Thank you for choosing on-load tap-changer

Prior to using the on-load tap-changer, make sure to pay attention to the following items:

1. Remove locating Pins between diverter switch and tap selector before tap changer operation.
2. The 6 connecting conductors which connect tap selector and diverter switch must be securely fastened, if loosen, the fixing screws inside the tap selector central shaft must be tightened.
3. Diverter switch, tap selector and motor drive unit must be connected on the same position.
4. The tap changer must not be operated after being dried without oil. If the operation is inevitable, the rotating parts and contacting parts of diverter switch and tap selector must be lubricated with transformer oil.
5. After the drive shafts are installed on transformer, motion angle must be calibrated (See operating instruction for the details).
6. The drive shaft must be exactly fit for operation, not too short in order to prevent from falling off or too long to be damaged due to heat expansion.
7. The worm gear reducers on the top-cover of the OLTC can be adjusted by loosening the bolts of the fixing ring according to user installation required. Please be sure to secure the bolts upon the completion of adjustment.
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1. PREFACE

This instruction provides information of on-load tap-changer (OLTC) transportation, installation, adjustment, test and commissioning. It gives detailed instruction for OLTC mounting onto transformer and set forth maintenance interval criteria during product operation. Safety notice is also mentioned for every process.

It is made for transformer production, process, test and inspection staff. Transformer design and commission personnel can also take it as reference.
2. GENERAL

CM on-load tap-changer (OLTC) can be applied to power and industrial transformer with rated voltage from 35kV to 500kV, with maximum rated through current of 600A for three phases and 1500A for single phase. It changes the winding taps under load to regulate the voltage. Three phases OLTC can be used at the neutral point of the Y connection, and the single phase OLTC can be used for any connections.

CM OLTC is a typical OLTC of combined structure, which consists of diverter switch and tap selector underneath (Fig.1). Diverter switch consists of diverter switch insert and oil compartment; and the diverter switch insert is installed in the oil compartment.

CM OLTC is to be mounted to the transformer tank cover by its tap changer head which serves also for connecting to the motor drive unit via the worm wheel reducer and bevel gear box for the purpose of tap changing.

The tap selector has three regulation types: linear regulation, reversing regulation, and coarse & fine regulation. For standard design, linear regulation without change-over selector provides up to 18 operating positions, and the reversing regulation or coarse & fine regulation with change-over selector provides up to 35 operating positions. Special operating position requirement must be consulted with our technical department. This instruction provides all necessary information for CM OLTC installation and operation.
3. TECHNICAL DATA

CM OLTC is produced according to IEC60214-1:2014. The technical data is as following:

Table 1: Technical data of series CM OLTC

| Item | Tap-changer Model | CM || 500Y | CM || 600Y | CM || 800 | CM || 1200 | CM || 1500 |
|------|-------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| 1    | Max. rated through-current(A) | 500   | 600   | 800   | 1200   | 1500   |
| 2    | Frequency (Hz)     |        |        |        | 50 or 60          |
| 3    | Connection method  | Star connection at neutral point for three phases | Any connection for single phase |
| 4    | Max. rated step voltage (V) |        |        |        | 3300   |
| 5    | Rated step capacity (kVA) | 1400  | 1500  | 2000  | 3100  | 3500  |
| 6    | Short-circuit current test (kA) | 8     | 8     | 16    | 24    | 24    |
|      | Thermal (3s)       |        |        |        |        |        |
|      | Dynamic (Peak)     | 20     | 20    | 40    | 60    | 60    |
| 7    | Max. operating positions | 18 without change-over selector | 35 with change-over selector |
|      | (Special design Linear regulation 34; coarse and fine 107) |
| 8    | Insulation grades to ground (kV) | 72.5  | 126   | 170   | 252   |
|      | Highest voltage for equipment Um (kV) |
|      | Rated power-frequency withstand voltage (kV/50Hz,1min) | 140   | 230   | 325   | 460   |
|      | Rated lightning impulse withstand voltage (kV,1.2/50μs) | 350   | 550   | 750   | 1050  |
| 9    | Tap selector       | 4 sizes of B, C, D and DE according to insulation level |
| 10   | Mechanical life    | Not less than 800,000 operations |
| 11   | Electrical life    | Not less than 200,000 operations |
| 12   | Oil Compartment of diverter switch | Operating pressure | 0.03MPa |
|      | Leakage test       | 0.06MPa without any leakage for 24 hours |
|      | Over pressure protection | Rupture disk bursts at 300kPa±20% overpressure |
|      | Protective relay   | Set oil flow speed 1.0m/s ± 10% |
| 13   | Motor drive unit   | CMA7 or SHM-D |
| 14   | On-line oil filter | ZXJY-1/ZXJY |
| 15   | Approximate Weight (kg) | CM || 500,600 | CM || 500,600 | CM || 800 | CM || 1200 | CM || 1500 |
|      | Without change-over selector | 265   | 240   | 250   | 260   | 270   |
|      | With change-over selector | 280   | 260   | 270   | 285   | 295   |
| 16   | Displacement volume approx.(dm^3) | 72.5kV | 200   | 190   | 195   | 200   | 210   |
|      | 126kV              | 225   | 225   | 220   | 225   | 215   |
|      | 170kV              | 245   | 235   | 240   | 245   | 235   |
|      | 252kV              | 260   | 255   | 260   | 265   | 275   |
| 17   | Oil volume of the diverter switch oil compartment (dm^3) | 72.5kV | 130   |
|      | 126kV              | 150   |
|      | 170kV              | 170   |
|      | 252kV              | 190   |
4. MODEL DESIGNATION

4.1 Type designation

Type CM OLTC models varies with number of phase, maximum rated through current, highest voltage for equipment, insulation level of tap selector and connection mode, etc. The parameters are represented as in Fig.2 below.

4.2 Designation of basic connection diagram of tap selector

The tap selector may have different specification with respect to the number of the steps required and connection of the tap winding. The basic connection diagrams reflects the relevant pitch of the contact circuit, the number of operating position, the number of mid-position and type of change-over selector. The designation of the basic connection diagram is according to Fig.3.
4.3 The basic connection diagram of tap selector

Different numbers of taps has different connection diagram. Fig.4 shows regular connection diagrams of the tap selector, and special diagram can be provided on customer request.

Figure 4 The basic connection diagram of tap selector
5. TRANSPORTATION AND PACKING

5.1 Delivery scope

The complete unit of CM OLTC mainly includes: diverter switch (Fig.5), tap selector (Fig.6), motor drive unit, controller, cables, driving shaft, coupling, gear box, protective relay and other accessories. Special installation tools and non-standard components ordered by client will also be packed up.

Detailed delivery scope is subject to packing list.

5.2 Transportation and acceptance inspection

<table>
<thead>
<tr>
<th>DANGER!</th>
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</thead>
<tbody>
<tr>
<td>Life danger or serious injury!</td>
</tr>
<tr>
<td><strong>By overturn or drop!</strong></td>
</tr>
<tr>
<td>• Lifting sling selection and fastening by professional worker</td>
</tr>
<tr>
<td>• Do not stand under hanging goods</td>
</tr>
<tr>
<td>• Lifting equipment with capacity &gt;500kg</td>
</tr>
</tbody>
</table>
ATTENTION!

Property damage!

By turn over or drop!

