ON-LOAD TAP CHANGER TYPE CMD
OPERATION INSTRUCTIONS

HM 0.460.1901

Shanghai Huaming Power Equipment Co.,Ltd.

Contents

1. Brief Introduction

CMD type of OLTC, an hi-tech product solely developed by HM Grp Ltd through technological innovation and constant efforts for past decades, not only maintains its original parts and structure, which qualified through practical operation for so many years, in addition to HM's unique design, but eventually enhances its reliability for long-time endurance.

The Highest Equipment Voltage of CMD On Load Tap Changer (OLTC) is 252KV. Three-phase CMD OLTC is applicable for transformers with highest equipment voltage up to 550KV or less with neutral point regulation. Single phase CMD OLTC is applicable to any connections. The maximum rated through current of three-phase CMD can reach 1000A. 2400A is for single phase. It is to regulate the voltage on load by changing the taps. The maximum operating position of CMD OLTC is 35 (with change-over selector).

CMD OLTC is a combined type OLTC, which consists of 2 main parts: diverter switch and tap selector.

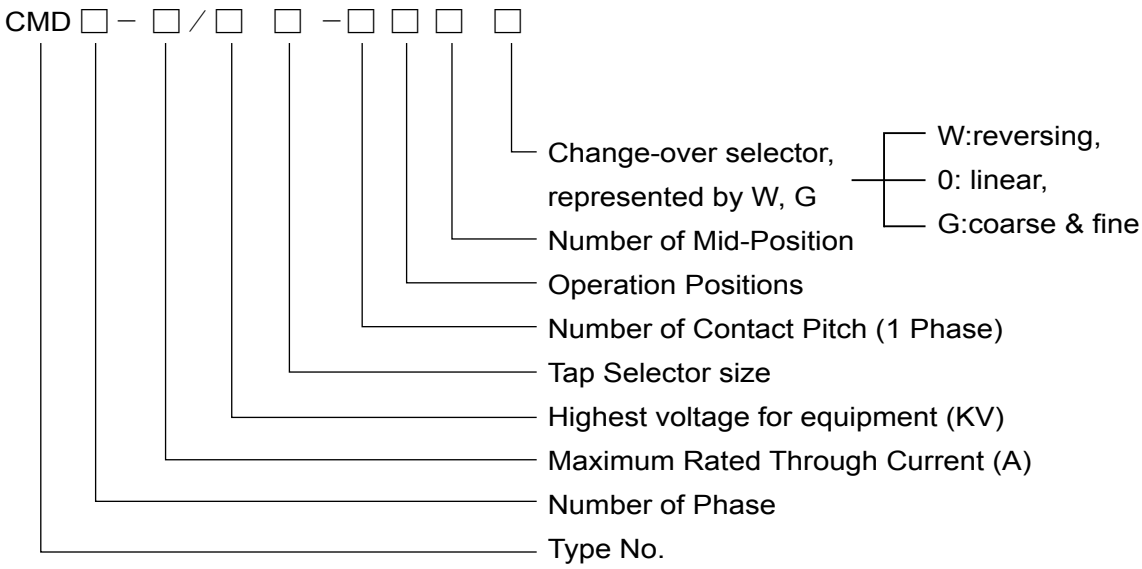
Fig 1. Outline view of CMD OLTC

CMD OLTC will be mounted to the transformer tank cover by its tap changer head flange, which serves also for connection to the motor drive SHM-1 through reducer and bevel gear box (appendix) for the purpose of motor drive and remote motor drive operation.

This operation instruction includes all the necessary information for the installation and operation of CMD OLTC.

1.1 Type Designation

1.1.1. Basic Connection Number



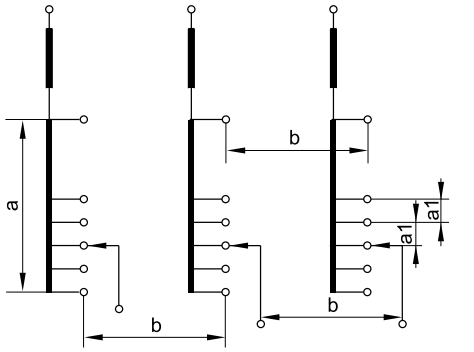
a. 10090 – Number of contacts in circle pitch selector for 1 phase is 10, maximum operating position is 9, and 0 represents a linear OLTC without change-over selector.

b. 10193W – Number of contacts in circle pitch selector for 1 phase is 10, maximum operating position is 19 and a mid position is 3. W represents an OLTC with reversing change-over selector.

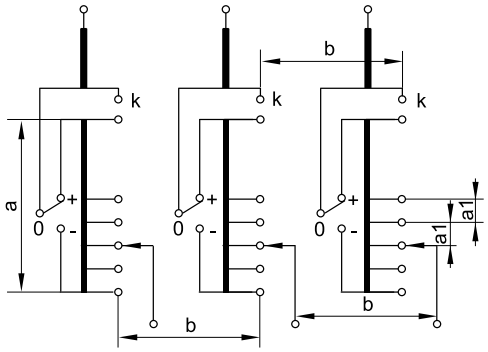
c. 10191G – Number of contacts in circle pitch selector for 1 phase is 10, maximum operating position is 19 and a mid position is 3. G represents an OLTC with coarse change-over selector.

1.1.2 Insulation Level of Tap Selector

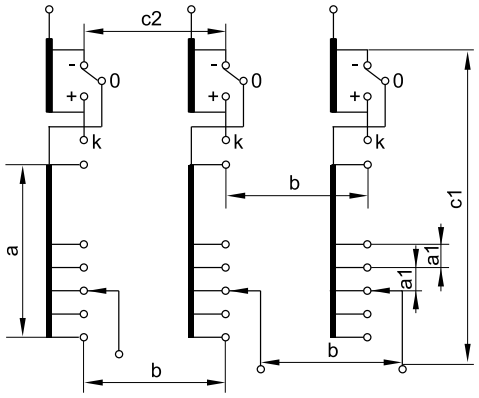
The insulation for the tap selector can be classified into 4 different insulation grades, namely B, C, D, DE. Table 1 shows the data of the internal insulation level. The basic connection drawings and the code for insulation distance shows in Fig. 2.



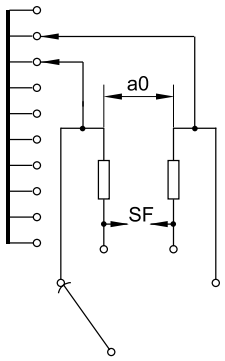
Linear regulation



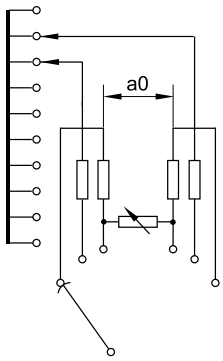
Reversing regulation



Coarse & fine regulation



Spark protection gap



Zinc Oxide Varistor

Explanation for Insulation Distance Code:

a. Between Maximum and Minimum tap positions of same-phrase voltage regulation windings, also between start terminal and end terminal of same-phrase coarse windings;

b. Between any tap positions of different-phrase voltage regulation windings or between any terminals of different-phrase coarse windings;

a_0: Between tap positions and preselected tap positions of diverter switch;

a_1: Between contacts of tap selector on any tap positions(connected or unconnected):

c_1: Start terminal and current output terminal of same-phrase coarse winding;

c_2: Between contacts of start terminal of coarse windings.

Fig 2. Basic Connection Drawings

Insulation grade of tap selector (Table 1) Unit: kV

Code of Insulation Distance Code		Tap selector B		Tap selector C		Tap selector D		Tap selector DE	
		1.2/50μs	50Hz 1min	1.2/50μs	50Hz 1min	1.2/50μs	50Hz 1min	1.2/50μs	50Hz 1min
a		265	50	365	82	490	105	550	120
b		265	50	350	82	490	146	550	160
a_0	I ⩽ 600A	90	20	90	20	90	20	90	20
	I ⩾ 1000A	130	20	130	20	130	20	130	20
a_1		150	30	150	30	150	30	150	30
c_1		500	145	550	180	590	225	660	230
c_2		500	145	550	195	590	225	660	250

Note: a_o internal insulation level refers to an insulation level with zinc oxide Zinc Oxide protection gap, 100% response at 1.2/50μs and 90kv BIL.

a_o internal insulation level refers to an insulation level with spark protection gap, 100% response at 1.2/50μs and 130kv BIL.

1.1.3 The operating condition of OLTC

a. The storage ambient temperature of OLTC is from -25℃ to 40℃ . The storage humidity of the OLTC should be no more than 85 percent.

The service temperature of standard designed OLTC is -25℃ to 40℃

If the temperature exceeds the range of above (-25℃ to 40℃), please specify when ordering.

To meet the ordering requirements and comply with the operating environment, if the requested service temperature is out of the range of -25℃ to 40℃ , the material and accessories of the OLTC will be specially designed and selected.

b. The vertical inclination level of the OLTC on the transformer towards ground level should not exceed 2%.

c. The operation site should be free from serious dust and other explosive and erosive gases.

1.1.4 Technical data of Type CMD On Load Tap Changer (Table 2)

Item	Specification		CMD III			CMD I				
1	Max. Rated Through Current (A)		400	600	1000	400	600	1000	1600	2400
2	Rated Frequency (Hz)		50 or 60							
3	Connection way		Three-phase for neutral point of star connection Single phase for any connection							
4	Max. rated step voltage (V)		3300		4000	3300		4000		
5	Rated step capacity (kVA)		1500	1600	3000	1500	1600	3000	4400	5600
6	Short Circuit Current Test (kA)	Thermal (r.m.s)3s	6	8	12	6	8	12	24	24
		Dynamic (Peak)	15	20	30	15	20	30	60	60
7	Number of Operating Positions		14 without change-over selector; 27 with changer-over selector							
8	Insulation to ground	The highest voltage for equipment (kV)	72.5		126		170		252	
		Rated separate source AC withstand voltage (kV/50Hz, 1min)	140		230		325		460	
		BIL kV(1.2/50μs)	350		550		750		1050	
9	Tap Selector		Categorized into B, C, D, DE four types							
10	Mechanical Life		Not less than 1,500,000 operations							
11	Electrical Life		Not less than 200,000 operations							
12	Oil Compartment of diverter Switch	Service Pressure	0.03Mpa							
		Leakage Test	No leakage under 0.08Mpa for 24 hours							
		Over Pressure Protection	Rupture disc bursts at 300 ± 20%kPa overpressure							
		Protection Relay	Set oil flow speed at 1.0m/s ± 10% or 1.2m/s ± 10%							
13	Motor Drive Unit		SHM-I or CMA7							
14	Oil Filter Plant		ZXJY-1/ZXJY-2/ZXJY-3 according to requirement (Necessary when max. rated through current is 1000A and above or OLTC used for industrial applications)							

Note: Step capacity equals to the product of step voltage and load current.

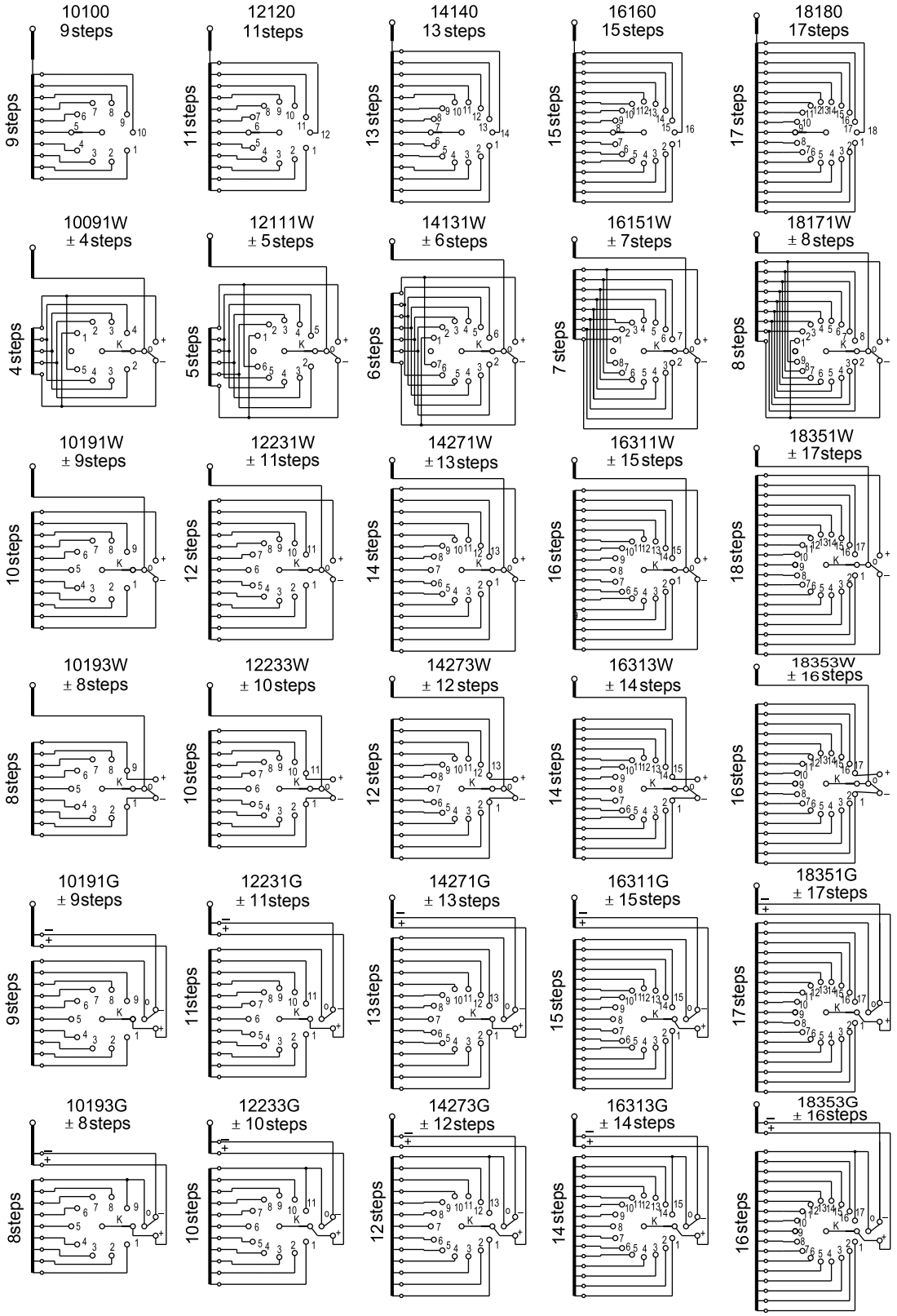
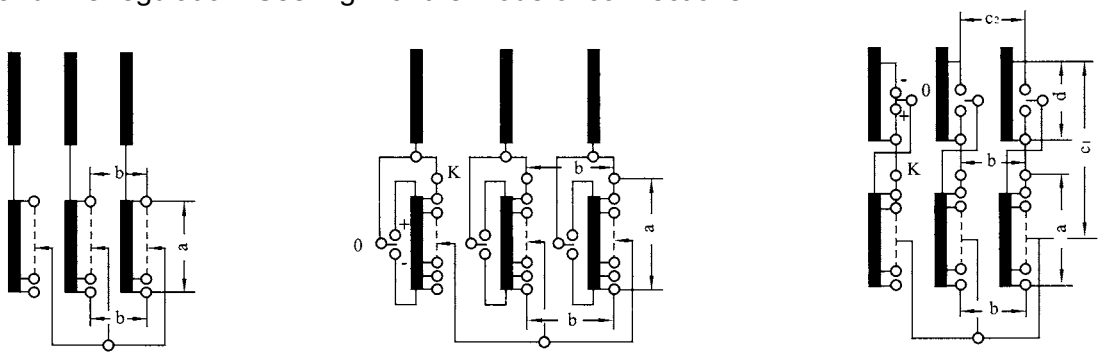


Fig 3. Tap selector basic connection diagram

1.1.5 Mode of Voltage Regulation

There are 3 modes of voltage regulation of CMD OLTC, i.e. linear regulation, reversing regulation, coarse and fine regulation. See Fig4 for the mode of connections.



