HWDK On-tank Reactive Vacuum Load Tap-Changer Operation Instruction

HM 0.460.5801

Shanghai Huaming Power Equipment Co.,Ltd.

Preface

1. Read the instruction carefully before using this product；

2. This product is specifically designed for electrical power systems and facilities, and shall be operated by appropriately trained professionals only, who are familiar with the installation, assembly, commissioning and operation of such products. They should follow all warnings and danger notices and be regularly trained on operation safety, especially the safety instructions included therein.

3. As part of our continuous improvement effort, Huaming reserves the right to modify the Technical Data and Operation Instruction；

4. For application of this product beyond our standard technical specification, please contact us to evaluate the possibility of a special design and customized the solution.

5. This Operation Instruction contains all the information’s required for the correct installation, connection, commissioning and monitoring of HWDK LTC. Read this technical document carefully and understand the working principle of the product. Particular attention should be paid to the information provided in this chapter. If the product is not used in accordance with the product instructions, it is considered improper use. Huaming shall not be liable for unauthorized or improper product changes and damages that may lead to personal injury or property damage caused by these improper changes.

Important safety instructions are emphasized in this manual in the following four ways:

The “Warning!” sign is given, when neglecting a request may cause injuries to operators. It indicates that life and health are at risk. Neglecting this warning can lead to serious or fatal injuries.

The “Careful!” sign is given when neglecting a request may cause damages to equipment. It indicates that this product or user’s other device is at risk, including serious or fatal injuries.

The “Attention” sign is given for the purpose of emphasizing. It requires users to be extremely cautious when dealing with requests with the "Warning" and "Careful" signs.

Reminder

This is a supplementary explanation for a specific matter.

CONTENTS

1. General

1.1 All components of HWDK on-tank reactive vacuum load tap-changer (henceforth referred to as HWDK), the tap selector included, are assembled in a separate oil compartment, completely isolated from the transformer oil tank, with no gas and oil exchange. The tap-changer oil compartment is mounted to one side of the transformer and the motor drive unit, as part of the tap-changer, is mounted at the same side.

1.2 Vacuum interrupters (VI) are used as arcing contacts to extinguish arcs generated when load current breaks in the VI. Such a design solves the problem of oil carbonization. Therefore, online oil-filter is not needed in any case and it ensures the tap-changer is mostly maintenance free.

1.3 The tap-changer main body and its mechanical drive mechanism are in different compartments. This not only facilitates maintenance, but also guarantees long-term clean oil and good insulation within the compartment.

1.4 HWDK's VI transmits current only during switching and long-term current loading is done through dedicated contacts. This allows the tap-changer to withstand large short-circuit.

1.5 The power input of the three-phase change-over switch is driven by a fast spring mechanism connected to a transmission shaft which operates the three-phase rocker arm. The three-phase change-over switch is synchronized within 3ms

1.6 All VIs are reliably bolted to the structure. This prevents any movement during operation which ensures that operation sequences are stable and will not change over time during switching.

1.7 Tap selector's moving and fixed contacts adopt multi-point contact to ensure good current transmission.

1.8 Tap selector's moving contacts uses bearing springs design, therefore reducing the axial dimensions.

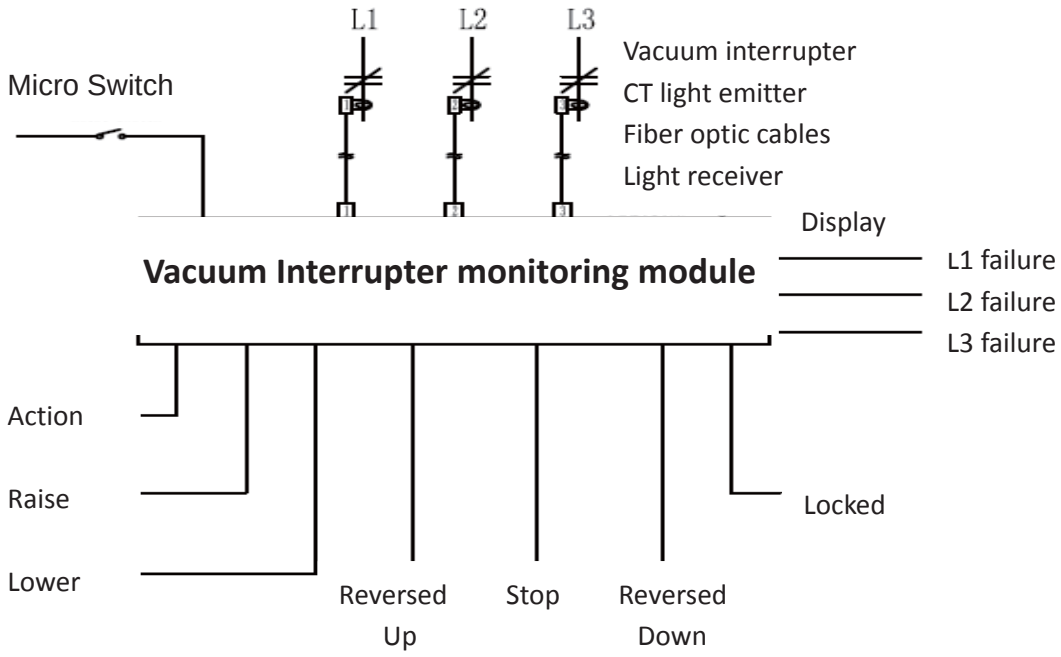
1.9 The HWDK adds to the traditional advantage of on tank LTC for which the transformer oil does not need to be drained when inspecting the LTC. With an internal layout that increases space inside the LTC compartment, it becomes possible to check or replace any LTC component without having to dismantle the LTC., This saves both time and cost.