• Lifting sling selection and fastening by professional worker
• Do not stand under hanging goods
• Lifting equipment with capacity >500kg

5.2.1 Transportation

1. Ex-works package is suitable for all means of transportation; allowed stacking weight not exceed 500kg/m².
2. Please properly place the wood case according to the center of gravity position sign on the case during transportation, and operate according to lifting standard during lifting.
3. Warning sign description (Fig.7)

![Up](image1)
![Fragile](image2)
![Damp-proof](image3)

Figure.7

5.2.2 Receiving inspection

The consignee shall examine the goods before signing on acceptance confirmation:

• Check case quantity as indicated in shipping documents
• Check if the package has been damaged (if possible, take photos of damage package) or package do not match with shipping document. If any above situation happens, please reject the goods, and communicate with shipping company, if any further assistance is needed, please contact Huaming directly.

Above procedure also applies to the case where the goods get corroded because of rain, snow, or moisture.
All components shall be stocked at dry environment and well sealed till installation.

During transportation and lifting, the OLTC shall be well fastened, in order to prevent damage caused by shock, crash, dropping, tipping, etc.

**Note:** Transportation and lifting of OLTC shall be done by professional personnel. The capacity of transportation vehicle and crane is not less than 1000kg.

During transportation and lifting, the OLTC shall be well fastened, in order to prevent the damage caused by shock, crash, dropping, tipping, etc.

If product dropped or crashed during this process, please do overall inspection, and contact HM for assistance.

### 5.2.3 Opening & Inspection

Open the package check whether there is any damage by transportation

- Send the package near to the place where it is to be mounted onto transformer.
- Check the equipment and accessories according to packing lists.

**Note:**

1. Do not break the original package of OLTC when open the case;
2. If OLTC and accessories does not match with packing document, please contact manufacturer as soon as possible.

<table>
<thead>
<tr>
<th>ATTENTION!</th>
</tr>
</thead>
<tbody>
<tr>
<td>Property damage!</td>
</tr>
<tr>
<td><strong>Broken package can cause OLTC damage!</strong></td>
</tr>
<tr>
<td>• Do not install the diverter switch and tap selector when the packing is broken</td>
</tr>
<tr>
<td>• Dry these components according to operation instruction.</td>
</tr>
</tbody>
</table>

• Confirm the damaged component.

In case, the damaged component is found after opening the case.

- Please contact the forwarder and keep the proof.
- Make sure the claim is within the valid period.

The hidden damage compensation is very difficult. It is possible only when it is clearly stated in insurance document.
5.3 Storage

Special package with seal design can be stored at out-door if following condition is met:

- The OLTC cannot be stored in flammable, explosive and corrosive environment.
- The temperature range for storage and operation shall be -25°C to 40°C, the humidity shall not exceed 85%. With special design, the working temperature range can be from -60°C to 40°C. Please specify when placing the order.
- In order to avoid the aging of sealing package, please avoid to expose the OLTC to the sun, ultraviolet radiation or high temperature.
- The OLTC shall be protected and shall be free from moisture, dust, rodent, and insect.
- Periodic inspection for equipment.

Notice:

1. If the goods are kept in storage for over one year, please make cautious inspection before installation.
2. For long-term storage, replace the desiccant at interval and seal it tightly.

6. INSTALLATION OF OLTC ON TRANSFORMER

6.1 Mounting flange

A mounting flange is required for installing the OLTC head on the transformer cover. This mounting flange is to be designed according to the sealing surface of the OLTC head (Fig.8). Studs (M12, max. length 45mm) should be accurately positioned.
6.1.1 Fasten bolts on mounting flange

A drilling template can be used when fixing the studs onto the mounting flange. If requested, the drilling template will be supplied for the first installation of an OLTC free of charge.

1. Put the drilling template above the installation flange and adjust it according to four markings (Fig.9).

![Figure.9 Drilling template](image)

![Mark Sealing Surface](image)

2. Install studs (M12, Max. length is 45mm) on the flange (Fig.10).

![Figure.10 Studs](image)

6.2 Assembly of tap selector and diverter switch
CAUTION!

Danger to place heavy component at uneven place.

**Serious injury caused by insecurely placed tap selector!**

- Ensure that the tap selector is placed at flat surface.
- Make sure tap selector will not tip over

NOTE!

Heavy components placed at uneven place causes damage.

**Tap selector tipping over will lead to damage!**

- Ensure that the tap selector is placed at flat surface.
- Lifting equipment with capacity >500kg

Put the diverter switch (dismantle the head cover if it is the bell type) above the tap selector by crane; and the detail as following:

1. Put tap selector on flat surface, unscrew six M12 socket-head bolts (use No.8 Allen wrench, Fig.11), spring washer, and nuts; check if six leads cover is worn-out, dismantle the lock pin on tap selector (Fig.12).

![Figure.12](image)

2. Lift the diverter switch and unscrew the locating pin (Fig.13).

3. Place diverter switch above tap selector; and in order to prevent damage please keep enough space between the connecting leads from tap selector and diverter switch.

4. Align two shaft couplings in the right position. Do not bump the coupling to each other.

**Note: Do not rotate the shaft coupling after dismantling the pin**
5. Fasten six M12 socket head bolts (by No.8 wrench) to install the tap selector at bottom of oil compartment. The torque for washer and bolt is between 50 to 60 N•m (Fig.14), pay attention to the assembling sequence.

**Note:** The verticality of diverter switch and tap selector (the tolerance is less than 2%).

6. Connect the output leads of tap selector to the diverter switch oil compartment. Remove the connecting bolts from diverter switch oil compartment contacts. The sequence of fasteners from the outside to the inside is: connecting bolts, spring washers, screen caps, and tap selector output leads. Fix the tap selector output leads onto the connecting contacts of oil compartment.

**Note:** Remember to connect the lead directly to the contact surface of the insulation cylinder, and do not clip the screen caps between the lead and contact terminal (Fig.15).

![Figure.13](image1) ![Figure.14](image2) ![Figure.15](image3)

Each phase of diverter switch must be connected with two connecting leads. (Before delivery, six leads have been fixed on the tap selector). Tighten the six M10 hexagon bolts (No.17 wrench), the torque is 28~34 N•m.

**Note** that all the output leads must be carefully connected. Make sure to use the specified tightening torque. Ensure bolt connection is completely reliable, and use the provided tap changer screen cap to shield terminal interface. When tap selector is connected to diverter switch, pay attention not to damage the insulation paper of conductor. When operating tap changer, motor drive unit or components, make sure that they are firmly fixed! Avoid any possible tipping of components!

1) The output leads of the selector part of tap changer (for III-500/600 and I-1200/1500) (total of 6 conductors, fig.16) must be connected to the lead out terminals of diverter switch oil compartment (M10 hole, Fig.15).

**Note:** the conducting ring is used on single phase tap changer only, including I-500, I-800, and I-1200/1500.

2) The output leads (total of 4) of the selector part of tap changer (for II-500/600 and I-800) must be connected to the lead out terminals of phase B and phase C of diverter switch oil compartment, then short connect phase A by conductor(Fig.17).
3) The lead out wiring (total of 2) of the selector part of tap changer (for I-500/600) must be connected to the contact terminal of the phase A of diverter switch oil compartment, and short connect phase B and phase C by conductor (Fig.18).

4) Screen cap must be locked after the bolt is connected.

Note: In the multi-step coarse & fine tap selector, must carefully arrange the conductors used for connection between terminals of fine regulating selector and coarse regulating selector. The distance between the leads and terminals of adjacent selector should be as big as possible. In order to ensure the dielectric strength, for terminals which is close to each other between the coarse and fine regulating selector, it is recommended to wrap more than 3mm thick insulating paper (Fig.19).