Without change-over selector **With reversing changer-over selector** **With coarse change-over selector**

Fig4. Basic Connection

1.1.6 Provided that OLTC operates under 1.2 times of its maximum rated through current, both contacts and conduction parts carrying currents for long-time shall not raise their temperature higher than 20k.

1.1.7 Provided that OLTC operates under 1.5 times of its maximum through current and continuously changes half circle from its first position, then its transition resistor shall not raise its temperature higher than 350K.

2. Structure of CMD OLTC

CMD OLTC is a combined type OLTC, which consists of 2 main parts, diverter switch and tap selector. The tap changer drives by the way of linking to the head cover with shaft installed outside cylinder. The reducer on the head of tap changer drives by insulated shafts with two parts. One is is to drive the diverter switch, the other is to drive the tap selector.

2.1 Oil compartment of Diverter Switch

The oil compartment of diverter switch will separate the carbonized oil due to arcing in the diverter switch from the oil in the transformer oil tank, so as to keep the oil in the transformer clean. It is composed of four parts: head flange, top cover, insulated cylinder and bottom of the cylinder.

2.1.1 Head Flange

Head Flange is composed of mounting flange and supporting flange, which are aluminum casting. Supporting flange is connected to the insulation cylinder by rivets. Tap changer is installed on the transformer tank cover by means of the mounting flange. (See Fig 4-1)

There are three connection pipes in the supporting flange. The bend pipe R is to be connected to the protective relay. Connection pipe S in connection with an oil suction pipe can suck the oil from the bottom of the oil compartment by connecting the head flange of tap changer and the oil suction pipe (insulated) in the oil compartment. Connection pipe Q acts as the oil return pipe in the oil compartment. It is connected to oil filling pipe and oil drain pipe separately on the oil filter plant if the oil filter plant is installed on the tap changer. Pipe E acts as the vent pipe for transformer oil overflow. All the connection bend pipes can be turned into different angle according to the requirements of installation. It should be re-tightened by the pressing plate after turning.

2.1.2 Top cover

In order to prevent oil compartment from being damaged due to bursting overpressure, a bursting cap together with an oil overflow vent valve are equipped on the top cover of OLTC. (See Fig. 4-2)

Fig. 4-1 (Head Flange of OLTC)

2.1.3 Tank Bottom (see Fig4-3)

Tank bottom is made of the aluminum alloy by the low-pressure casting with good sealing performance and free from leakage. All the gear wheels are installed on the tank bottom, so it's easy for installation and maintenance.

The coupling of tank bottom uses the crossing structure, so it's firmly strong. There are oil drain bolts on the tank bottom. A special wrench is provided for the customers to release the condensation kerosene during the vapor phase drying process if it needs.

Fig. 4-2 (Head Cover)

Current ⩾ 1000A **Current ⩽ 600A**

Fig.5

Fig 4-3 Tank bottom

2.2 Diverter Switch Insert (See Fig. 5)

Diverter switch insert has two kinds of structure according to different current. It adopts the parallel connective contacts in several points, in order to have strong carrying capacity.

2.3 Tap Selector(Fig.6)

Tap Selector is composed of step-by-step drive mechanism and contact system. Tap selector can be installed with or without change-over selector.

2.3.1 Change-over Selector

Change-over selector is classified into reverse regulation selector and coarse & fine regulation selector. It is a simple and compact device. The stationary contact of change-over selector is installed in a semi-circular insulating cylinder.

2.3.2 Tap Selector Contacts(Fig7)

The contacts of tap selector use the multi-points and shunt-wound clamp structure. They increase the effect of cooling of contacts; and improve to endure the short-circuit capability.

2.3.3 Geneva Wheel Mechanism (Fig8)

Geneva wheel mechanism of the tap changer uses solid arrangement of upper and lower Geneva wheel, and they change the alternating movement in turns. It turns by the crank mounted to the

Fig 6 Tap Selector

Fig 7 Tap Selector Contacts

Fig 8. Geneva Wheel Mechanism

tank bottom of tap changer, then the Geneva wheel alternates in turns. It takes the movable contact of tap selector to the pre-selected tapping position. Also, it has mechanism limit block parts in Geneva wheel mechanism.

3. Operation Principle

While working under maximum rated through current<=600A and the principle of double resistor transition, CMD OLTC is capable of carrying out on-load operation of changing transformer voltage regulation winding positions. Such operation shall be executed by an alternative combination of operation exchanges between moving contacts both in odd & even orders,i.e. a combination of moving contacts both in odd & even orders alternating each other and diverter switch moving back and forth. Operation sequence shall be shown as Fig 9.

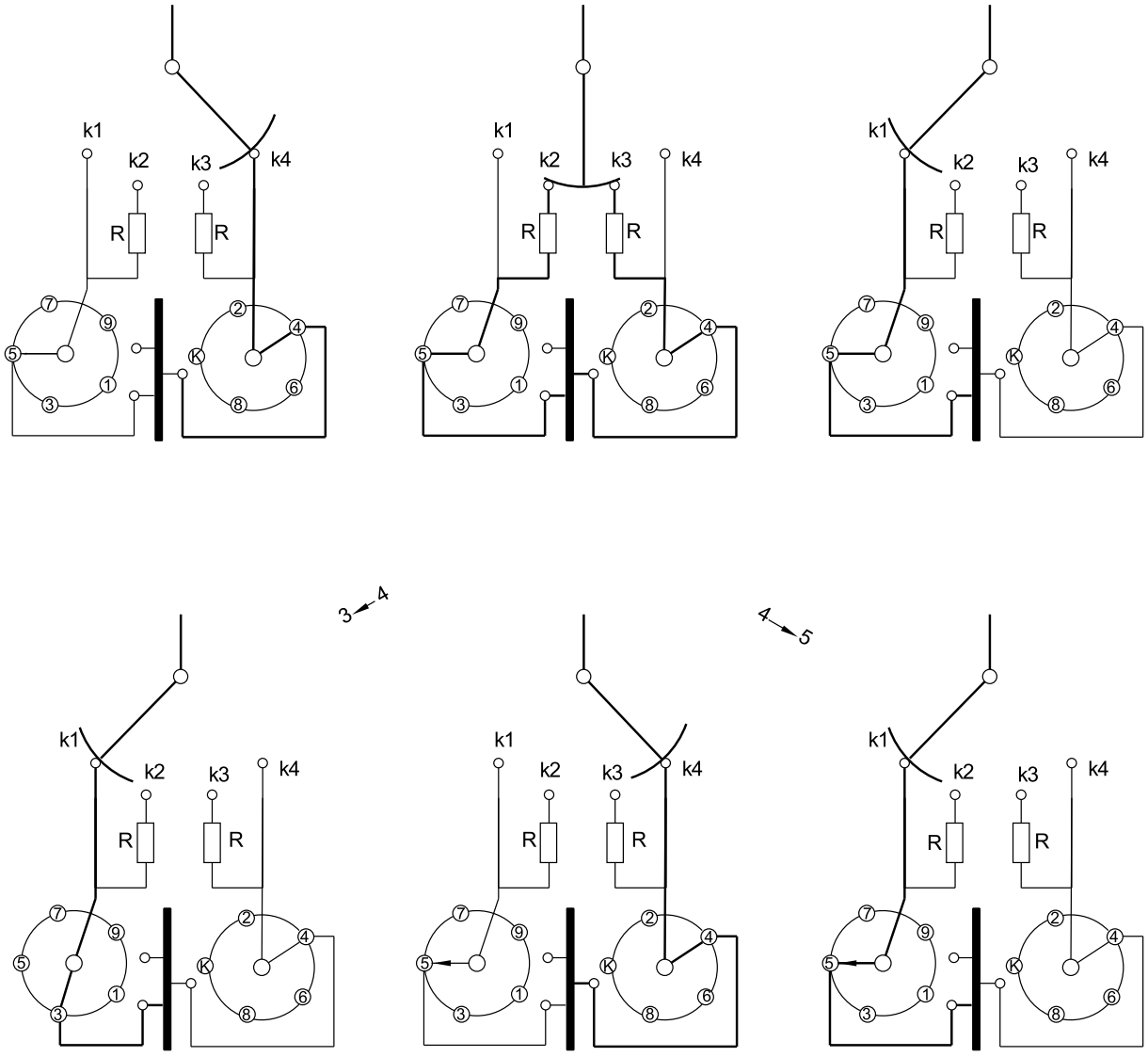


Fig 9A Switching Sequence Diagram

Maximum Rated Through Current ≥1000A; Use four resistors and double connecting transition circuit in series

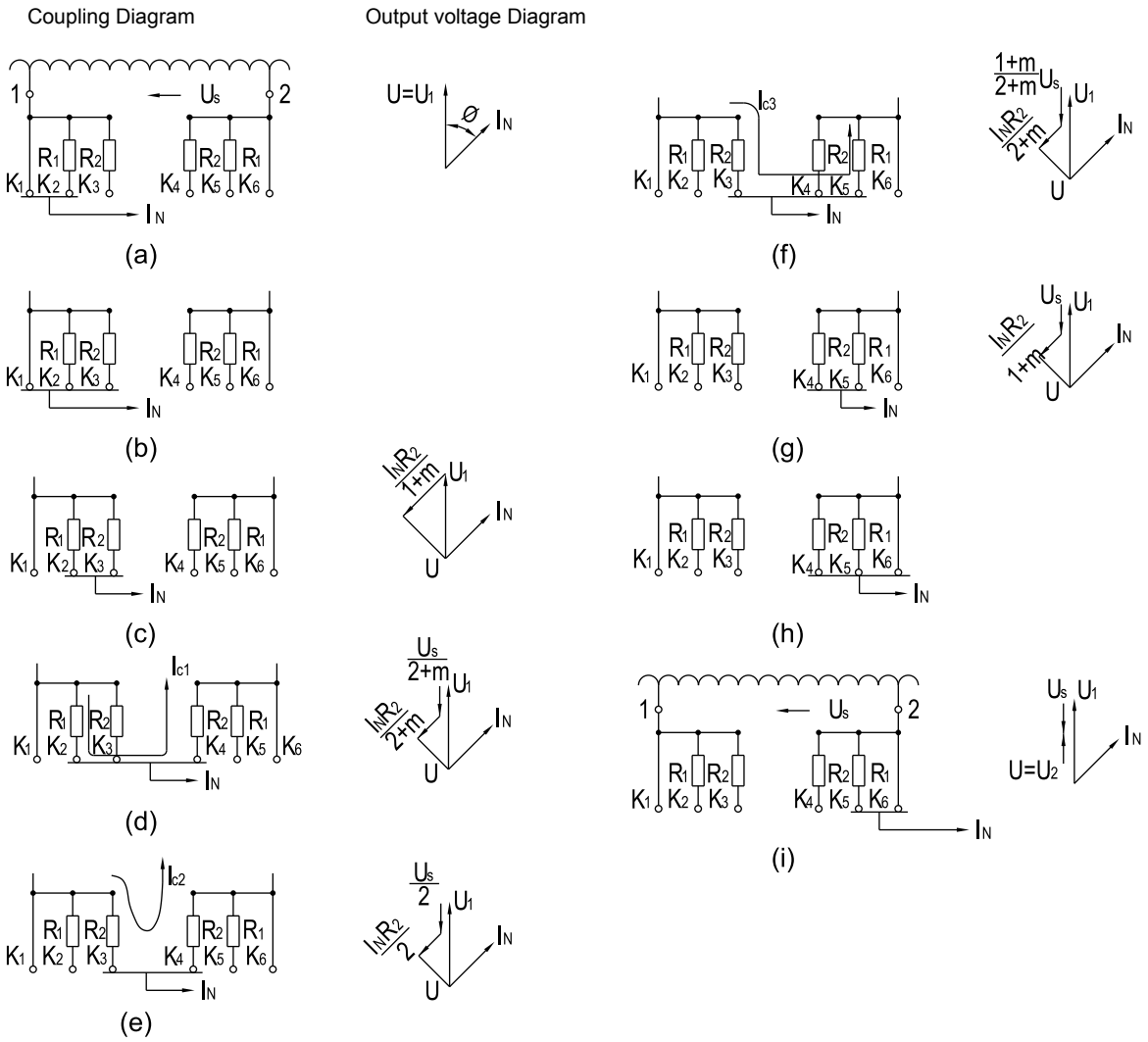


Fig 9B Switching Sequence Diagram

3.1 Mechanical operation principle

The operation of tap changing begins with the electric motor of the motor drive unit. The driving force is transmitted to the bevel gear box through vertical driving shaft, and then transmitted to reducer on the top cover of the tap changer through horizontal driving shaft. The output shaft of this mechanism drives the insulation shaft. Through turning of the main insulation shaft, it drives the operation of main driving system of tap changer. One is transmitted to the energy storage mechanism of the diverter switch (then the energy released by the energy storage mechanism will drive the diverter switch operation). The other is transmitted to Geneva wheel mechanism of tap selector.Rotation of Geneva wheel forces either odd or even moving contacts of tap selector move one position in order.