1.10 HWDK has a highest operational voltage of 72.5kV, 3-phase rated through-current levels of 1500A and 2000A and a maximum of 33 positions (with change-over selector). It is suitable for power

and industrial transformers with 50Hz or 60Hz and 3-phase Y or D connection.

1.11 HWDK is usually welded to the transformer tank through its flange. With the motor drive unit, it supports local and remote motor operation. Upon request, HWDK can also be attached with bolts and nuts to the transformer.

1.12 HWDK is equipped with a control module which protects the tap-changer in case of accidents.



Picture 1 VI Failure Detection and locking control module

The control module detects potential VI's failure and lock the tap-changer when critical conditions are detected. The protective module operates by monitoring the current flowing through the VI's after a switch. Should the monitored current exceed a set value, the module immediately sends a stop command to prevent the motor drive from running and avoid significant failures.

1.13 Standards

(1) IEC60214-1 Tap-changers-Part 1： Performance requirements and test methods

(2) IEEE Std C57.131™-2012 : IEEE Standard Requirements for Tap Changers

1.14 Rated lightning impulse and separate source AC withstand voltage tests
Refer to Table 1 for test positions and requirements.

Unit: kV

Test Positions		Power frequency rated separate source AC withstand voltage (kV/50Hz,1min)	Rated lightning impulse withstand voltage (kV,1.2/50μs)
To the ground		140	400
Between phases		140	400
Between max. and min. taps		70	250
Between steps	Diverter switch	5	20
	Tap selector	50	150

Table 1 Highest Operational Equipment Voltage 72.5kV

Test Positions and Required Values

1.15 HWDK Technical Data

Type		HWDK	
Max. rated through-current I_{um} (A)		1500	2000
Rated frequency (Hz)		50	60
Max. rated voltage tap-to-tap (V)		2000	
Max. rated voltage per step (V)		1000	
Rated switching capacity (kVA)		1500	2000
Standard operating positions (with change-over selector)		33	33
Regulating winding section		9（8 effective）	
Short-circuit current test (kA)	Thermal (3s)	12	
	Dynamic (Peak)	30	
Insulation to ground（KV）	max. continuous voltage between circuits（IEEE/CSA）（KV）	72.5	
	Rated separate source AC withstand voltage (50Hz 1min)	140	
	Rated lightning impulse withstand voltage（1.2/50us）	400	
Maximum and minimum insulation level of switch (limit range) (kV)	Rated separate source AC withstand voltage (50Hz 1min)	70	
	Rated lightning impulse withstand voltage（1.2/50us）	250	
Insulation level between two taps stages (KV)	Rated separate source AC withstand voltage (50Hz 1min)	50	
	Rated lightning impulse withstand voltage（1.2/50us）	125	
Mechanical life		1,500,000 operations	
Maintenance interval		500,000 operations	
Tap changer oil tank		Leakage test	No leakage under 11psi for 24 hrs
		Withstand full vacuum （±17psi）	
Dimension of tap-changer oil compartment (Inch)		L×W×H	68×33×46
Weight (lbs)		3010	
Filling volume of oil tank (Gallon)		383	

Table 2 HWDK Technical Data

2. Structure of HWDK LTC

2.1 General structure

HWDK on-tank reactive vacuum tap-changer is composed of insert, oil tank, driving mechanism, MDU, etc. See Figure 2.