NOTE!
Improper connection of tap selector leads causes damage of equipment!
Improper connection, loose fixation or poor shielding of tap selector connection will cause the damage of OLTC and transformer!

- Be careful to the connection of tap selector.
- Use specified tightening torque.
- Make sure the bolt connection is completely reliable.
- Screen caps to shield the terminal interface.
6.3 Tap changer installation on standard type transformer

6.3.1 Tap changer assembly on transformer tank.

According to the procedure of 4.2, lift up the assembled tap changer on the transformer tank. The installation procedures as follows:

- Clean the under surface of tap changer head flange and the installation flange surface of transformer; place a sealing gasket on the installation flange surface of transformer. (Fig.20).
- Lift up the completely assembled tap changer on the transformer installation flange, and carefully go through the installation hole into transformer tank (Fig.21).

**Note:** Make sure that tap changer connection terminal, screen caps of diverter switch oil compartment shield and grading ring shall not be damaged during the process of tap changer installation. (Only 170kV or above is required to equip with grading ring).

- Check if the tap changer head installation position angle complies with design requirements, after confirming the correct position, fix the tap changer head flange on the transformer tank installation flange, screw up 24 nuts, torque is 100-110 N-m.

---

**NOTE!**

When diverter switch oil compartment goes down, it may cause damage of equipment!

If diverter switch oil compartment is not vertically lifted down through the opening hole of tank cover, it will cause damage to the oil compartment grading ring. (only when Um≥170)

- Be careful when diverter switch oil compartment is lifted down.
6.4 Tap changer installation on bell type transformer

NOTE!

Diverter switch being stuck will cause damage of tap changer and transformer!

Small parts in diverter switch will jam the diverter switch to damage tap changer and transformer!

- Make sure small parts do not fall into OLTC oil compartment.
- When disassemble and reassemble, all small parts must be complete, make sure to check carefully.

6.4.1 Disassemble tap changer head installation flange and lift up diverter switch insert

1. Make sure tap changer is at set position.
2. Unscrew twenty-four M10 bolts on the head cover of tap changer (with spring washer, by No. 17 wrench).
3. Remove tap changer head cover. During the process of removing and other operations, it is necessary to avoid damaging tap changer head cover and its sealing ring (O ring, Fig.22).
4. Position indication disk removal. First remove the locking tab from shaft end, then remove the position indication disk. (Fig.23)

![Figure.22](image1)

![Figure.23](image2)
5. Remove fastening nuts on the supporting plate (Non red zone) (Ten M8 nuts, No. 13 wrench, with spring washer).

6. Carefully lift diverter switch insert out of the oil compartment (Fig.24)

7. Pull out the pipe connector, which is inserted into tap changer head flange, and remove the oil suction pipe (Fig.25).

**Note:** do not damage the O ring on the pipe joint.

---

**CAUTION!**

Danger to place heavy component at uneven place!

**Serious injury caused by insecurely placed diverter switch!**

- Diverter switch insert must be placed on flat surface to avoid tipping.

---

**NOTE!**

Heavy components placed at uneven surfaces causes damage

**Diverter switch tipping over results in damage of itself or other components!**

- Diverter switch insert must be placed at flat surface to avoid tipping over.
8. Remove the rest of fastening nuts on the installation flange (12 M8 nuts, no. 13 wrench, with spring washer). Lift up the tap changer installation flange from the supporting flange.

**Note: do not damage the O ring, keep in good condition.**

Do not drop the fasteners into the oil compartment, properly put away.

- Put the diverter switch insert on flat surface.
- Avoid diverter switch insert to tip over. After lifting up diverter switch insert, do not change the tap selector position during the process of assembly.

### 6.4.2 Install OLTC into bell type transformer tank

**NOTE!**

Pulling force will cause the risk of tap changer damage and functional detect!

**If tap changer is not in the correct vertical position on the yoke, after connecting tap winding leads and tap changer, there might be pulling force, which may result in the damage of tap changer! In addition, it will also cause the risk of failure due to the wrong connection of tap selector contact.**

- Place the tap changer on the yoke vertically. (The maximum allowable deflection of the vertical direction is 1°).

**NOTE!**

Pulling force will cause the damage of tap changer!

**When tap winding leads are connected to tap changer, if tap changer is not at the final position, after connecting tap winding and tap changer, there might be pulling force which may result in the damage of tap changer and transformer!**

- Put the tap changer on the yoke by using spacers to reach the final installation position, only need to increase 5-20mm after installing the bell type transformer tank.

First put the tap changer on the temporary yoke inside the transformer. For this, the tap changer diverter switch oil compartment is provided with a supporting flange. Assembly steps as follows:

1. Lift up tap changer on the yoke and connect it to the tap winding.
2. Temporarily fix the tap changer on the yoke via the mounting holes of the supporting flange. If necessary, place a temporary adjustment spacer between the yoke and supporting flange. Adjust the installation height of tap changer to the final installation position. Before installing transformer bell type tank cover, need to take out the spacers (Fig.26).
Note: The connected tap leads should never apply force on the tap changer. Secondly, it should keep sufficient space. Thus, when bell type tank cover is in position, tap changer can be lifted to reach the final position.

6.4.3 Assemble bell type transformer tank cover

1. Before assembling bell type transformer tank cover, clean the sealing surface of tap changer supporting flange, put a sealing ring on the supporting flange (Fig.27), and take out the spacers.

2. Lift the bell type transformer tank cover above the transformer active part, and assemble it.

3. Before mounting tap changer installation flange, clean the sealing surface. Place the sealing gasket on the transformer installation flange, and fix the tap changer installation flange on the transformer installation flange (24 M10 bolts, torque 100~110 N•m).

4. Slightly lift up the tap changer by special lifting device, make sure all the studs of supporting flange are accurately positioned in the tap changer fixing holes (Fig.28).
NOTE!

Improper lifting up tap changer will cause damage of OLTC!

When lifting up OLTC, if utilize the connection studs of supporting flange, it may cause damage of studs, consequently it is not possible to correctly use the studs to connect OLTC and tap changer head!

Always use the specified lifting tools to lift up OLTC, never use the connection studs of supporting flange to lift up.

5. Install tap changer on the head mounting flange. Pay attention to the two positioning studs (with extended length), supporting flange and red triangle mark on the head cover of tap changer. It ensures that tap changer is installed at the correct position.

6.4.4 Installation of diverter switch insert

1. Make sure tap selector and bottom cylinder gear must be placed at set position when installing the diverter switch insert (Fig.29).
2. Diverter switch needs to be placed at set position of installation (Fig.30).
3. Installation of suction pipe
   • Install the suction pipe in the positioning hole of oil compartment bottom from above (Fig.31).
   • Install the suction pipe in the connection hole of tap changer head flange (Fig.32).
NOTE!

Make sure that O ring in the right position and lubricating before installation.

4. Lift up diverter switch insert above diverter switch oil compartment, slowly put down the diverter switch insert till its final position. Make sure the mounting plate of diverter switch insert is the right position (There are 2 notches separated by 120° on the top plate of diverter switch insert. One gap is aiming at suction pipe, and other is the installation of driving shaft of position indication disk.). Fasten supporting plate by ten M8 nuts (No.13 wrench, torque 12~15N•m, with spring washer)(Fig.33).