4. Installation Method of CMD On Load Tap Changer (For Bell Type)

4.1 OLTC being installed on transformer's tank cover via mounting flange

A mounting flange with Φ650mm inner diameter will be required on the tank cover together with oil resistant sealing gasket (prepared by the user). Please see Appendix Fig. D. Studs will be used with its one end threaded into the mounting flange. The stud should project at least 45mm above the mounting flange.

4.2 Procedure of installing CMD OLTC on tank cover of Bell-type transformer is listed as follows:

There is a demountable head flange for the installation of "Bell-type" OLTC, which is composed of two parts, i.e. one is temporarily fixed to supporting flange of transformer's supporting frame where insulation cylinder of oil compartment is to be installed, the other fixed to head flange of transformer tank cover. Both flanges are connected by O-type ring and fasteners.

4.2.1 Remove mounting flange from head cover

a. Let off Fixing- Position plate from bevel gear box on the head of flange and put it on the flat side of shaft and then fix it as shown as Fig 10 in order to prevent from shaft rotation in gear box as consequences of installation position change of diverter switch insert.(Please restore the position to its normal operation position after installation .)

b. Take off flange cover on the head of OLTC and Be cautious of its 0-type ring (sealing gasket) .

c. Remove M8 fixing nuts and washers that fasten the diverter switch insert unit.

d. Hoist up main body of OLTC out of transformer and leave it in a clean space. Note: No free operation after taking out.

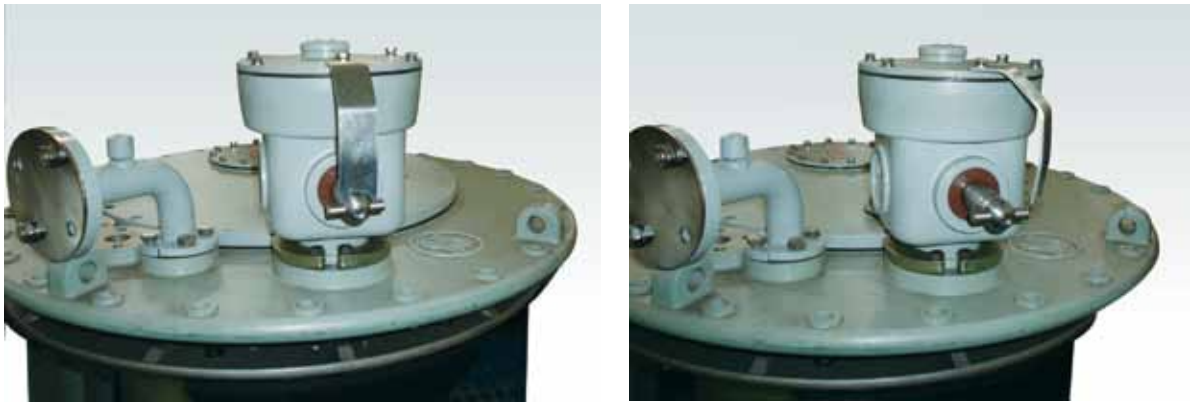


Fig 10 OLTC Head fixed position of fixing plate loosening position of fixing plate

e. Take off oil suction pipe and be cautious of o-type sealing gasket ring.

f. Unscrew the three M8 fixing nuts on the bevel gear box of the head cover. Lift the bevel gear box out upwards.

g. Loosen the bolts between supporting flange and mounting flange, and pay more attention to the triangle position mark between two flanges. Remove the mounting flange, and keep the o-ring between two flanges properly.

4.2.2 In order to ensure correct procedure of installing OLTC, pre-installation is a must

a. Contra-position pre-installation of supporting flange and mounting flange

Fix an adjustable supporting structure on transformer yoke, lift up OLTC onto the supporting structure and then install OLTC's supporting flange on the structure temporarily.

Pre-installe head flange on the mounting flange on the transformer tank cover, adjust OLTC and its supporting structure's positions in order to ensure both head mounting flange and supporting flange in a natural contra-position against each other, and the position of OLTC on the supporting structure correct.

b. Adjust assembly space between supporting flange and head flange

To adjust supporting structure by raising or lowering down installation height of supporting flange in order to ensure the assembly space within the limit of 20mm between supporting flange and installation flange.

After confirming that the pre-installation of OLTC on transformer's supporting structure is correct, transformer winding lead shall be connected with its responding selector terminal. Now pre-installation shall be carried out once more after connection. If there is no tap-position change, no deformation or impact caused by lead with inappropriate length, then both flanges as abovementioned shall be contra-positioned against each other during the period of transformer installation.

4.3 Connecting transformer voltage regulation winding lead with OLTC

4.3.1 Connection between lead and tap selector

Voltage regulation winding lead shall be connected with its responding selector terminal as shown as connection diagram supplied on delivery. In the meantime, codes marked on connection terminals on selector's insulation cylinder shall be in correspondence with codes on winding leads.

Each unit of OLTC provides M10 bolts for connecting tap selector and transformer lead. Voltage

regulation winding lead shall be directly connected with connection terminals as shown as below figuration with shield cover being installed, i.e. tightening it up by M10 bolts and nuts eventually shield cover washers shall be bent towards outside in 90. Please see as shown as Fig 11.

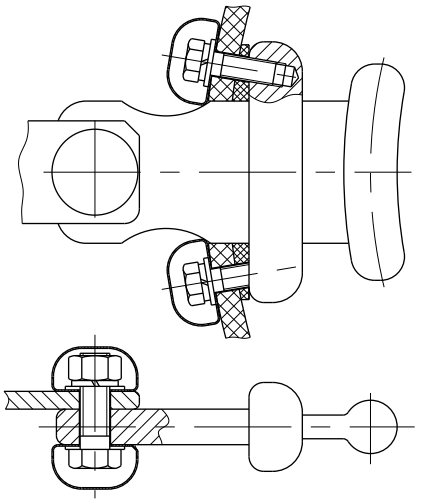


Fig 11. Illustration on how selector's terminals are fastened.

4.3.2 Matters to be noted during the lead wire connection between the tap selector and the voltage regulation winding of the transformer

a. The connecting leads of the tap selector after connecting should not cause the tap selector to deform due to tension.

The connecting leads should be connected from the two sides of tap selector, in order to avoid the distortion of tap selector due to the leads.

The connecting leads between the end clamping of tap selector's terminal and the transformer lead wire should not be too short. It should be soft and should not be coated with insulating vanish to avoid the hardening of the coated vanish after drying, which makes the tap selector to deform under tension.

The terminal wire of the tap selector should be led out from the exterior of the insulating cylinder. It doesn't allow the wire passing through the interior of the insulating cylinder.

The tap changer shall be lifted up 5~20mm after the connection of the lead wire. Therefore, special care should be given to the degree of tightness of the connecting leads. It is recommended to install the supporting flange on the

supporting structure, and then put a pad between the supporting flange and the head flange temporarily, so as to obtain the required actual assembly gap, and then the lead will be wired. After that the temporary pad will be removed, in order to keep enough length for the leads. Selector terminal lead shall be connected through insulation cylinder's exterior not interior.

b. Don't damage the connecting terminals of the tap selector during installing the leads.

4.3.3 Connection with output terminal of diverter switch

a. Output terminal of 3-phrase OLTC

I3-phrase output terminal of diverter switch inside 3-phrase OLTC have already been connected together. Thus, either of two neutral terminal leads from diverter switch's oil compartment shall be

optional and be directly clamped with 10 or 14 copper pole and be fastened with M10 bolts.

b. Output terminal of single-phrase OLTC

A single-phase tap changer is formed by parallel connection of the contacts of three-phase tap changer. On the oil compartment of the diverter switch, there is a belt type conducting ring. The leads of the take-off terminal of the tap changer are connected to the conducting ring. On this ring, there are three Φ12.5 holes. Cheese head screws pass through these holes, and connect with the leads and are locked by the shield cover together with the M10 nuts. After tightening up the nuts, the lock washer of the shield cover is pried up 90°, thus stop the nuts from loosening.

4.4 Transformer Ratio Test

Before drying the transformer, a ratio test should be carried out with alternating voltage. To operate the tap changer, insert a short pipe of Φ25mm nominal diameter into the horizontal shaft of bevel gear box on the head flange of the tap changer, and fastened them with a M8 screw. A crank handle is filled on the other end of the short pipe.

8.25 turns of the horizontal driving shaft are required for each tap changing operation. Because the tap changer is not oil immersed, the number of tap changing should be reduced to a minimum.

After the ratio test, the tap changer must be returned to the default adjustment position. This position can be determined from the adjustment position diagram supplied together with the tap changer during delivery.

4.5 Drying and Oil Fill-in

Generally the tap changer is dried together with the transformer; however, it can be dried separately through the same drying process. The purpose of drying is to ensure the insulation level of the tap changer. It should be follow the process below,

4.5.1 Vacuum drying

a. Drying in the oven room

During drying in the oven room, the tap changer's top cover must be removed. Remove the temporary plate on the suction pipe S and make sure to keep the oil pipe unobstructed.

The tap changer is put into the oven room with a temperature of about 60℃, and heated in the air under atmospheric pressure. The rate of temperature rise is 10℃/h and the maximum heating temperature is 110℃.

Pre-drying: Drying process shall be done with ventilation and the highest temperature reaching for 110 for 10 hours.

b. Drying in the transformer oil tank

When the transformer is vacuum drying in its oil tank, the top cover of the tap changer is kept tightly closed throughout the whole process. To ensure sufficient drying of the interior of the oil compartment and the diverter switch insert, a by-pass pipe supplied by our factory (see appendix drawing G) must be used to connect the oil filling flange on tap changer head to the overflow pipe flange on the transformer oil tank (see appendix drawing B for the flange position).

It adopts the vacuum dryness under the remnant pressure putting on the tap changer in maximum temperature 110℃ and no more than 10-3bar.

4.5.2 Vapor phase drying

When vapor phase drying is employed for drying the transformer and tap changer, the kerosene drain plug at the bottom of the oil compartment should be opened to drain the kerosene condensate from the oil compartment by special wrench. After the vapor phase drying, the kerosene drain plug should be closed again.

a. Drying in the oven room

In the case of oven room drying, the top cover of the tap changer must be removed. Make sure to keep the oil extraction pipe unobstructed.

Under the kerosene vapor temperature of 90 ℃ , the duration of heating is 3-4 hours. Raise the temperature of kerosene vapor at a rate of 10℃ /h. Maximum temperature is 125℃ . The time for drying basically depends upon the time required for transformer drying.

b. Drying in the transformer oil tank

If the transformer is vapor-phase dried in its tank, it should be lifted out the diverter switch insert. After the vapor phase drying, check the kerosene drain plug at the bottom of the oil compartment to make sure that it is tightly closed.

Matters to be noted after the drying process of the tap changer:

a. Do not operate the tap changer after drying without oil filling. If operation is required after drying, the oil compartment of the diverter switch shall be fully filled with transformer oil and the tap selector should be lubricated with transformer oil.

b. Check the tightness of fasteners. If any fastener is found out loosening, it must be retightened and locked against looseness.

4.5.3 Oil Fill-in

Fasten up 24 M10 bolts and make sure that O-type sealing gasket ring be in right position When

OLTC's head cover is closed again.

The operation of filling oil in both transformer and OLTC shall be carried out only if both of them are under vacuum circumstances. Fill sufficiently qualified oil in OLTC till it reaches the level of transformer head cover horizontally. Thus, accessories such as bypass pipes supplied by our factory shall be installed between OLTC's head oil fill-in flange and transformer's oil overflow flange so as to pump both OLTC and transformer into vaccum state.

4.6 The installation of pipe connection

The head flange of the tap changer is equipped with three bent pip. The orientation of these bent pip can be determined as the requirements of installation. It can loosen the thrust collar of bent pip, or bent pip freely.

4.6.1 Pipe connection of QJ4G-25 gas relay

QJ4G Buchholz relay (Gas relay) can be installed on the connection tube between the head of the tap changer and the oil conservator, and it should be as close as possible to head of the tap changer. Frequently it is connected directly to the flange of the bend pipe R. It must be installed with the arrow of the gas relay pointing to the oil conservator.

4.6.2 Oil suction pipe connection

An oil suction pipe in the oil compartment reaches the bottom of oil compartment. It is connected with oil suction pipe connection. It is used to extract the oil in the oil compartment of diverter switch during maintenance or oil changing. Therefore, it should be taken out an oil suction pipe from a oil suction pipe connection. The oil suction pipe goes through the lower part of oil compartment from the sides of tap changer, and the length of oil suction pipe must be longer and lower the bottom of the oil compartment. It is installed an oil drain valve in the lower end of the pipe.

This oil suction pipe may also be used as the oil discharge pipe with an oil filter plant.

4.6.3 Outlet of Oil fill-in Bent Pipes

This connection can be regarded as oil return pipe for oil filter plant and sealed with a dummy plug if there is no oil filter plant. It is suggested to use an outlet pipe, of which one end is fixed with an oil release valve, so that oil circulation filter be carried out through both oil suction pipes and oil fill-in pipes in oil filter plant.

4.7 Installation of Motor Drive Unit

As OLTC's position control and driving device in the operation of tap position change, motor drive unit can be operated either electrically or manually.

