td>
<td>up to 600 A</td>
<td>80 000</td>
<td>100 000</td>
</tr>
<tr>
<td>RM I 601</td>
<td>up to 600 A</td>
<td>80 000</td>
<td>100 000</td>
</tr>
<tr>
<td>RM I 1201</td>
<td>up to 600 A</td>
<td>60 000</td>
<td>100 000</td>
</tr>
<tr>
<td></td>
<td>up to 1200 A</td>
<td>60 000</td>
<td>100 000</td>
</tr>
<tr>
<td>RM I 1502</td>
<td>up to 1000 A</td>
<td>60 000</td>
<td>100 000</td>
</tr>
<tr>
<td></td>
<td>up to 1500 A</td>
<td>50 000</td>
<td>100 000</td>
</tr>
</tbody>
</table>

Table I    Inspection intervals

Note: *) If $U_m \geq 245$ kV at the tap changer the indicated numbers of operations must be halved.

Regardless of the number of tap change operations listed in table I, inspection must be carried out after 6 to 7 years.

If $U_m \geq 245$ kV of the tap changer (autotransformer or regulation at the line-end of the transformer winding) the first inspection must be carried out after 20,000 switching operations or after 2 years of service respectively, whichever comes first. Further inspections are required every 4 years.
<table>
<thead>
<tr>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>On-load tap changer type RM, installation drawing</td>
<td>897 597</td>
</tr>
<tr>
<td>Bridges for parallel connection of tap selector planes</td>
<td>897 595</td>
</tr>
<tr>
<td>Installation position of tap selector terminals</td>
<td>897 596</td>
</tr>
<tr>
<td>Tap changer head</td>
<td>893 899</td>
</tr>
<tr>
<td>Drilling template for tap changer head</td>
<td>890 183</td>
</tr>
<tr>
<td>Supporting flange for the installation into a bell-type tank</td>
<td>896 762</td>
</tr>
<tr>
<td>Lifting traverse</td>
<td>890 180</td>
</tr>
<tr>
<td>Socket wrench for kerosene drain plug</td>
<td>890 182</td>
</tr>
<tr>
<td>Protective relay RS 2001, dimension drawing</td>
<td>892 608</td>
</tr>
<tr>
<td>Motor drive unit MA 7, dimension drawing</td>
<td>895 660</td>
</tr>
<tr>
<td>Motor drive unit MA 9, dimension drawing</td>
<td>893 381</td>
</tr>
<tr>
<td>Bevel gear CD 6400, dimension drawing</td>
<td>892 916</td>
</tr>
</tbody>
</table>
RM 1201 SIZE C/D/DE
RM 1502 SIZE C/D/DE

3 TAP SELECTOR CONTACT PLANES IN PARALLEL

FOR TAP SELECTOR TERMINALS
WITH HORIZONTAL THROUGH-HOLE

FOR TAP SELECTOR TERMINALS
WITH VERTICAL THROUGH-HOLE

INDICATION WITHOUT BRACKETS: DISTANCE BETWEEN CONTACTS $t_1$ (SEE DIM. DWG.)
INDICATION WITH BRACKETS: DISTANCE BETWEEN CONTACTS $t_2$ (SEE DIM. DWG.)

PLEASE NOTE: CONTACT BRIDGES ARE NOT INCLUDED IN THE STANDARD DELIVERY VOLUME.

On-load tap changer type RM
Contact bridges for parallel connection of
tap selector terminals

897 595:1E
On-load tap changers type MS, M, RM, R
Tap changer head, centric drive

E₁ = BLEEDING FACILITY FOR TAP CHANGER HEAD
E₂ = BLEEDING FACILITY FOR SPACE UNDER THE HEAD OUTSIDE
     THE TAP CHANGER OIL COMPARTMENT (SAME PIPE CONNECTION AS R, S, Q OR BLEEDER SCREW
     CAN BE USED)
Q = CONNECTION FOR OIL RETURN PIPE (ONLY FOR OIL FILTERS)
S = CONNECTION FOR SUCTION PIPE
R = CONNECTION FOR PROTECTIVE RELAY (EXCHANGEABLE WITH CONNECTION Q)
    CONNECTIONS ORIENTABLE THROUGH 360°

O-RING 44.2-5.7

= EARTH CONNECTION M12
MARKS TO BE POUNDED

On-load tap changers type MS, M, R
Drilling template for tap changer head
M 24
DIN 580

2 x 4.5°

33

445

2 x 4.5°

8

90

270

220

411

10

90.6

SHEET STEEL
St 37 – 2 DIN 17 100

On-load tap changers type MS, M, R
Lifting traverse

890 180:3E
**Socket wrench**

<table>
<thead>
<tr>
<th>Item-No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>014 820</td>
<td>L = 1350 mm</td>
</tr>
<tr>
<td>017 660</td>
<td>L = 1860 mm</td>
</tr>
</tbody>
</table>

**To be used for OLTC**

- Type M (except MD)
- Type MS

- M III 350/600 D
- Type T, R, RM, G

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**On-load tap changers type MS, M, T, RM, R, G**

Socket wrench for kerosene draining screw

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890 182:7E
The protective relay must be connected in such a way that, on response of the protective relay, the transformer is immediately switched-off by its circuit-breakers.
Motor drive unit MA 7
Door lock with clamp lever, dimension drawing