5. Put nuts on the studs which are not covered in the red mark area and tighten by twelve M8 nuts (No.13 wrench, torque 12~15N•m, with spring washer), and fix tap changer head on installation flange.

6. Reassemble position indicating disk, and make sure snap ring is securely in place.

7. Put tap changer head cover on the tap changer head flange and make sure that the sealing ring in cover plate in correct position.

Notice: The red mark on top cover and flange should be aligned, and carefully clean the sealing surface before mounting to the top cover (Fig.34).

8. Fasten the tap changer top cover: evenly by tightening twenty-four M10 bolts (No.17 wrench), torque 29~35 N•m.
6.5 Connection of tap winding leads and tap changer connection terminals

Tap winding leads must be connected according to connection diagram. Tap changer connection terminal is marked with contact position code on the tap selector insulating bar. Tap winding leads and tap changer connection terminal should be in accordance with the indicating code of the tap changer.

Note: All the tap leads connected to tap changer must be securely fastened. The connection of tap leads should not cause any pulling force to the terminals of tap selector.

6.5.1 The fixation of tap winding leads and tap changer connection terminals.

Tap selector connection terminal is provided with M10 bolts through-holes, which is convenient for the connection and fixation of tap winding leads.

Screen caps supplied together with the product is intended for shielding M10 bolts (Fig.35). Lock washer must be installed underneath every screen caps. In order to prevent loose nuts after connection the locking side of the washer should be turned by 90° to lock the nuts.
6.5.1.1 Reversing tap selector terminal

There are M10 bolts through-holes on Reversing tap changer (+) and (-) connection terminals and change-over selector terminal K, which is for the connection of tap winding leads (Fig.36).

Notice: The lead connected to terminal K is not allowed to bend or deform, otherwise it will affect the performance of tap changer.

6.5.1.2 Coarse & fine tap selector terminal

The terminals of Coarse & fine tap selector (+), (-), and (0) are similar with Reversing tap selector; and the connection methods are same (Fig.37).

NOTE!

Change-over selector being stuck will cause damage of tap changer!

If the distance between conductors and change-over selector movable part is too small, it will cause change-over selector to get stuck and consequently damage the OLTC!

- The conductors close to the change-over selector (Polarity selector or coarse change-over selector) must keep sufficient distance for the change-over selector movable part.
6.5.2 Tap selector terminal leads shall not cause forced distortion or damage to tap selector.

1. The tap winding leads should be connected from two sides to the tap selector. Avoid stressing the lead wire from one side, which will cause deformation of the tap selector.

2. The conductor between tap selector terminal and the tap closest to the winding clamps should have some flexibility and not too short. It should be soft and not coated with insulating paint to avoid hardening of the coating after drying, which makes the insulating bar deformed under force.

3. The tap leads connected to the tap selector should be arranged in smooth circle curves, so that the insulating bar of the tap selector will not be impacted by force.

4. The connection leads of the tap selector should be lead out from the exterior of the tap selector. Must not allow the wire to pass through the interior of the selector.

5. The connection leads of the change-over selector should be lead out from the exterior of the change-over selector insulating bar. Adequate clearance shall be maintained between the leads and the insulating bar of the change-over selector’s moving contacts, so that the obstruction to the operation of the change-over selector can be avoided.

6. The bell type tap changer shall be lifted up 5-20mm after the connection of the tap leads. Therefore, special attention should be given to the flexibility of connecting leads. It is recommended to install the intermediate flange on the yoke, and put some spacers between the intermediate flange and the head flange, so as to obtain the required actual assembly clearance. After the lead is connected, remove the temporary spacers and check for the flexibility of the connection leads and whether the tap changer is affected by any force.

7. TRANSFORMER RATIO TEST AND DC RESISTANCE MEASUREMENT

**NOTE!**

Operation without oil will lead to damage of tap changer.

**Without oil, too many operations will lead to damage of tap changer!**

- Without oil, tap changer cannot be operated over 250 times before drying.
- For the first operation of tap changer after transformer drying, must make sure tap selector is fully immersed in oil and the diverter switch oil compartment is full of oil.

**Notice:** Tap changer not reaching the right position will lead to damage of tap changer; It is recommended to perform transformer ratio test and DC resistance measurement before drying.
7.1 Transformer Ratio test (Bell type tap changer needs to temporarily install head flange, diverter switch insert and head cover)

To operate through the bevel gear on head cover, use a short pipe of 25mm inner diameter, drill two holes to allow a 12mm bolt to go through. Connect the short pipe to the bevel gear output shaft and fix with the bolt by the through-holes, then operate the pipe by hand wheel or hand crank.

OLTC mechanically inter-connected in two or three units shall be connected by horizontal driving shaft. For each tap change, the operation of diverter switch can be heard distinctly from outside. After hearing the diverter switch operation, continue to turn 2.5 revolutions to complete one tap change.

In order to prevent tap changer exceeding limit position, please observe the operating position through OLTC position display window at head cover (Fig.39).
NOTE!

Tap changer can only be operated through drive shaft of top gear box.

Without oil or too many operations will lead to damage of OLTC!
  • Without oil, tap changer cannot be operated over 10 cycles before drying.

7.2 Transformer DC resistance measurement

Notice tap changer is not oil immersed during transformer DC resistance measurement, so operator should minimize tap changing during test.

The tap changer must be turned to the set position after the DC resistance measurement.

8. DRYING AND OIL FILLING

8.1 Drying

The purpose of drying is to maintain the insulation level of the tap changer. Must follow the instruction as following (Vacuum drying and Vapor-phase drying):

8.1.1 Vacuum drying

Notice: tap changer head cover, top bevel gear and accessories cannot be sent for vacuum drying with transformer, otherwise it will be damaged.

Tap changer cover and other accessories must be removed before drying, including top gear box, motor drive unit, protective relay, pressure relieve valve, bevel gear box, oil filter, which cannot be dried.

8.1.1.1 Vacuum Drying in the oven

1. Raise temperature: tap changer in normal air pressure, the rate of temperature rise is 10°C/h till the max. temperature of 110°C.
2. Heating in circulating hot air for 20 hours, the maximum heating temperate is 110°C.
3. Drying in vacuum for 50 hours, highest temperature for tap changer is from 105°C to 125°C. Highest residual pressure is 133Pa.

8.1.1.2 Vacuum drying in transformer oil tank

1. By-pass connector (25mm nominal diameter) can be connected between E2 and Q connecting flange on tap changer head.
2. Tap changer in normal air pressure, the rate of temperature rise is 10°C/h and the max. heating temperature is 110°C.

3. Heating in circulating hot air, max. temperature is 110°C, duration is 20 hours.

4. Drying in vacuum for 50 hours, temperature is 105°C to max. 110°C, duration is 50 hours and max. residual pressure is 133Pa.

8.1.2 Vapor-phase drying

8.1.2.1 Vapor-phase drying in vacuum chamber

Notice: Tap changer head cover, top gearbox and accessories cannot be vacuum dried with transformer, otherwise it will be damaged.

Tap changer head cover must be removed before drying, include top gear box, motor drive unit, protective relay, pressure monitoring device, pressure relieve valve, bevel gear box, temperature sensor, oil filter, and etc. Before starting the drying procedure, the oil drain screw in the oil compartment bottom must be opened to drain the condensate from the oil compartment.

8.1.2.2 Release the oil drainage screw

Release the oil drainage screw with a special wrench in anticlockwise direction, fully release the oil drainage screw is forbidden (Fig.40).