Matters to be noted during the installation of motor drive unit, as follows,

4.7.1 The motor drive unit must be connected to the adjustable position of tap changer, which is indicated in the tap changer connection diagram supplied with the equipment.

4.7.2 Motor drive unit shall be installed vertically on transformer tank wall without inclination.
Attention: The mounting plate of the motor drive unit should be flat, otherwise the motor drive unit will be deformed by twisting, or it will affect the tank sealing.

For the actual installation of the motor drive unit, see the operation instruction of Type SHM-1 motor drive unit.

4.8 Installation of bevel gear box

The overall and mounting dimension of the bevel gear box, see appendix diagram C.

4.8.1 The bevel gear box is to be installed to a supporting structure on the transformer cover by 2 pieces of M16 bolts.
4.8.2 Driving Shaft (square shaft)
a. Installation of horizontal driving shaft
Rotate head gear box by loosening its thrust collar(6 M8 bolts) in order to keep its horizontal driving shaft aiming at its bevel gear box's counterpart.
Install the horizontal driving shaft and tighten the fixing plate of bevel gear box.

b. Installation of vertical driving shaft
According to the dimension between the bevel gear and the vertical driving shaft of the motor drive unit, minus 9mm and determine and machine the actual size of the vertical driving shaft. After taking account of the expansion and contraction, certain gap (a total of gap about 2mm) should be reserved for the connection of vertical driving shafts.

Install the vertical driving shaft; the locking plate in the clamping brackets near the motor drive unit can only be turned up after checking the connection between the motor drive unit and tap changer.
If it has any difficulty to install the vertical driving shaft, an universal joint can be installed on the driving shaft of bevel gear box.

The length of the vertical driving shaft may exceed 2 meters. In order to avoid swaying we recommend installing a middle gear as a support for the vertical shaft. This can be specially supplied if requested during ordering.

4.9 Verification of the connection of the tap changer and motor drive unit

After connecting the tap changer with the motor drive unit, the mechanism should first be manually operated for a complete cycle and make sure the indication of the position must be identical between the motor drive unit and that tap changer before any operation by motor drive unit.

When the tap changer has been connected to the motor drive unit, the interval(or time interval) between the instant of switching of the diverter switch and the ending of operation of the motor drive unit should be the same in both direction of rotation.

In order to make sure the reliability of operation of tap changer, if vertical or horizontal shaft is disconnected from the tap changer, test has to be taken after re-connection.
The verification of connection is carried out according to the following procedure:

4.9.1 Rotate the handle in the 1 → N direction. After the diverter switch has operated (start when the sound of switch is heard), turn the handle continuously and record the number of turns until a centre mark within grey area on the indicating wheel of the motor drive unit appears the same position with the arrow. Record the number of turns as m.

4.9.2 Rotate the handle in the reverse direction N → 1 to return to its adjustment position. Record the number of turns K in the same way as mentioned above.

4.9.3 The connection will be correct if m=K. If m ≠ K and m-K>1, then turn the handle 1/2 (m-k) turns in the direction of increment of turns, and finally connect the vertical driving shaft to the motor drive unit.

4.9.4 Check the different of turns between the motor drive unit and the tap changer in the same way as mentioned above, until the same number of turns for the two direction of switching operations.

For example:
The verification of connection of Type CMD tap changer and Type SHM-I motor drive unit: Turn from position 10 (adjustment position) to position 11, m=5 turns. Turn backward from position 11 to position 10 (the original adjustment position), k=3 turns. The difference of turns of the handle m-k=5-3=2 turns.
Turn to be adjusted 1/2 (m-k) = 1/2 (5-3) = 1 turn.

Loosen the connection between the vertical driving shaft and the motor drive unit. Turn the handle in the direction 10 → 11 for one turn. Then again make connections.

Check that the difference of turns in both directions has been balanced.

a. Record number of turns m an k

b. Turn 1/2 (m-k) turns in the direction in the increment of turns during loosening of connection

c. Again make connection and verify until m-k<1.

4.10 Operational test of the tap changer

4.10.1 Mechanical operational test

Before the test of transformer with electricity, 5 complete cycles of mechanical operating test (no less than 200 operations) must be performed. There should be no damage to the tap changer and motor drive unit. The position indication of the motor drive unit, its position indication of the controller and the position indication of the tap changer should be the same. Both the mechanical and electrical limit protection should be reliable.

4.10.2 Last Oil Supplement

Oil supplement shall be done after test operation. Loosen gas-release & oil-overflow screw on suction pipe and release gas by opening gas-release & oil-overflow pin on OLTC's head cover.

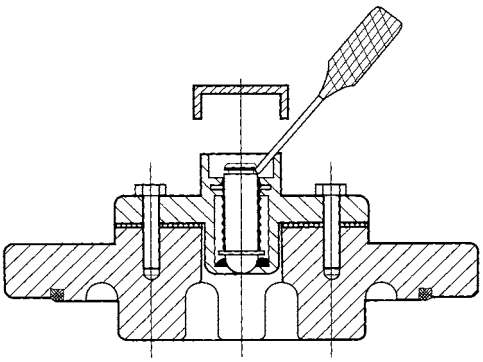


Fig. 13 Schematic diagram of oil vent on top cover when filling tap changer with oil

4.10.3 Grounding connection

The grounding screw on tap changer head should be connected to the cover of transformer tank by the conductor.

The grounding screw on motor drive unit should be connected to the cover of transformer tank by the conductor.

Grounding screws for protective relay QJ4G-25 should be connected to the cover of transformer tank cover by the conductor.

4.10.4 Transformer electrical test

After completing the above-mentioned operations, the transformer acceptance test can now be performed. The tap changer should be tested with the conservator connected.

4.10.5 The adjustment position of the tap changer

When the test is completed, the tap changer should be turned to the adjustment position.

4.11 Transportation of Transformer & OLTC together

Make sure the safety of transportation (such as adding up an additional supporting structure temporarily) before assembly of OLTC and transformer. It is unnecessary to dismantle OLTC due to its "immersed" structure. Provided that dismantlement is unavoidable due to transportation problems, the connection between vertical driving shaft & motor drive unit shall be let off so that motor driving unit can be transported on horizontal level. Installation of motor driving unit after arrival can be restored as stated as abovementioned.

If the transformer is transported or stored without the conservator, then the bypass pipe (see the appendix drawing F) supplied as a spare part can be installed between the oil filling flange of the tap changer and the overflow pipe flange of the transformer.

When transformer is under transportation or storage without oil being filled-in, then oil in diverter switch's compartment shall be dispelled from completely. In the meantime, bypass pipe must be installed so that both diverter switch's compartment and transformer's oil tank be borne with same pressure. (nitrogen sealing)

In order to avoid damaging the tap changer caused by the shifting of moving parts, they must be temporarily secured.

Note: Bypass pipes must be dismantled before transformer is installed and put into operation on site.

4.12 Put into operation on site

Before putting into operation of the transformer, the operating test of the tap changer and motor drive unit must be done according to section 4.9. In the same time, check the proper function of the Buchholz relay.

The Buchholz relay should be connected to the tripping circuit of the line circuit breaker, in case the Buchholz relay is energized, it will instantly cut off the transformer circuit. “Transformer Off’ test button on the top of the Buchholz relay can be used to test the function of the line circuit breaker.
Check whether all the valves between the oil conservator and the tap changer open or not, then put the tap changer into operation. In the meantime, exchange gas accumulated under OLTC's head cover may cause certain amount of oil outlet. Make sure everything is ok with OLTC before putting it into operation.

5. Operation Supervision

Periodically examining oil pollution level in oil compartment of diverter switch is an effective

measure of monitoring OLTC's operation.

5.1 For periodic examination of the oil in the insulating cylinder of the diverter switch, we recommend carrying out oil sampling test after one-year operations under rated current to ascertain that the dielectric strength is not less than 30kV, the water content is not over 40PPm. For single phase OLTC, the dielectric strength is not less than 40kV, the water content is not more than 30PPm.

5.2 Frequent operation of OLTC causes an impact on contact's endurance. Thus, "Overcurrent self-locking device" shall be installed for automatically stopping operation provided that onload current exceeds 2 times of max.rated through current.

5.3 the tripping contact of the QJ4G-25 protective relay is set to operate at an oil speed of 1.0m/s ±10% or 1.2m/s ± 10%. This contact should be connected the tripping circuit of the transformer circuit breaker. In case a failure occurs within the on load tap changer, then large amount of gas will generate, causing a rush of oil flow to move the relay flapper, which breaks the tripping contacts, it must cut off the electricity of the transformer to avoid overspreading of the damage. Once the protective relay relay operated, don't re-energize the transformer before the inspection by lifting the diverter switch insert.

5.4 An rupture disk is installed on the top cover of the tap changer which should not be damaged during normal tap changing operation of the diverter switch. Only when a failure is generated within the diverter switch, then the disk bursts when the pressure in the oil compartment exceeds 30±20%KPa, thus it functions as an overpressure protection to avoid overspreading of the damage. During the installation and maintenance of on load tap changer, please pay more attention that don't step on or put heavy things on the pressure cover.

6. Whole Set Supply Range

6.1 Range of a whole set of OLTC Supply

a. Tap changer unit

b. Buchholz relay

c. Driving shaft and bevel gear box

d. Motor Drive Unit

e. Accessories

Check the contents according to the packing list. Place the tap changer equipment in a well-ventilated warehouse with relative humidity of less than 85% and temperature between -25℃ and +40℃ . There should be no corrosive gas and it will not affect by the rain or snow.

7. Maintenance and Repair

7.1 Periodical Maintenance

The transformer oil in the oil compartment of diverter switch will become carbonized after many times of switching, so it is recommended that periodic oil sampling should be done according to Section 5.1 for laboratory test. The oil shall be replaced when its dielectric strength is less than 30kV and the water content is over 40PPm.

During the oil changing, the dirty oil is completely extracted from the oil compartment, then the insulating cylinder and the diverter switch are flushed with clean oil. This oil is again completely extracted. Finally fill with clean oil again.

If the tap changing operation exceeds 15,000 operations annually, it is recommended to install a fixed oil filter plant to the tap changer.

The oil conservator and the breather for this on load tap changer are maintained usually the same as those of the transformer.

7.2 Periodical Inspection & Repair

During the period of long-time operation, only diverter switch need be periodically inspected and/or repaired. Please refer to Timetable of Inspection & Repair for details.

To enhance OLTC's reliability, the operation of inspection & repair shall be carried out once every five years (or even once every seven years if it is equipped with online filter instrument). However, such operation shall also be carried out even if OLTC's operation in practice fail in reaching standard as shown on Timetable 3.

Table 3 The time interval of the inspection for type CMD OLTC

Type No. of OLTC	CMD III	CMD I		
Rated Current (A)	400/600/1000	400/600	1000	2400
Number of Operation	50000	70000	50000	35000

For the on load tap changer that the voltage class ≥245kV（for the autotransformer or line end voltage regulation transformer）, after operated for 15000 operations or 2 years since installed, it should be examined. The inspection may be carried out every 3 year afterwards.

The inspection items include lifting out the diverter switch insert, cleaning the entire switch and insulating cylinder properly, measuring contact erosion, checking and re-tightening all the insulator and energy storage mechanism. Small capacity lifting equipment may be used to lift out the diverter switch insert. During the repair, the time of air exposure of diverter switch insert shall not exceed 10 hours or it shall be dried as specified in section 4.5.

7.3 Diverter Switch Insert Take-out

All the terminals (primary and secondary) shall be grounded after the transformer is disconnected from the networks. The diverter switch insert can be drawn out at any operating position. However, we recommend that the diverter switch insert be drawn out at its adjustment position. (See Appendix Working Position's Layout).

7.3.1 Close all the valves on the oil conservator, transformer oil tank and the head of tap changer.

7.3.2 Open the valve on the oil draining pipe. Lower the oil level of the tap changer head until it is flush with the surface of the transformer tank cover. Loosen the gas vent and oil overflow screw.

7.3.3 Loosen the connection bolts of the head cover. Remove the cover; Be Cautious of sealing gasket.

7.3.4 Dismantle the bolt and washer of tightening diverter switch insert.

7.3.5 Carefully lift up the diverter switch insert; And do not touch oil suction pipe.

7.4 Cleaning

7.4.1 Cleaning oil compartment of diverter switch

Thoroughly drained the dirty oil from the oil compartment of diverter switch and flush it with qualified transformer oil. If necessary, brush away the carbon deposits stuck to the inner wall of the insulating cylinder. Then again flush it with new oil, drain away all the dirty oil. After cleaning, tightly close the top cover of the diverter switch.

7.4.2 After taking out diverter switch insert, it can be washed with qualified transformer oil and be brushed if necessary.

7.5 Preliminary examination of the diverter switch insert

7.5.1 Check whether all the fasteners and screws are loosen or not.

7.5.2 Check whether the main spring, reset spring and jaw plate of the energy storage mechanism are deformed or broken. Check the damping device of the energy storage mechanism.

7.5.3 Check whether the braided wire connection of each contact is damaged or not.

7.5.4 Inspect moving contacts & stationary contacts' burning and/or damage degree.

7.5.5 Check whether the flat wire of the transition resistor break or not. Measure and compare the value of transition resistor and the value on the nameplate (The resistor value should be measured at the open side of the transition contact.). It shall be within the tolerance of ±10% rated value.

7.5.6 Measure the contact resistance of the odd and even number contacts of each phase to the output terminal.

7.5.7 Mensurate the switching sequence of movable contact (for double-resistor transition diverter switch, electric current≤600A)

If the burning is over 3mm for any contact in arcing contact of diverter switch, it must replace the all arc contact.
1.Check the braided contact lead connecting with main and arc contact and transition contact.

2.Check whether M6 x 18 bolts connecting with main and arc contact loosen or not.
After 100,000 operations of the tap changer, all braided contact lead have to be replaced even they are not damaged.

3.Check the switching sequence of diverter switch.

The switching time of diverter switch (direct current oscillogram) is 35~50ms. The bridging connecting time of transition contact is 2~7ms。See Fig 14.