1. Release the oil drainage screw between oil compartment bottom and tap selector in clockwise direction.(Fig. 41)

2. Remove the head cover of tap changer, and put it outside the vacuum oven.

3. Remove elbow pipes and put it outside the vacuum oven.

4. Put vapor phase kerosene around 90°C into oven, and keep the temperature constant for 3~4 hours.

5. Raise the temperate of the vapor phase kerosene at the rate of 10°C/h and max. heating temperature for tap changer is 125°C.
6. Drying in vacuum, temperature for tap changer is 105°C to max. 125°C. Max. residual pressure is 133Pa. The duration is same as transformer but at least 50 hours.

7. Close the oil drainage screw after drying (Torque 18~20 N•m).

**NOTE!**

Oil leakage will lead to damage of tap changer and transformer!

*Untightened oil drainage screw will cause oil flow from tap oil compartment and consequently damage the tap changer and transformer.*
8.1.2.3 Vapor-phase drying in the transformer oil tank

The oil drainage screw must be released before drying, so that oil compartment condensate can flow out. If vapor-phase drying in transformer tank, then only way is to release the oil drainage screw from inside of oil compartment with special wrench (after taking out the diverter switch insert); small parts dropping into oil compartment is forbidden.

Pay attention to the number of small parts during dismantling and reassembling

<table>
<thead>
<tr>
<th>NOTE!</th>
</tr>
</thead>
<tbody>
<tr>
<td>The jam of diverter switch will lead the damage of the tap changer and transformer. Small parts left in oil compartment will lead to a jam of diverter switch, and will cause damage of the tap changer and transformer!</td>
</tr>
<tr>
<td>• Small parts left in diverter switch oil compartment are forbidden.</td>
</tr>
<tr>
<td>• Pay attention to the number of small parts during dismantling and reassembling.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NOTE!</th>
</tr>
</thead>
<tbody>
<tr>
<td>The damage of sealing surface will lead to damage of tap changer and transformer. The damage of sealing surface between tap changer head and head cover will lead to oil leakage, and consequently cause damage of tap changer and transformer!</td>
</tr>
<tr>
<td>• Pay attention not to damage the sealing surface between OLTC head and head cover during dismantling and other operation.</td>
</tr>
</tbody>
</table>

Before the first tap change after transformer drying process, must make sure that the tap selector is fully immersed in transformer oil and the diverter switch oil compartment is full of oil.

If tap changer is dried in transformer tank, release the oil drainage screw. Take out diverter switch insert first, then close the oil drainage screw after drying, and put diverter switch insert back.

<table>
<thead>
<tr>
<th>NOTE!</th>
</tr>
</thead>
<tbody>
<tr>
<td>Damage of tap changer O ring will lead to oil flow away from oil compartment, and cause the damage of tap changer.</td>
</tr>
</tbody>
</table>
8.1.2.3.1 Put kerosene vapor into tap changer

Use pipe of at least 50mm inner diameter to connect R and Q connecting flange and inject kerosene vapor.

8.1.2.3.2 Drying

1. Supply kerosene vapor at a temperature of approx. 90°C, and keep this temperature constant for approx. 3~4 hours.
2. Increase the kerosene vapor temperature by approx. 10°C/h to the desired final temperature, which should not exceed 125°C.
3. Drying in vacuum, temperature for tap changer is 105°C to max. 125°C. Max. Residual pressure is 133Pa. The duration is same as transformer but at least 50 hours.

8.1.2.3.3 Lift out diverter switch insert and close oil drainage screw

1. Follow the 6.4.1 instruction to take out diverter switch insert.
2. Use the extended T-wrench to tighten oil drainage in clockwise direction (Torque 20 N•m).

8.1.2.3.4 After tightening the oil drainage screw, put diverter switch back by the instruction 6.4.4

8.2 Filling with oil

After drying process, in order to keep oil compartment dry, oil compartment (diverter switch insert already installed) should be filled up with oil in a short time.

The head cover of the tap changer should be closed again. Tighten twenty-four M10 bolts. O ring must be in correction position. Fill the OLTC and transformer simultaneously. In order to balance the vacuum between OLTC and transformer tank, a by-pass connector is provided and to be installed between tap changer oil filling flange and the transformer oil bleeding flange.

New transformer oil is filled into the tap changer up to the same level of the transformer tank cover. For this reason, the by-pass connector provided by our company can be installed between tap changer head oil filling flange and the transformer oil bleeding flange, in order to simultaneously vacuum the transformer tank and diverter switch oil compartment.

Only qualified new transformer oil should be filled into oil compartment and oil conservator. Fill the OLTC and transformer simultaneously with new transformer oil under vacuum.

1. A by-pass connector between E2 and Q is to be installed in order to simultaneously apply vacuum to the transformer and the diverter switch oil compartment.
2. Use tap-changer pipe S or Q for oil filling (Fig.42).
Lack of oil in diverter switch oil compartment will damage tap-changer.

**Operating tap-changer without oil after drying will damage tap-changer!**

- For the first operation after transformer drying process, must make sure that the tap selector is fully oil immersed in transformer oil and diverter switch oil compartment is full of oil.
- According to the Standard 60214-1, the OLTC can be operating in the oil temperature range between -25°C~105°C, the oil temperature can exceed the range if operating in overload condition.

For the first operation after transformer drying procedure, must make sure that the tap changer is fully oil immersed in transformer oil and the diverter switch oil compartment is full of oil.

**Note:** No step on rupture disk during oil filling, and oil filling through Rapture disk is forbidden (Fig.43-44).
9. PROTECTION DEVICE AND DRIVE ASSEMBLY INSTALLATION

9.1 Installation of protective relay
Install protective relay according to the installation instruction which is supplied with tap-changer.

9.2 Application of pressure relieve valve
Remove the red protective plate on the pressure relieve valve before operation (Fig.45).

Figure.45

9.3 Installation of motor drive unit
Install the motor drive unit according to Huaming operating instruction of motor drive unit.

9.4 Installation of bevel gear box
Bevel gear box is to be attached to a bracket on the transformer cover by 2 bolts (through-holes 18mm diameter).

Notice: the inscribed serial number on bevel gear box must match the serial number of the OLTC name plate.

If the length of vertical drive shaft and horizontal drive shaft are over 2m, an intermediate supporting gearbox should be installed. The installation of special designed intermediate supporting gearbox between bevel gear box on head cover, gear box above MDU, horizontal drive shaft, and vertical drive shaft can use the reference of above.

Top gear box is fixed on head cover by three retaining plates (2 screws for each retaining plate); Driveshaft direction can be adjusted according to the requirement.

1. Loose the retaining plates of gear box, and pull out one end of the retaining plate a little bit (six M8
2. Turn top gear box driving shaft to change the direction to meet installation requirement.

Notice: Gear box must not be turned by itself.

3. Fasten all screws of the retaining plates and fix the gear box tightly (Torque 15 N•m) (Fig.47).

Notice: Avoid pressure relieve valve when turning the gear box (if any)

**NOTE!**

Improper adjustment of gear box will lead to property loss.

**Improper adjustment of top gear box will lead to damage of tap changer!**

- Adjust the gear box only when the retaining plates are loose.

- The gear box must not be turned by itself during adjustment.

- The gear box can only be adjusted by turning drive shaft of gear box.

9.5 Installation of horizontal and vertical drive shafts

1. Install the horizontal and vertical drive shaft by following Huaming motor drive unit operation instruction (Fig.48).
2. Connecting the drive shaft, motor drive unit, and tap changer by following Huaming motor drive unit operation instructions.