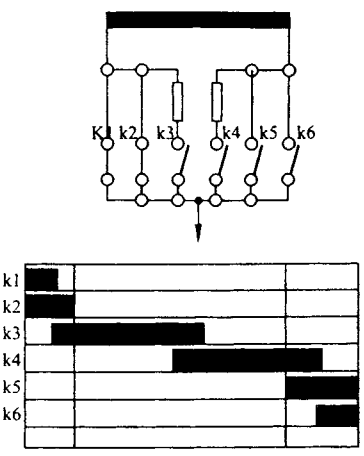


Fig 14 The switching sequence of the diverter switch contacts

7.5.8 Mensurate the switching sequence of movable contact (for four-resistor transition diverter switch, electric current ＞ 600A)

If the burning is over the data in attached Fig N for any contact in arcing contact of diverter switch, it must replace all arc contacts.

1.Check whether the M6 bolts connecting with arc contact loosen or not.

2.Check the switching sequence of diverter switch.
The switching time of diverter switch (DC oscillogram) is 45~55ms. The bridging connecting time of transition contact t2 is 10ms. Time of t4 and t5 is about 1~2ms. See Fig. 15.

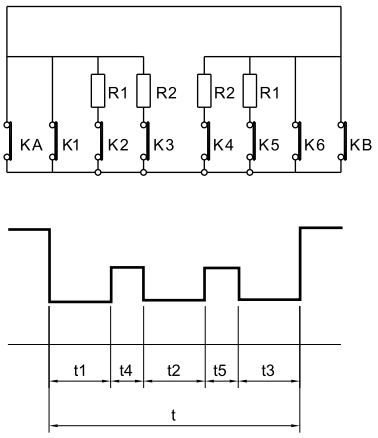


Fig 15. The switching sequence of diverter switch contacts (Current >600A)

7.6 installation of diverter switch insert

After diverter switch insert have been testified, cautiously lift it up into oil compartment, fasten head bolts, install cover and put sealing gaskets into accurate positions. Especially pay attention to the position of eccentric wheels on energy storage mechanism.

7.7 Oil Fill-in

Before closing the head cover, it should fill with qualified transformer oil to the level of supporting plate of diverter switch insert. Then close the head cover and fasten the fixing bolts of head cover. Then open the valve between gas relay and conservator tank to fill the oil. Filling the oil into the oil compartment slowly and exhaust the air through bleeder valve of the head cover.
The conservator shall be replenished with new oil up to its original oil level and open all the valves of the conservator and transformer oil tank.

7.8 Check before operation

7.8.1 Connect all the grounding screws on the head cover.

7.8.2 Check Buchholz relay's tripping function by pressing trip-testing button. Once tranformer's circuit breaker trips, the transformer can be put into operation again by pressing position-restoration button.

7.8.3 Since horizontal & vertical shaft doesn't have to be dismantled while repairing, normal maintenance doesn't require of position checking. Otherwise, after having dismantled horizontal shaft, the operation of position checking is a must.

Check if the position indicator of the tap changer and that of the motor drive unit are identical. If they are in the same positiion, please connect the tap changer to the driving shaft of the motor drive unit and conduct connection check according to section 4.8.

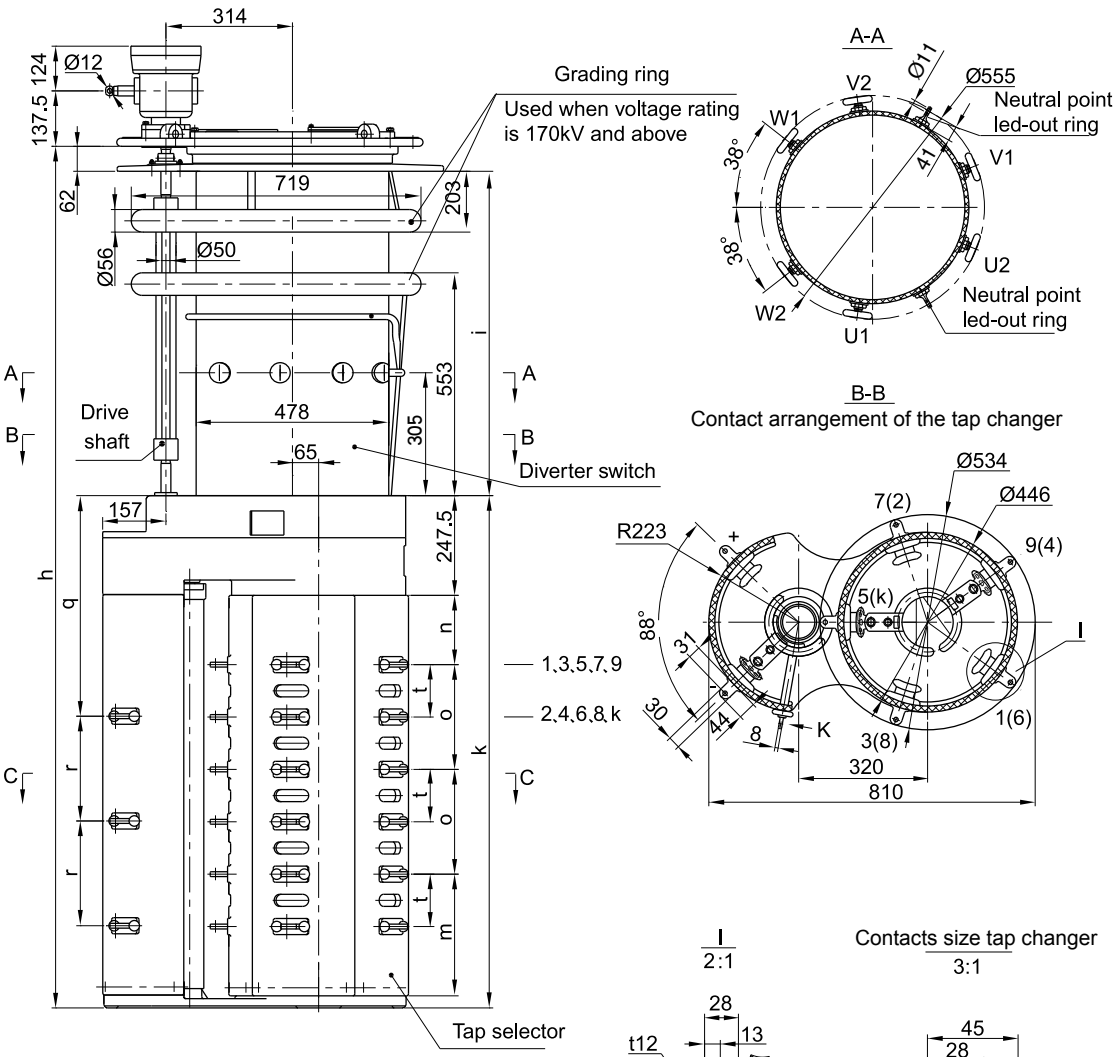
7.8.4 Mechanical operating test of on load tap changer
Ten cycles of motor-drive operations should be conducted, the result of which shall show no

malfunctioning.

After having verified all the inspection, OLTC can be put into normal operation ever since then. The inspection of the tap selector will only be performed along with the overhaul of the transformer. No separate inspection is required.

8. Appendix

Appendix Fig. A-1 Dimension of Type CMD OLTC (Current≤600A)

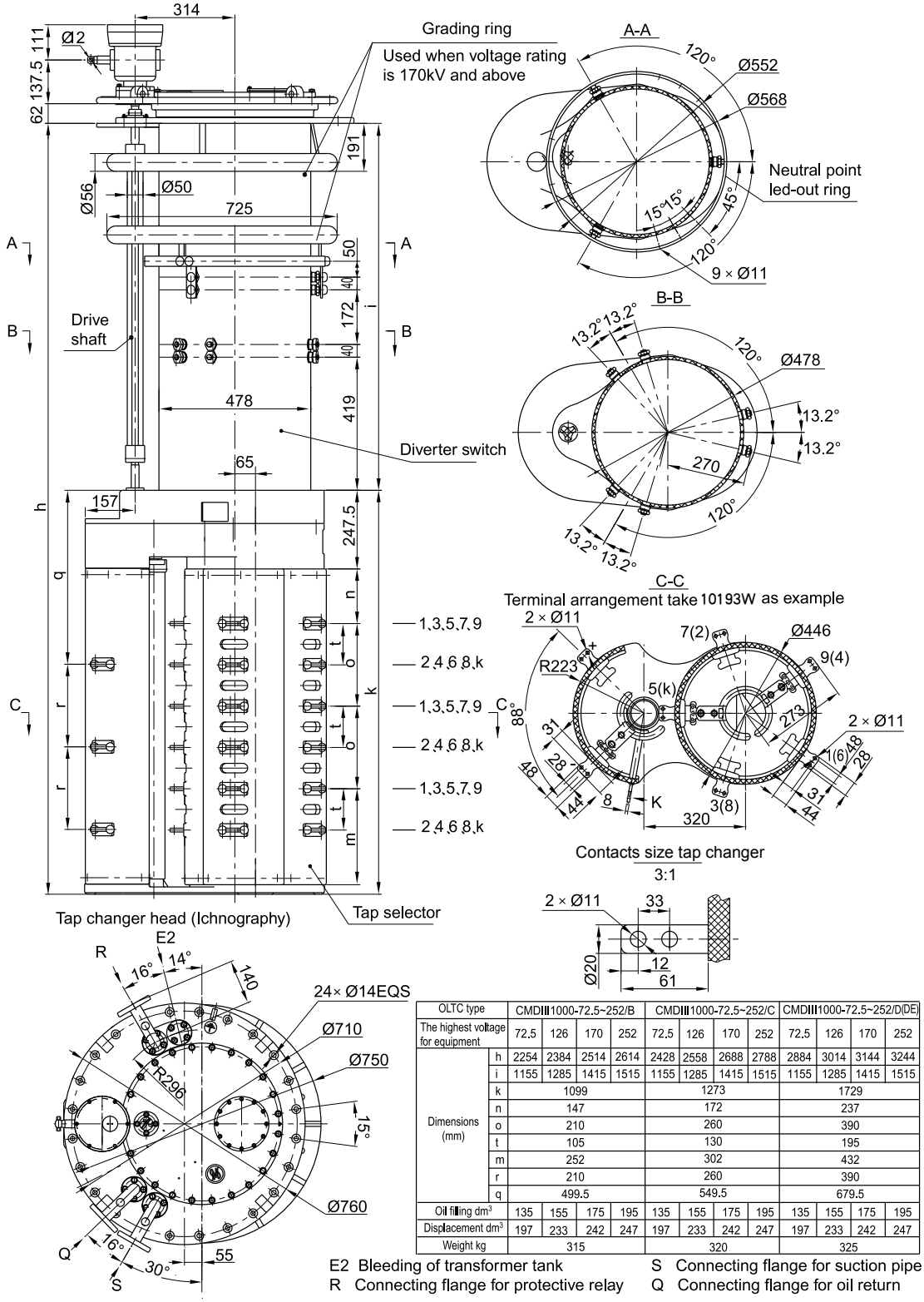


OLTC type		CMDIII400/600-72.5 ~252/B				CMDIII400/600-72.5~252/C				CMDIII400/600-72.5~252/D(DE)			
The highest voltage for equipment		72.5	126	170	252	72.5	126	170	252	72.5	126	170	252
Dimensions (mm)	h	1966	2096	2226	2326	2140	2270	2400	2500	2596	2726	2856	2956
	i	805	935	1065	1165	805	935	1065	1165	805	935	1065	1165
	k	1099				1273				1729			
	n	147				172				237			
	o	210				260				390			
	t	105				130				195			
	m	252				302				432			
	r	210				260				390			
	q	499.5				549.5				679.5			
Oil filling dm^3		130	150	170	190	130	150	170	190	130	150	170	190
Displacement dm^3		200	225	245	160	200	235	255	270	215	240	260	275
Weight kg		300				305				310			

E2 Bleeding of transformer tank
R Connecting flange for protective relay
S Connecting flange for suction pipe
Q Connecting flange for oil return

Unit:mm

Appendix Fig. A-2 Dimension of Type CMD OLTC (Current>1000A)

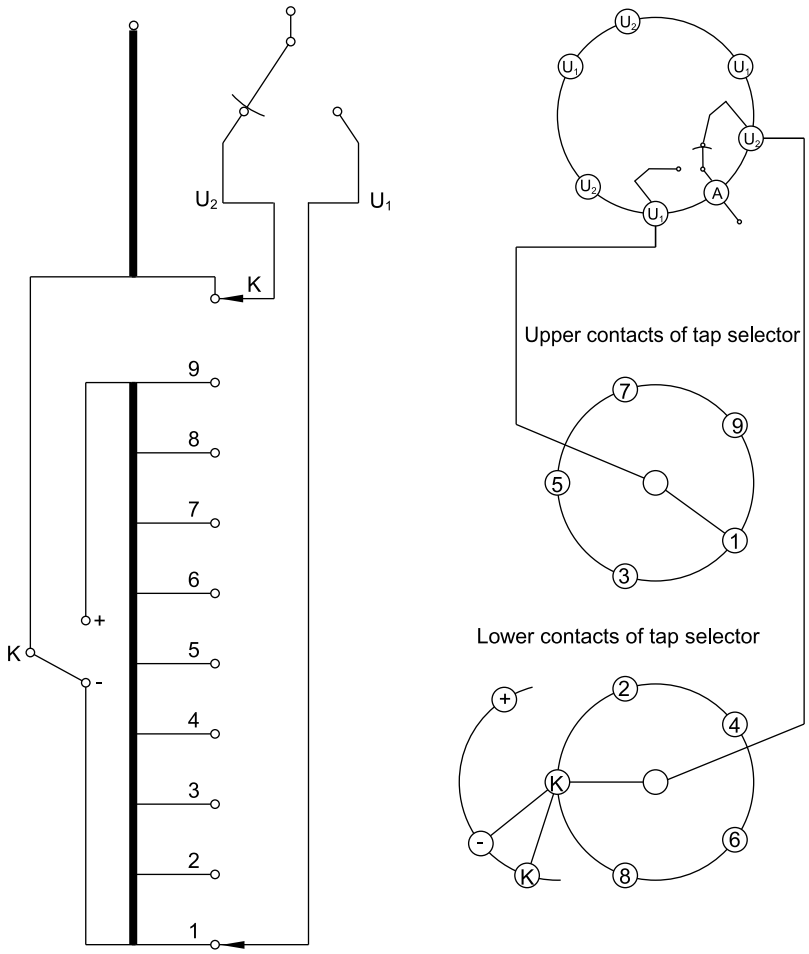


OLTC type		CMDIII1000-72.5~252/B				CMDIII1000-72.5~252/C				CMDIII1000-72.5~252/D(DE)			
The highest voltage for equipment		72.5	126	170	252	72.5	126	170	252	72.5	126	170	252
Dimensions (mm)	h	2254	2384	2514	2614	2428	2558	2688	2788	2884	3014	3144	3244
	i	1155	1285	1415	1515	1155	1285	1415	1515	1155	1285	1415	1515
	k	1099				1273				1729			
	n	147				172				237			
	o	210				260				390			
	t	105				130				195			
	m	252				302				432			
	r	210				260				390			
	q	499.5				549.5				679.5			
Oil filling dm^3		135	155	175	195	135	155	175	195	135	155	175	195
Displacement dm^3		197	233	242	247	197	233	242	247	197	233	242	247
Weight kg		315				320				325			