**Notice:** Improper adjustment of gear box will lead to damage of OLTC! Adjust the gear box only when the retaining plates are loose. The gear box must not be turned by itself during adjustment. The gear box can only be adjusted by turning drive shaft of gear box.

**Notice:** Only when the length of vertical and horizontal drive shaft is over 2m, the intermediate supporting gear box is needed.
9.6 Installation of protective cover

9.6.1 Installation of horizontal protective cover

The length of horizontal protective cover is designed and decided by transformer factory. After installation of drive shaft, put clamping ring on two ends of horizontal protective cover (provided with the product), and move it on the protrusions of bevel gear box and top gear box. Tighten the clamping ring onto the protrusions (Fig.50).
9.6.2 Installation of vertical protective cover

9.6.2.1 Fix three stainless steel straight pins (6X16) on the HM 8210.303.3 liner bushing (120° each), the pins should leave 5mm outside the bushing and are not allowed to appear in the inner diameter (Fig.51-1, 51-2).

![Figure.51-1](image1) ![Figure.51-2](image2)

9.6.2.2 Put HM8210.303.3 liner bushing underneath the gear box, and fix with four M6X10 locking bolts (90° each) (Fig.52).

9.6.2.3 Put HM8210.301.5 liner bushing on top of motor drive unit (except SHM-D), and fix with four M6X10 locking bolts (Fig.53).

9.6.2.4 Put two protective covers outside the drive shaft, and keep the notch side to the two ends. Put the bigger one (HM8170.301) on the top, then put the whole assembly into the space between gear box and motor drive unit by following the diagram below, and connect the vertical drive shaft first (Fig.54).

![Figure.52](image3) ![Figure.53](image4)
9.6.2.5 Put the lower protective cover HM8170.302 on MDU output head (Fig.55).

Figure.54                                                                                             Figure.55

9.6.2.6 Pull the HM8170.301 upper protective cover up to underneath of bevel gear box, clamp on the HM8210.303.3 liner bushing, and adjust three notches aiming to three straight pins. Turn the protective cover to allow straight pins to stay in the horizontal groove (Fig.56).

9.6.2.7 After two protective covers fixed at the correct position, use the clamping rings to clamp the bigger HM8170.301 protective cover (Fig.57).

Figure.56                                                                                             Figure.57

9.7 Installation of mechanically inter-connected tap changer

Make sure each tap changer is in set position and the connecting procedure as following:

1. Check that the operating positions of all OLTCs are identical (through position indication window, each tap changer should be at set position).

2. Loose the retaining plates of top gear box, and pull out one end of the retaining plate a little bit (six M8
3. Turn top gear box to desired position by turning its drive shaft.
4. Tighten the retaining plates of top gear box, lock screws by locking plate (Torque 15N•m).
5. Pay attention to the serial number on the gearbox flange and the arrow direction below. The direction of the arrow indicates how the gear box moves when turning the hand crank of the motor drive unit clockwise. The gear box can be adjusted only when the retaining plates are loose.

Note: The gear box can only be adjusted by turning drive shaft of gear box. The gear box must not be turned by itself during adjustment. Improper adjustment of gear box will lead to damage of OLTC!

6. Turn the output shaft counter-clockwise for one switching of diverter switch for each tap changer.
7. Make sure MDU and tap-changer at the same position.
8. Install the horizontal drive shaft on each tap changer head. Connect each tap changer by starting from the one closest to motor drive unit.
9. After installation of all the drive shafts, turn the top gearbox's drive shaft by 2.5 revolutions more to complete a tap change.
10. In order to turn OLTC to set position, the drive shaft must operate in clockwise direction. For one complete tap change operation, the bevel gear needs to operate 2.5 circles more after reaching set position and diverter switch acts.
11. Make sure all tap-changers operate at same time (by hearing the diverter switch sound).
12. Make sure MDU and tap-changer at the same tap position.
13. Install the vertical drive shaft.

9.8 Position calibration of OLTC drive system

After connecting the tap changer with motor drive unit, manually operate a full cycle of operations before driving by motor. When connecting the tap changer with motor drive unit, the time difference between the completion of diverter switch and the ending of motor drive unit operation should be the same in both direction of rotation. Generally, calibration of tap changer and motor drive connection has been done in the factory. However, for proper operation of the tap changer, the calibration should be performed again by the client before operation. The calibration of connection is carried out according to the following procedure:

1. Turn the crank in 1→N direction. After the diverter switch has operated (by hearing the switching sound in oil compartment), continue to turn the crank and record the number of turns until the red mark of the green area reaches on the center of the position indication window. Record the number of turns as “m”.
2. Turn the crank in the reverse direction N→1 to return to its set position. Record the number of turns as “K” in the same way as mentioned above.
3. The connection is correct if m=K. If m≠K and m-K>1, then the difference of turns shall be balanced. Loosen the vertical driving shaft, turn the crank by (m-K) / 2 turns in the direction of “m” (the direction with more recorded turns), and then connect the vertical driving shaft to the motor drive unit.
4. Calibrate the difference of turns between the motor drive unit and the tap changer as above, till the same number of turns in both directions, i.e. \( m = K \).

**Example:**

- Calibration of the connection between CM type tap changer and CMA7 motor drive unit: Turn from position 10 (set position) to position 11, \( m = 5 \) turns, Turn backward from position 11 to position 10 (the original set position), \( K = 3 \) turns. The difference of turns of the handle \( m - K = 5 - 3 = 2 \) turns.
- Turns to be adjusted is \( (m-K)/2 = (5-3)/2 = 1 \) turn.
- Loosen the connection between the vertical driving shaft and the motor drive unit. Turn the crank in the direction 10→11 for one turn.
- Reconnect the driving shaft.
- Check whether the difference of turns in both directions has been balanced.
  a. Record number of turns “m” and “K” under connected condition.
  b. Turn \( (m-K)/2 \) turns in the direction of more recorded turns after loosening the connection.
  c. Reconnect and calibrate until \( m = K \).

### 10. TAP CHANGER ROUTINE TEST AND PRE-TEST PREPARATION

#### 10.1 Preparation before test

10.1.1 Fully bleed the tap changer

Fully bleed the OLTC before energizing, by using the gas discharge plug on oil suction pipe.

10.1.1.1 Bleed of tap changer

1. Remove the M30 screw cap on gas discharge plug E1 (No.36 wrench).
2. Lift the valve stem to bleed by a screwdriver (Fig.58).

![Figure.58](image_url)
3. Tighten the Screw cap on gas discharge plug (Torque 9~12 N•m).

10.1.1.2 Bleeding of the suction pipe S

1. Remove the M16 screw cap on oil suction pipe S (No.16 wrench) (Fig.59).
2. Unscrew M6 gas discharge plug.
3. Tighten the gas discharge plug (Torque 2 N•m).
4. Close the screw cap on gas discharge plug (Torque 8~10 N•m).

10.1.2 Earthing connections

1. Connect the grounding screw on the OLTC head (1 screw M12 with nuts, No.19 wrench, Torque 50~60 N•m) to the transformer cover (Fig. 60).

2. Connect the grounding screw (M12, No.19 wrench, torque50~60 N•m) of the motor drive cabinet to the transformer tank.

10.2 Test in transformer factory

10.2.1 Operation test

Before energizing, tap-changer operation test must be carried out to check the mechanical function of OLTC and motor drive unit.