E2 Bleeding of transformer tank
R Connecting flange for protective relay
S Connecting flange for suction pipe
Q Connecting flange for oil return

Unit:mm

Appendix Fig. B The connection diagram and operating position of Type CMD OLTC (e.g. 10193W)



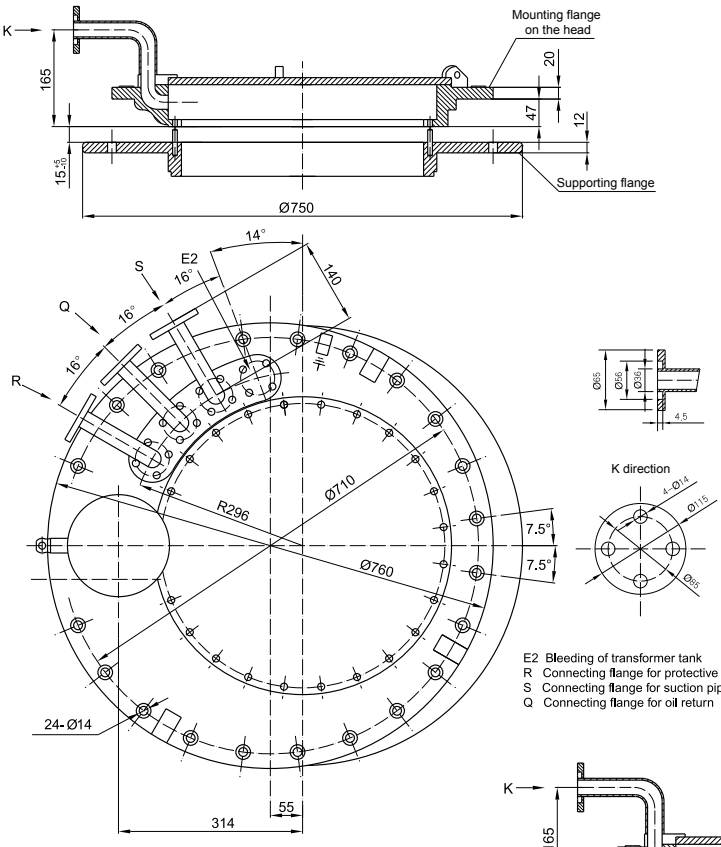
Operation position number	19
Different voltage number	17
Set position●	9b

Change-over selector	K+									K-								
Tap selector contact position	1	2	3	4	5	6	7	8	9	K	1	2	3	4	5	6	7	8	9
Display position	1	2	3	4	5	6	7	8	9a	9b	9c	10	11	12	13	14	15	16	17

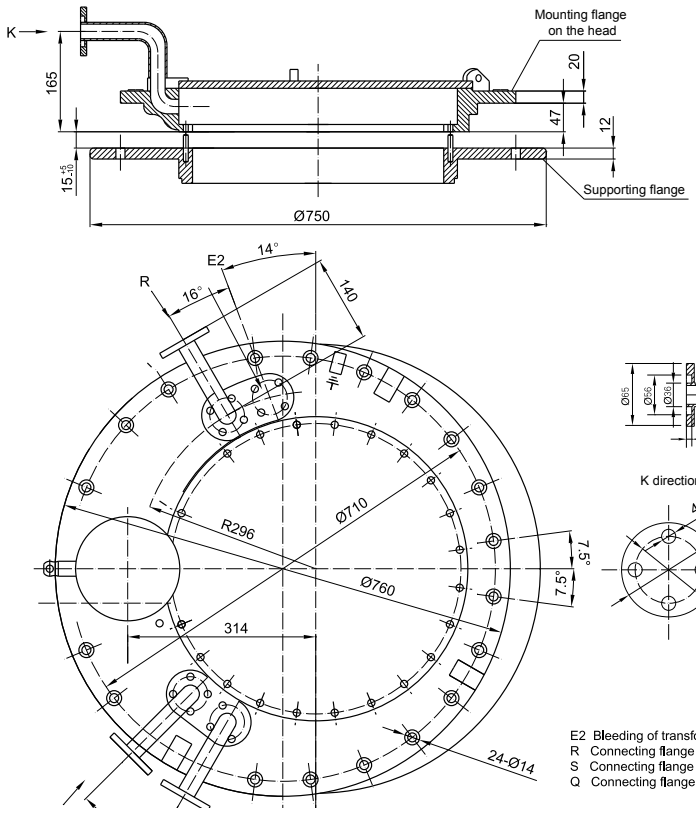
(The transformer manufacturer shall connect the leads between 9 and ＋; 1 and －)

● Drawing is shown at the set position

Appendix Fig. C Overall dimension of mounting flange of Type CMD OLTC for bell type transformer

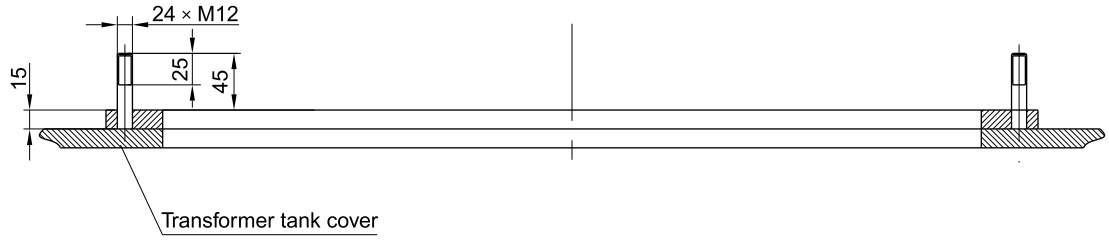


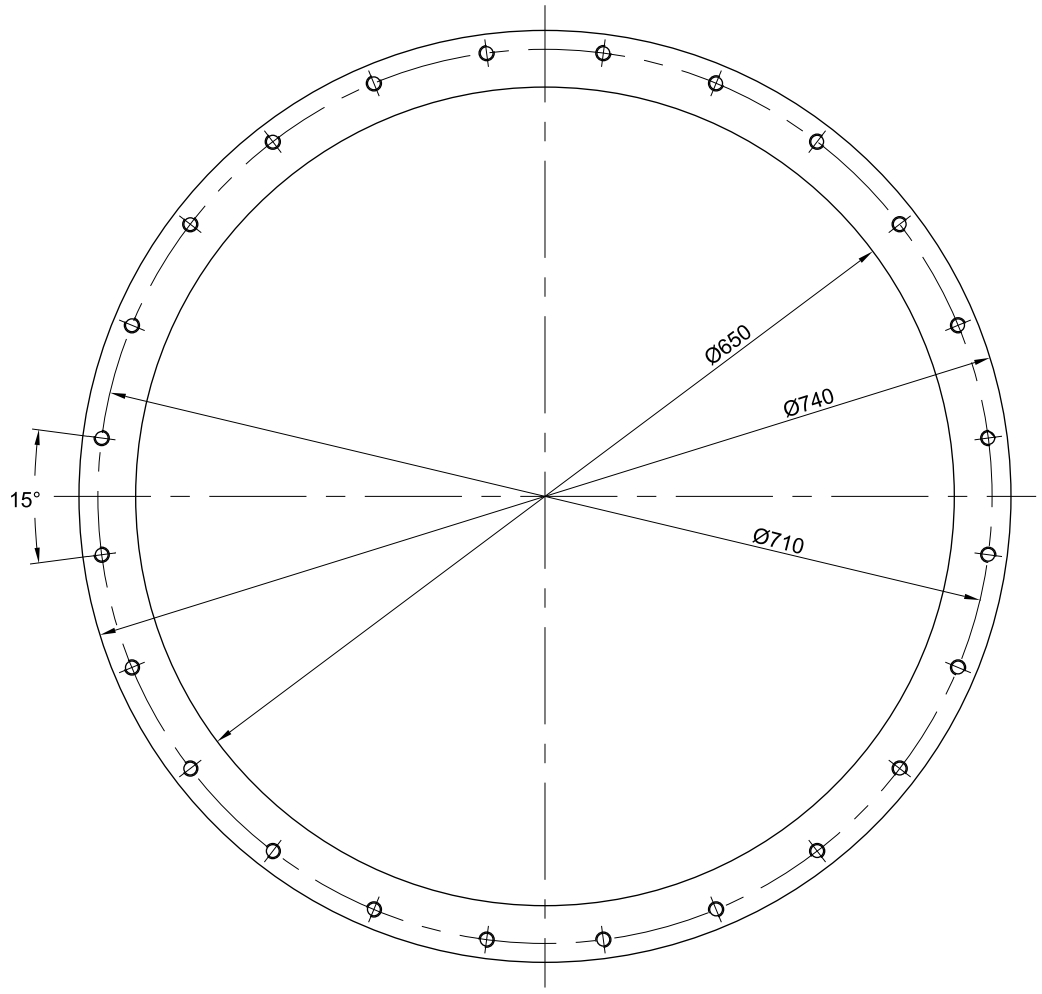
(Standard Design)



(Fixing in Left and right side;
For the product of 1000A)

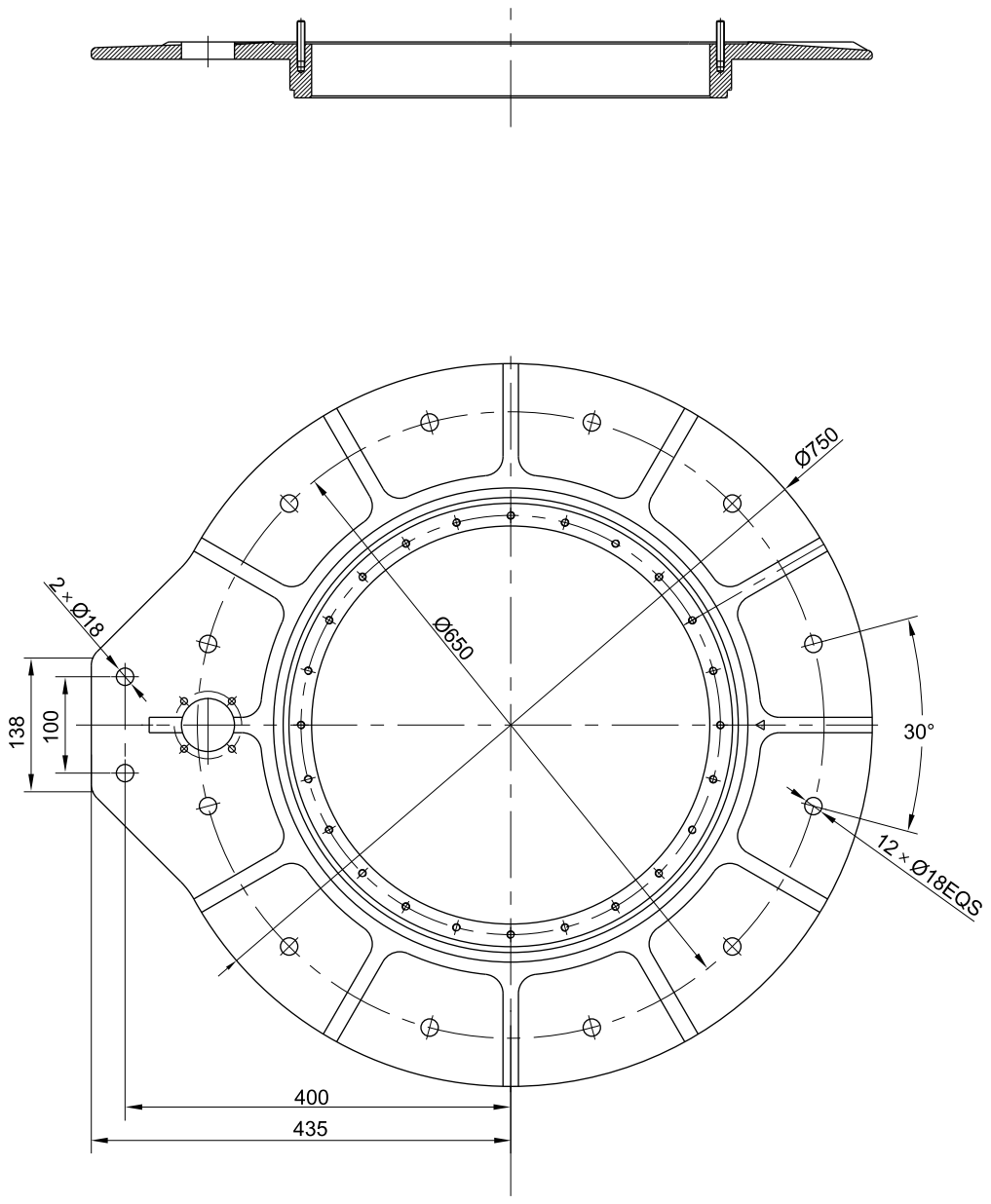
Appendix Fig. D Overall dimension of mounting flange of tap changer





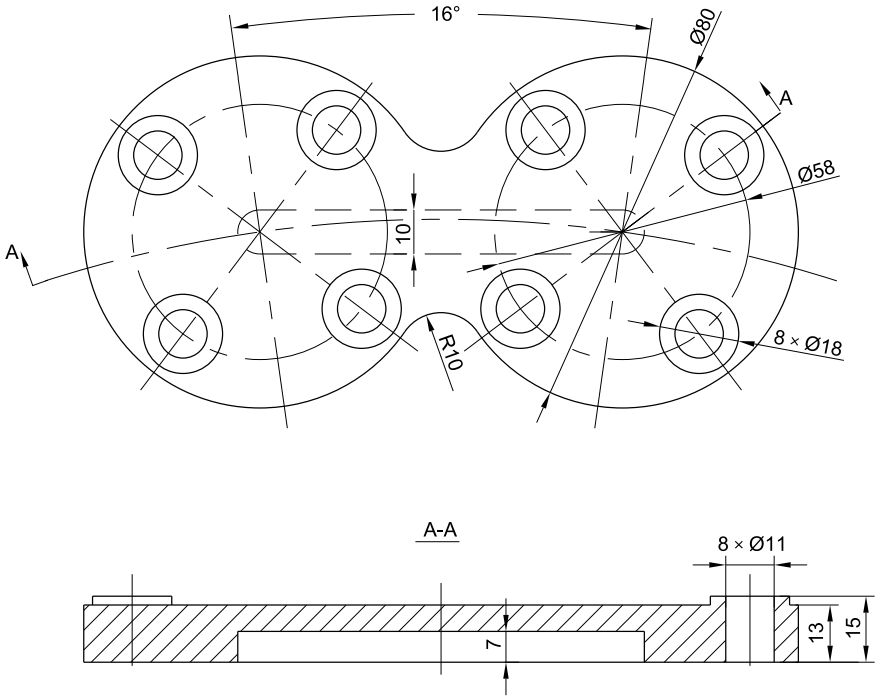
Unit:mm

Appendix Fig. E Dimension of supporting flange of CMD OLTC for bell type

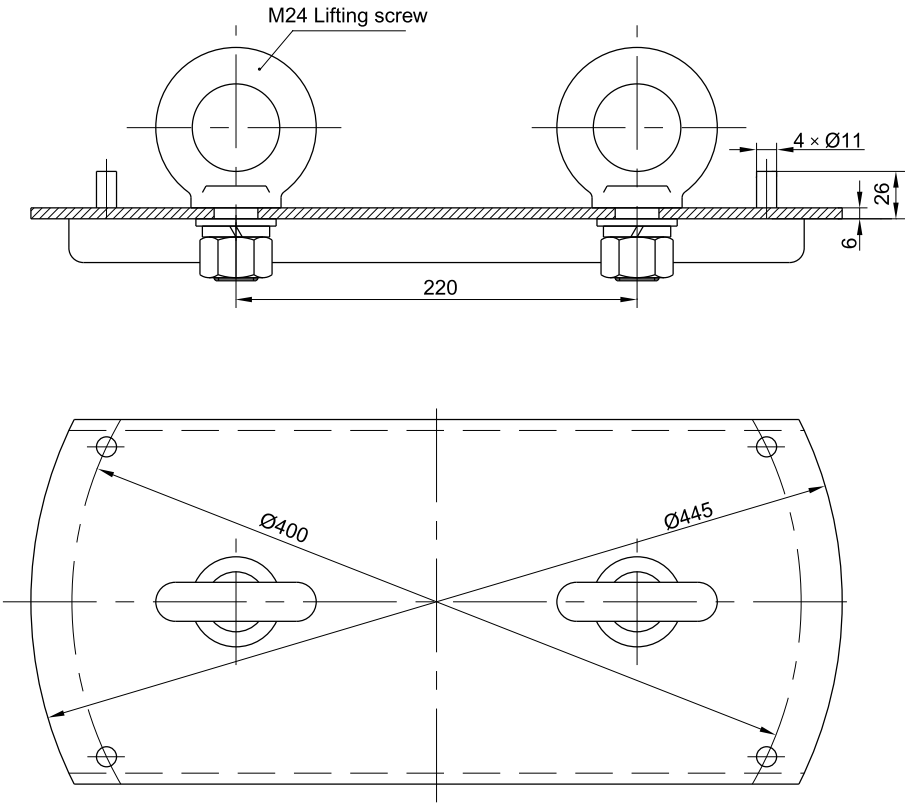


Unit:mm

Appendix Fig F Bypass pipe structure

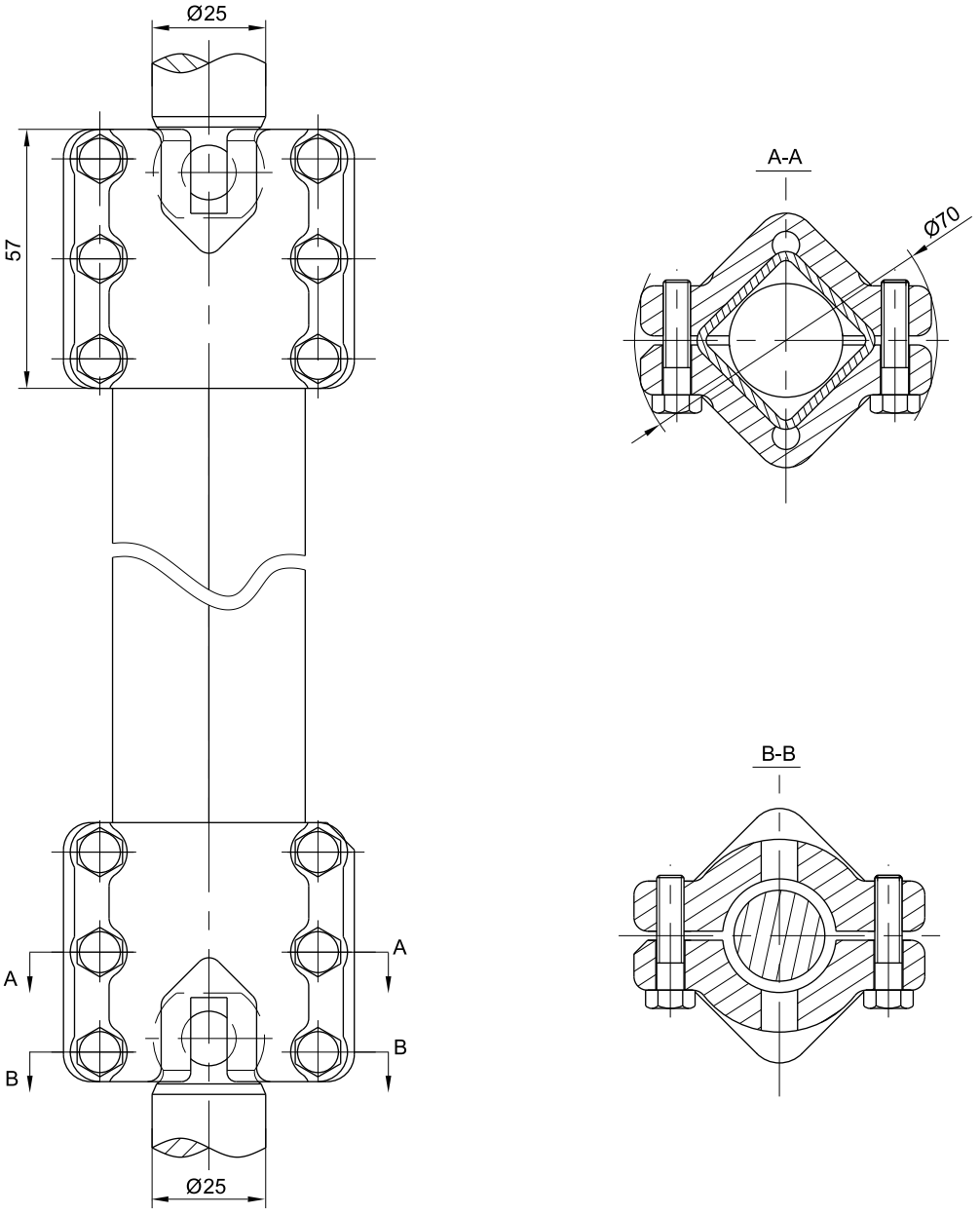


Appendix Fig. G Dimension drawing of lifting plate for bell type



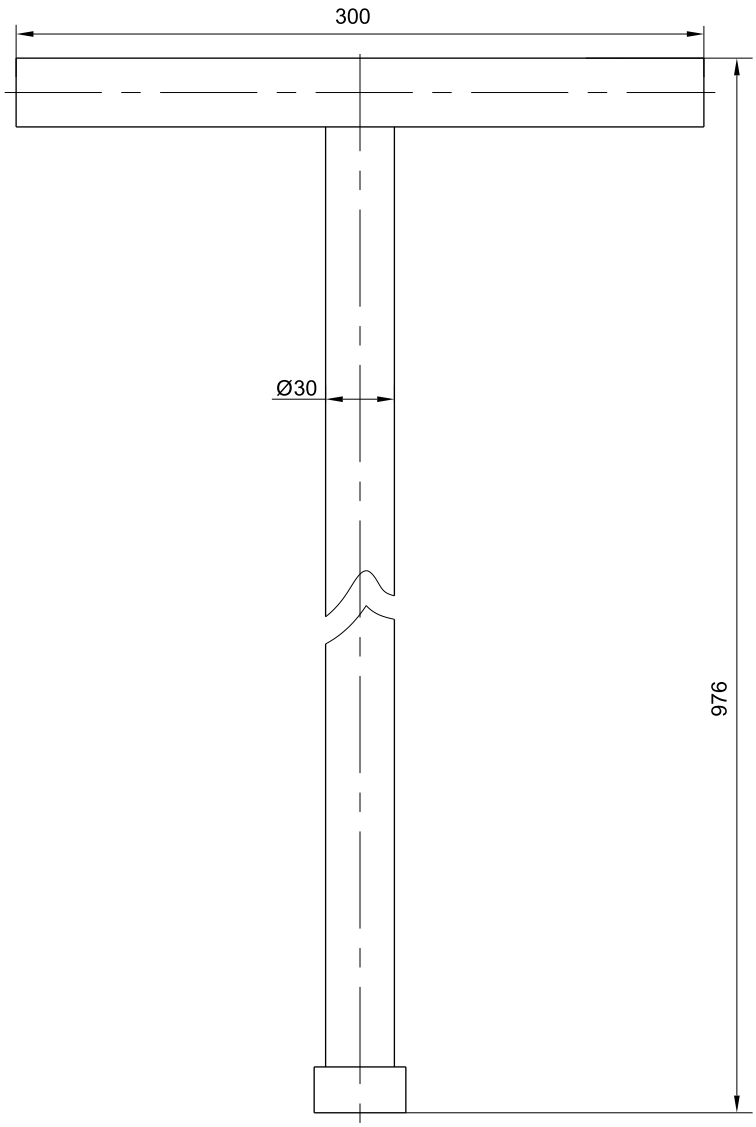
Unit:mm

Appendix Fig. H Overall mounting schematic drawing of horizontal and vertical driving shafts



Unit:mm

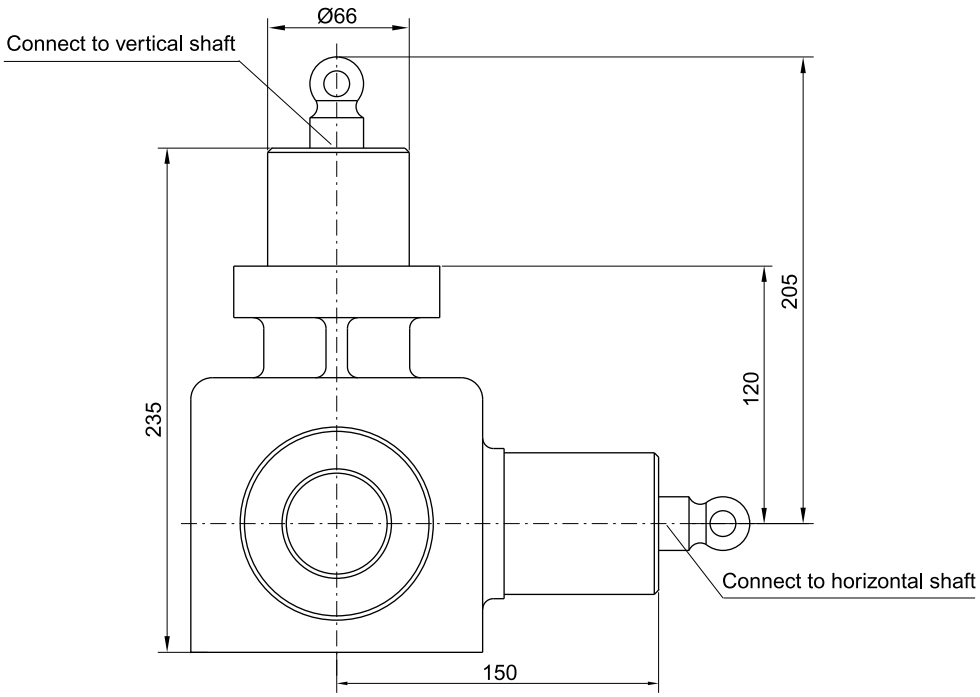
Appendix Fig. I Socket wrench for kerosene draining valve (retractable)