Notice: Operating tap changer without oil will damage tap changer!

Before the first operation after transformer drying process, must make sure that the tap selector is completed immersed in oil and diverter switch compartment is full of transformer oil.

1. Tap selector is completed immersed in oil and diverter switch compartment is full of transformer oil.
2. During operation test, tap changer must go through whole tap range.
NOTE!
Under the condition of improper connection between tap changer and motor drive unit, continuous operation will lead to damage of tap changer!

Must make sure that motor drive unit and tap changer at the same position on position indicator!

3. Make sure OLTC and MDU is at the same position on each tap position.
4. Test the mechanical and electrical limit switch at both Max. and Min. position.

10.2.2 Transformer electrical test

DANGER!
During operation, explosive gases may accumulate under the OLTC cover, in the piping, oil conservator or dehydrating breather, explosion of which may spurt parts and high temperature oil causing death or serious injury!

Please ensure that there is no flame, heat source or sparks (e.g. through electrostatic interaction) in surrounding environment.

Make sure that tap-changer test must be carried out by professional test staff according to test guidance.

11. TRANSPORTATION AND COMMISSIONING AT SITE

11.1 Transportation of dismounted motor drive until

1. Put the motor drive unit at set position and dismount drive shaft.
2. Dismount motor drive unit.
3. Do not operate the motor drive unit OLTC is properly connected. Motor drive unit reinstallation according to instruction section 9.3~9.7.

11.2 Transportation with oil and without oil conservator

If the transformer is filled with oil but stored or transported without oil conservator, a by-pass connector must be installed between the interior of the diverter switch oil compartment and the transformer oil tank to equalize the pressure caused by the expansion of the oil. Install this by-pass connector at OLTC head between connecting flange E2 and Q.

11.3 Transportation without oil filling

If the transformer is to be transported or stored without oil, drain the OLTC oil compartment completely. OLTC oil compartment should be treated in the same way as the transformer (e.g. by filling with nitrogen gas).
11.4 Commissioning at the operating site

**DANGER!**

Danger of death and serious injury!

**Potential explosive gases accumulated under the OLTC cover, in the piping, in the oil conservator or at the dehydrating breather may lead to death or serious injury.**

Please ensure that there is no flame, heat source or sparks (e.g. through electrostatic interaction) in surrounding environment, and there is no possibility to produce it.

**NOTE!**

Lack of oil in diverter switch oil compartment will lead to damage of OLTC!

**Continuously operating OLTC without oil will lead to damage of OLTC!**

Make sure that tap selector is fully oil immersed and the oil compartment is full of oil before transformer energizing.

Make sure that tap selector is fully oil immersed and the oil compartment is full of oil before transformer energizing.

1. Fill the oil into OLTC according to instruction 8.2 (Oil quality limit see Table-2). The specified values in table-2 are referred for oil temperature of 20±5°C.

| Table-2 Dielectric strength limit values (dielectric strength Ud as per IEC 60156) |
|---------------------------------------|---------------------|---------------------|
| For newly commissioned transformer    | 40 (Min.)           | 12 (Max.)           |

Please ensure that there is no flame, heat source or sparks (e.g. through electrostatic interaction) in surrounding environment, and there is no possibility to produce it.

Make sure that tap selector is fully oil immersed and the oil compartment is full of oil before transformer energizing.

2. Bleed of OLTC following the instructions in 10.1.1.
3. Trial operation following the instructions in 10.2.1.
4. Make sure oil conservator Min. oil level signal is connected to circuit breaker’s tripping circuit.
5. Inspect whether the protective relay is functional by following the operation instructions of protective relay.
6. Remove the red locking plate of pressure relieve valve before operation. All the functional inspection and test during operation must follow the safety explanation which is indicated in Section 2 and 9.2.2.
12. OLTC MAINTENANCE

12.1 OLTC maintenance (See Table-3).

Notice: In order to guarantee the reliability of OLTC, end user should do maintenance at certain intervals. Lack of maintenance may cause serious damage of tap changer and transformer.

1. For safety purpose, for new OLTC, it is recommended to have first maintenance after two years or 20,000 operations, whichever comes first.

2. After that, the tap changer should have routine maintenance for every 7 years or after the number of operations indicated in Table-3, whichever comes first.

3. If OLTC does not operate or energized for a long time, at least make five full cycles of operations after the power is cut off.

4. Tap selector usually do not need maintenance only when used in industrial transformers, where maintenance is needed after 1,000,000 operations.

5. The diverter switch insert must be replaced after 800,000 tap change operations.

6. After 250,000 tap change operations, the lead-out braided leads must be replaced even if they are not damaged and regardless whether the contacts are to be replaced or not.

<table>
<thead>
<tr>
<th>OLTC</th>
<th>Transformer rated current</th>
<th>Number of operations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Without oil filter</td>
</tr>
<tr>
<td>CMIII 500</td>
<td>≤400A</td>
<td>100,000</td>
</tr>
<tr>
<td>CMIII 500</td>
<td>&gt;400A</td>
<td>80,000</td>
</tr>
<tr>
<td>CMIII 600</td>
<td>≤400A</td>
<td>100,000</td>
</tr>
<tr>
<td>CMIII 600</td>
<td>&gt;400A</td>
<td>80,000</td>
</tr>
<tr>
<td>CMI 500</td>
<td>≤500A</td>
<td>100,000</td>
</tr>
<tr>
<td>CMI 500</td>
<td>&gt;500A</td>
<td>100,000</td>
</tr>
<tr>
<td>CMI 600</td>
<td>≤600A</td>
<td>100,000</td>
</tr>
<tr>
<td>CMI 800</td>
<td>≤500A</td>
<td>100,000</td>
</tr>
<tr>
<td>CMI 800</td>
<td>&gt;500A</td>
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</tr>
<tr>
<td>CMI 1200</td>
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<td>CMI 1200</td>
<td>&gt;800A</td>
<td>70,000</td>
</tr>
<tr>
<td>CMI 1500</td>
<td>≤1200A</td>
<td>70,000</td>
</tr>
<tr>
<td>CMI 1500</td>
<td>&gt;1200A</td>
<td>60,000</td>
</tr>
</tbody>
</table>
12.2 The quality criteria of transformer oil and monitoring intervals

1. Test oil sample before filling oil into OLTC for first time commissioning or after each maintenance.
2. Routine oil sample test should be done once a year or according to oil inspection criteria of the transformer.
3. The recommended monitoring parameters for newly filled oil or oil during operation under relative transformer temperature see Table-4.