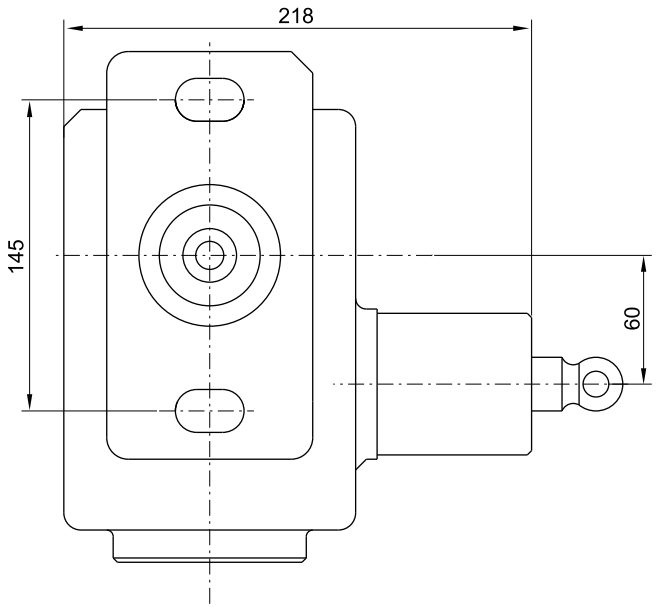


If shortened, it can be used to operate the diverter switch. If extended, it can be used to operate to drain valve

Unit:mm

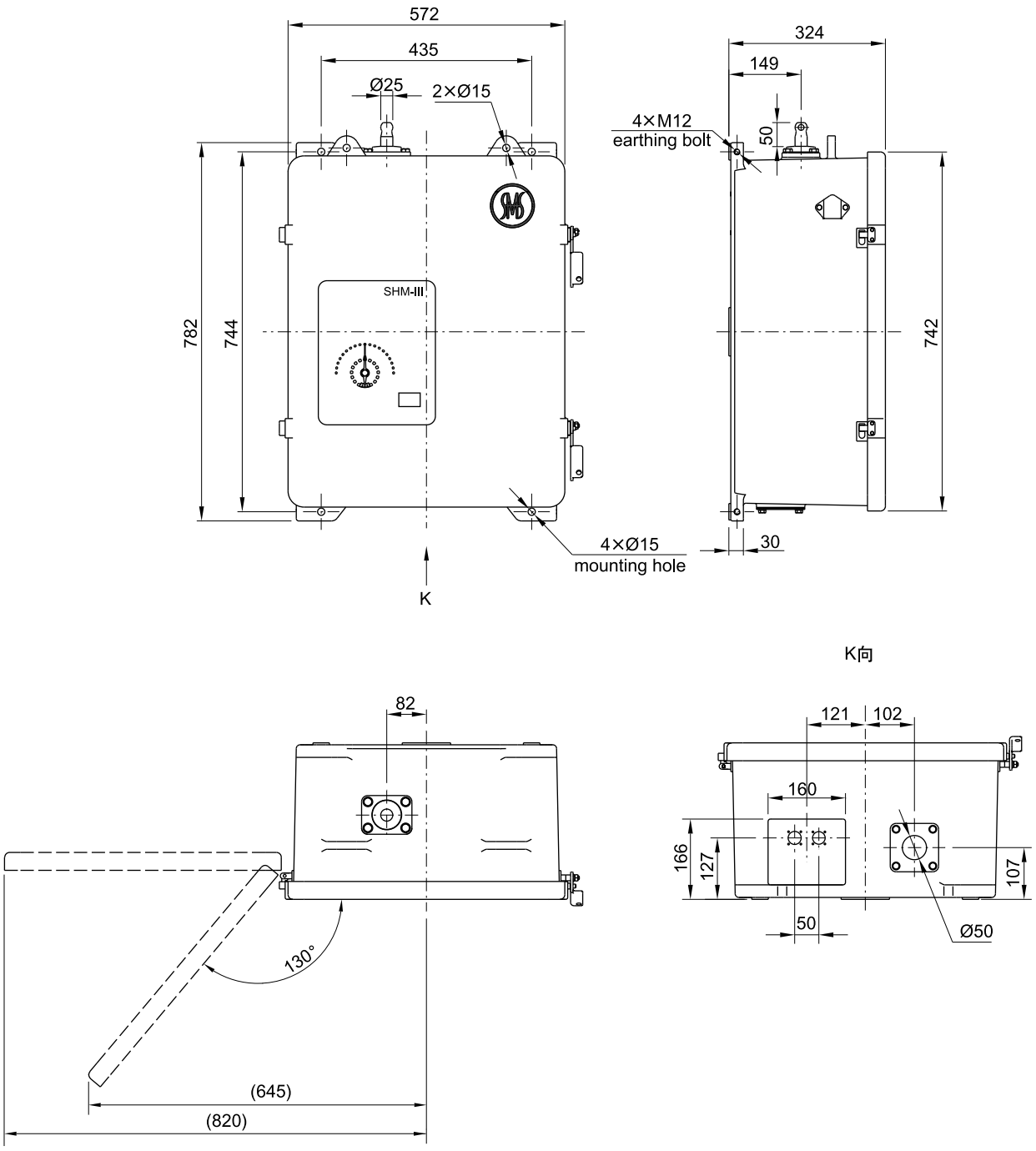
Appendix Fig. J Dimension of Bevel Gear Box





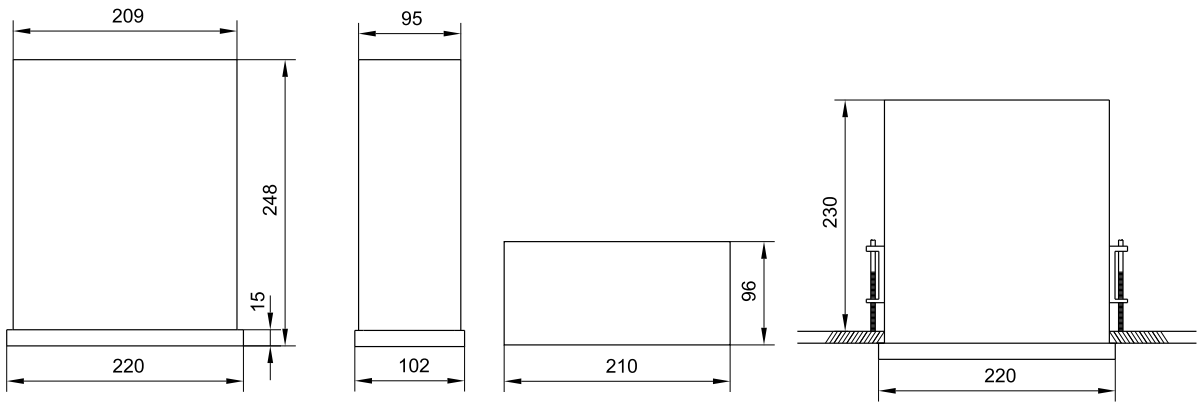
Unit:mm

Appendix Fig. K Overall dimension of Type SHM-III motor drive unit
Dimension drawing of HMK8 Controller

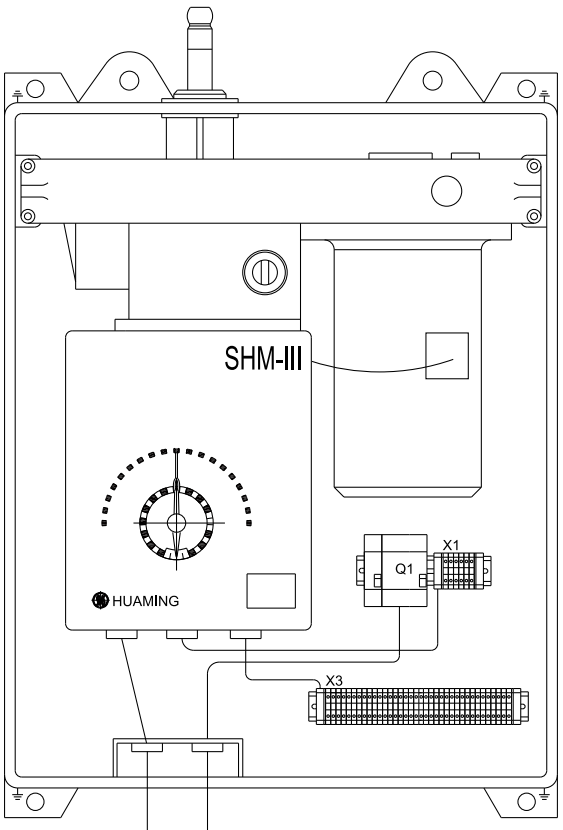


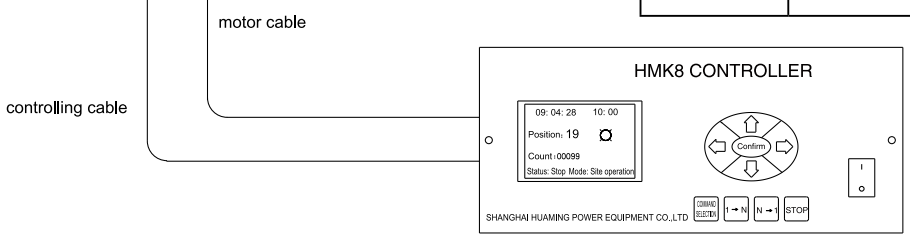
Unit:mm

Schematic Drawing of outside connecting leads for SHM motor drive unit and HMK8 Controller



Appendix Fig .L





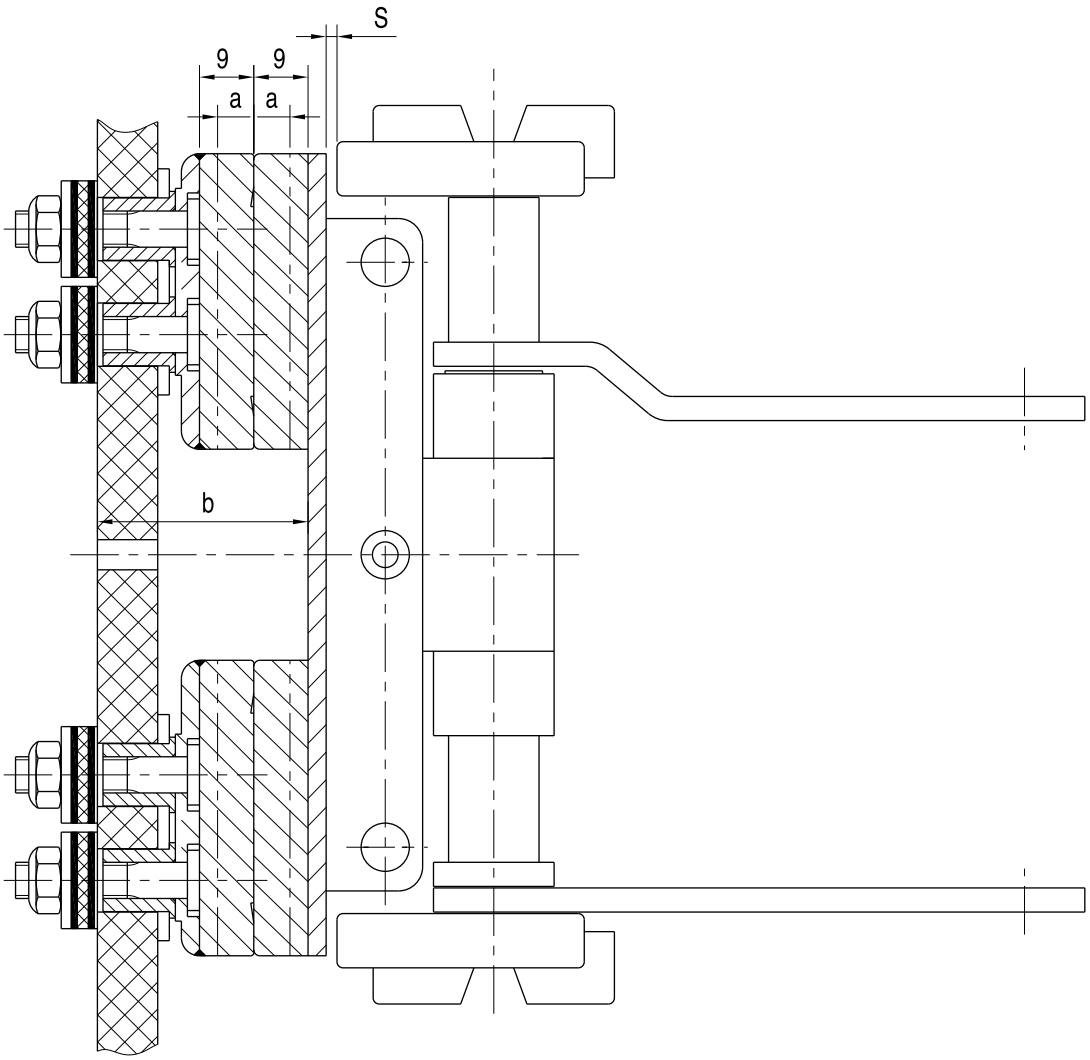
X1 Terminal designation

X1 socket No.	Designation
X1-1	L1
X1-2	L2
X1-3	L3
X1-4	L2
X1-5	N
X1-6	N

X3 terminals designation : One-to-one corresponding signal output

X3 socket No.	Designation	
X3-1	Tap position signal No. “1”	
X3-2	Tap position signal No. “2”	
X3-3	Tap position signal No. “3”	
X3-4	Tap position signal No. “4”	
X3-5	Tap position signal No. “5”	
X3-6	Tap position signal No. “6”	
X3-7	Tap position signal No. “7”	
….	….	
…..	….	
…..	….	
X3-34	Tap position signal No. “34”	
X3-35	Tap position signal No. “35”	
…..	….	
X3-40,41	In-progress operation signal output terminals connecting to CX3-1 in tap changer oil filter	
X3-42	Tap position signal common terminal	
X3-43,44 X3-45,46	Q1-13,Q1-14 Q1-21,Q1-22	Q1:circuit breaker (with auxiliary contact) contact capacity: DC220V/1A

Appendix M Measure Drawing of Contact Erosion



The maximum allowed contact erosion for each contact is a=6mm. Therefore, the maximum contact erosion for a pair of contacts is 2a=12mm. This dimension can be determined by the minimum thickness of dimension b=22mm.If it has reached this value or it is estimated to reach this value in the next inspection, the contacts shall be replaced

Measuring the contact wear is carried out before removing the contact shell plate of diverter switch. Therefore, a hole in the contact shell plate between every pair of contacts is used for this purpose. Measuring the distance b can be performed from outer surface of the contact shell plate when the contacts are closed (bridging position). (refer to Fig. M).

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