<table>
<thead>
<tr>
<th>OLTC Highest voltage for equipment (kV)</th>
<th>Oil before operation</th>
<th>Oil during operation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Moisture (mg/L)</td>
<td>Breakdown strength (kV/2.5mm electrode)</td>
</tr>
<tr>
<td>252</td>
<td>≤15</td>
<td>≥50</td>
</tr>
<tr>
<td>123</td>
<td>≤20</td>
<td>≥45</td>
</tr>
<tr>
<td>72.5</td>
<td>≤20</td>
<td>≥35</td>
</tr>
<tr>
<td>≤35</td>
<td>≤20</td>
<td>≥30</td>
</tr>
</tbody>
</table>

12.3 Recommendation of oil filter installation

1. In high humidity environment such as tropical or subtropical region, to save the OLTC from extra moisture, it is recommend to install online oil filter.
2. For frequent switching applications such as industrial transformer or daily operations over 50 times, it is strongly recommended to install online oil filter.
3. For OLTC with highest equipment voltage of 245kV or above, it is strongly recommended to install online oil filter.
13. APPENDIX

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Appendix 1 CM OLTC head flange for standard tank type, overall dimensions

E1: Bleeding for on-load tap changer
E2: Bleeding for transformer oil tank
R: Connection flange for protective relay
S: Connection flange for oil suction pipe
Q: Connection flange for oil return pipe

Unit: mm
Appendix 2 CM OLTC head flange with pressure relief valve, overall dimensions

E1: Bleeding for on-load tap changer
E2: Bleeding for transformer oil tank
R: Connection flange for protective relay
S: Connection flange for oil suction pipe
Q: Connection flange for oil return pipe

Unit: mm
Appendix 3 CM OLTC head flange installation for bell-type, overall dimensions
Appendix 4 The overall dimension of bevel gear
Appendix 5 Transformer connection flange for CM OLTC, overall dimension

Unit: mm
Appendix 6 Dimension of lifting plate for bell type

Appendix 7 Diagram of the installation of horizontal and vertical drive
Appendix 8 Structure diagram of bypass connector
### Appendix 9 Overall dimension of protective relay

<table>
<thead>
<tr>
<th>Model</th>
<th>D</th>
<th>D1</th>
<th>D2</th>
<th>D3</th>
<th>D4</th>
<th>d1</th>
<th>H1</th>
<th>H2</th>
<th>L1</th>
<th>L2</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>QJ4-25</td>
<td>25</td>
<td>35</td>
<td>65</td>
<td>85</td>
<td>115</td>
<td>14</td>
<td>215</td>
<td>158</td>
<td>208</td>
<td>200</td>
<td>Single signal and single trip signal</td>
</tr>
<tr>
<td>QJ4G-25</td>
<td>25</td>
<td>35</td>
<td>65</td>
<td>85</td>
<td>115</td>
<td>14</td>
<td>215</td>
<td>158</td>
<td>208</td>
<td>200</td>
<td>with one pair of trip signal</td>
</tr>
<tr>
<td>QJ6-25</td>
<td>25</td>
<td>35</td>
<td>65</td>
<td>85</td>
<td>115</td>
<td>14</td>
<td>215</td>
<td>158</td>
<td>208</td>
<td>200</td>
<td>with two pair of trip signal</td>
</tr>
</tbody>
</table>

Note: 1. Head MA20-10(M20x1.5 outside thread) fixed by nylon cable
2. Probe is test bottom

Unit: mm
Appendix 10 CM (10070) operating position table and connection diagram

<table>
<thead>
<tr>
<th>Operation position number</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Different voltage number</td>
<td>7</td>
</tr>
<tr>
<td>Set position</td>
<td>4</td>
</tr>
</tbody>
</table>

| Tap selector contact position | 1 2 3 4 5 6 7 |
| Display position              | 1 2 3 4 5 6 7 |

* Drawing is shown at the set position
Appendix 11 CM (10071W) operating position table and connection diagram

Please connect terminal 1 and "-", 4 and "+", 2 and 2, 3 and 3 in the same phase.

<table>
<thead>
<tr>
<th>Operation position number</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Different voltage number</td>
<td>7</td>
</tr>
<tr>
<td>Set position</td>
<td>4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Change-over selector location</th>
<th>K+</th>
<th>K-</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tap changer position</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
</tr>
<tr>
<td>Tap selector contact position</td>
<td>1 2 3 K 2 3 4</td>
<td></td>
</tr>
<tr>
<td>Display position</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
</tr>
</tbody>
</table>

* Drawing is shown at the set position
Appendix 12 CM (10191G) operating position table and connection diagram

| Operation position number | 19 |
| Different voltage number | 19 |
| Set position             |   |

III 350/500/600

<table>
<thead>
<tr>
<th>Change-over selector location</th>
<th>O+</th>
<th>O-</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tap changer position</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Tap selector contact position</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Display position</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

Drawing is shown at the set position
Appendix 13 CM (10191W) operating position table and connection diagram

| Operation position number | 19 |
| Different voltage number  | 19 |
| Set position              | 10 |

**III 350/500/600**

<table>
<thead>
<tr>
<th>Change-over selector location</th>
<th>K+</th>
<th>K-</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tap changer position</td>
<td>1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19</td>
<td></td>
</tr>
<tr>
<td>Tap selector contact position</td>
<td>1 2 3 4 5 6 7 8 9 K 1 2 3 4 5 6 7 8 9</td>
<td></td>
</tr>
<tr>
<td>Display position</td>
<td>1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19</td>
<td></td>
</tr>
</tbody>
</table>

* Drawing is shown at the set position
Appendix 14 CM (10193W) operating position table and connection diagram

<table>
<thead>
<tr>
<th>Operation position number</th>
<th>19</th>
</tr>
</thead>
<tbody>
<tr>
<td>Different voltage number</td>
<td>17</td>
</tr>
<tr>
<td>Set position</td>
<td>9b</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Change-over selector location</th>
<th>K+</th>
<th>K-</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tap changer position</td>
<td>1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19</td>
<td></td>
</tr>
<tr>
<td>Tap selector contact position</td>
<td>1 2 3 4 5 6 7 8 9 K 1 2 3 4 5 6 7 8 9</td>
<td></td>
</tr>
<tr>
<td>Display position</td>
<td>1 2 3 4 5 6 7 8 9a 9b 9c 10 11 12 13 14 15 16 17</td>
<td></td>
</tr>
</tbody>
</table>

* Drawing is shown at the set position
Appendix 15 CM (12233G) operating position table and connection diagram

<table>
<thead>
<tr>
<th>Change-over selector location</th>
<th>O+</th>
<th></th>
<th>O-</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tap changer position</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Tap selector contact position</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Display position</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

Operation position number: 23
Different voltage number: 21
Set position: 11b

Notes:
- Drawing is shown at the set position.
Appendix 16 CM (12233W) operating position table and connection diagram

<table>
<thead>
<tr>
<th>Operation position number</th>
<th>23</th>
</tr>
</thead>
<tbody>
<tr>
<td>Different voltage number</td>
<td>21</td>
</tr>
<tr>
<td>Set position</td>
<td>11b</td>
</tr>
</tbody>
</table>

III 350/500/600

<table>
<thead>
<tr>
<th>Change-over selector location</th>
<th>K+</th>
<th>K-</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tap changer position</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Tap selector contact position</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Display position</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

Drawing is shown at the set position
Appendix 17 CM (14273W) operating position table and connection diagram

<table>
<thead>
<tr>
<th>Operation position number</th>
<th>Different voltage number</th>
<th>Set position</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>27</td>
<td>13b</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Change-over selector location</th>
<th>K+</th>
<th>K-</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tap changer position</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tap selector contact position</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Display position</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Drawing is shown at the set position
Appendix 18 CM (18353W) operating position table and connection diagram

<table>
<thead>
<tr>
<th>Operation position number</th>
<th>35</th>
</tr>
</thead>
<tbody>
<tr>
<td>Different voltage number</td>
<td>33</td>
</tr>
<tr>
<td>Set position</td>
<td>17b</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Change-over selector location</th>
<th>1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tap changer position</td>
<td>K+</td>
</tr>
<tr>
<td>Tap selector contact position</td>
<td>k</td>
</tr>
<tr>
<td>Display position</td>
<td>K-</td>
</tr>
</tbody>
</table>

III 350/500/600

* Drawing is shown at the set position