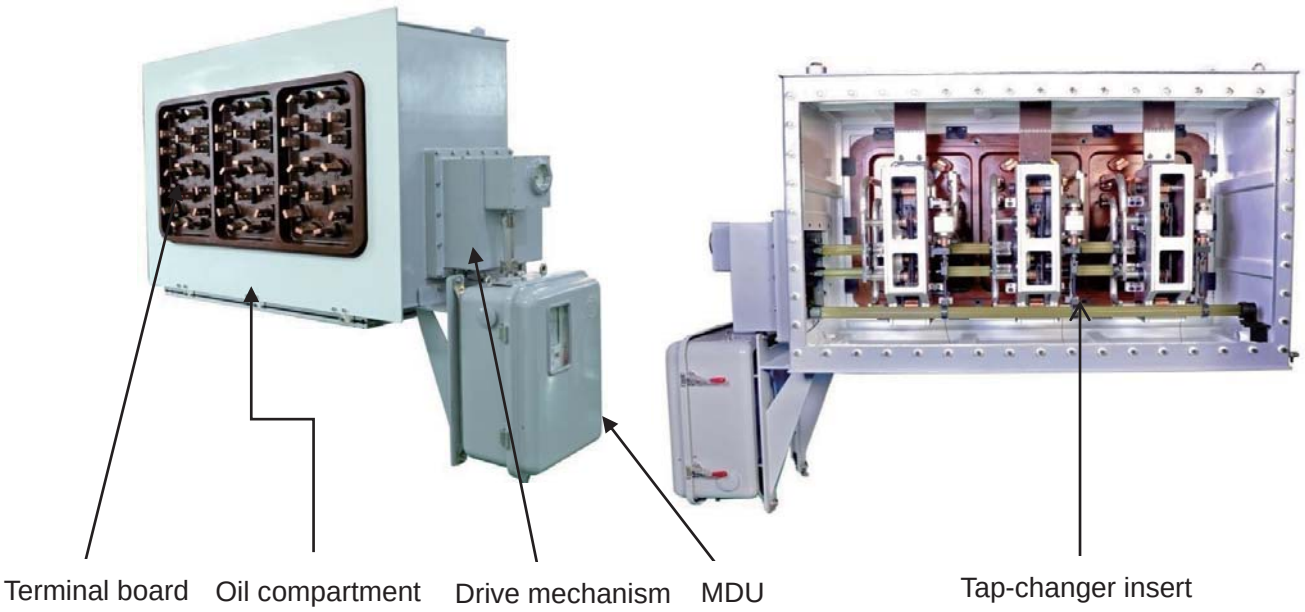


Figure 2. Structure of HWDK external reactance vacuum tap changer

2.2 Structure of the switch insert

The switch insert is composed of one terminal board, one tap selector, one change-over selector, one diverter switch, etc. These components realize tap changes of transformer. See Figure.3.

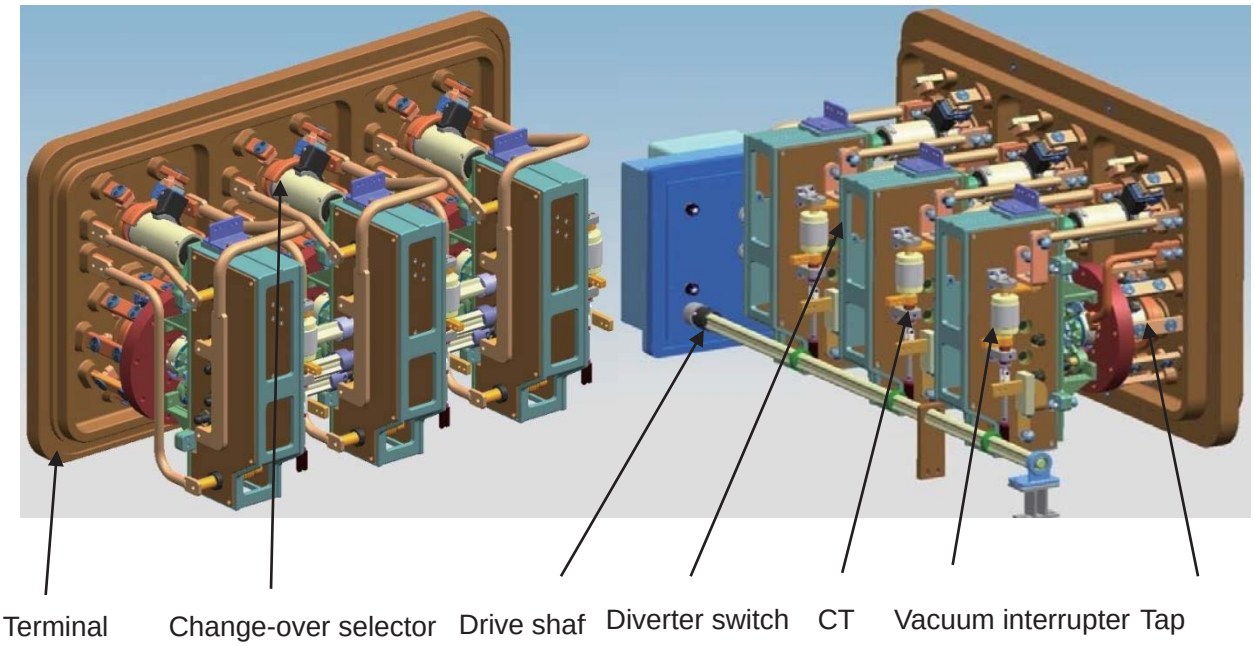
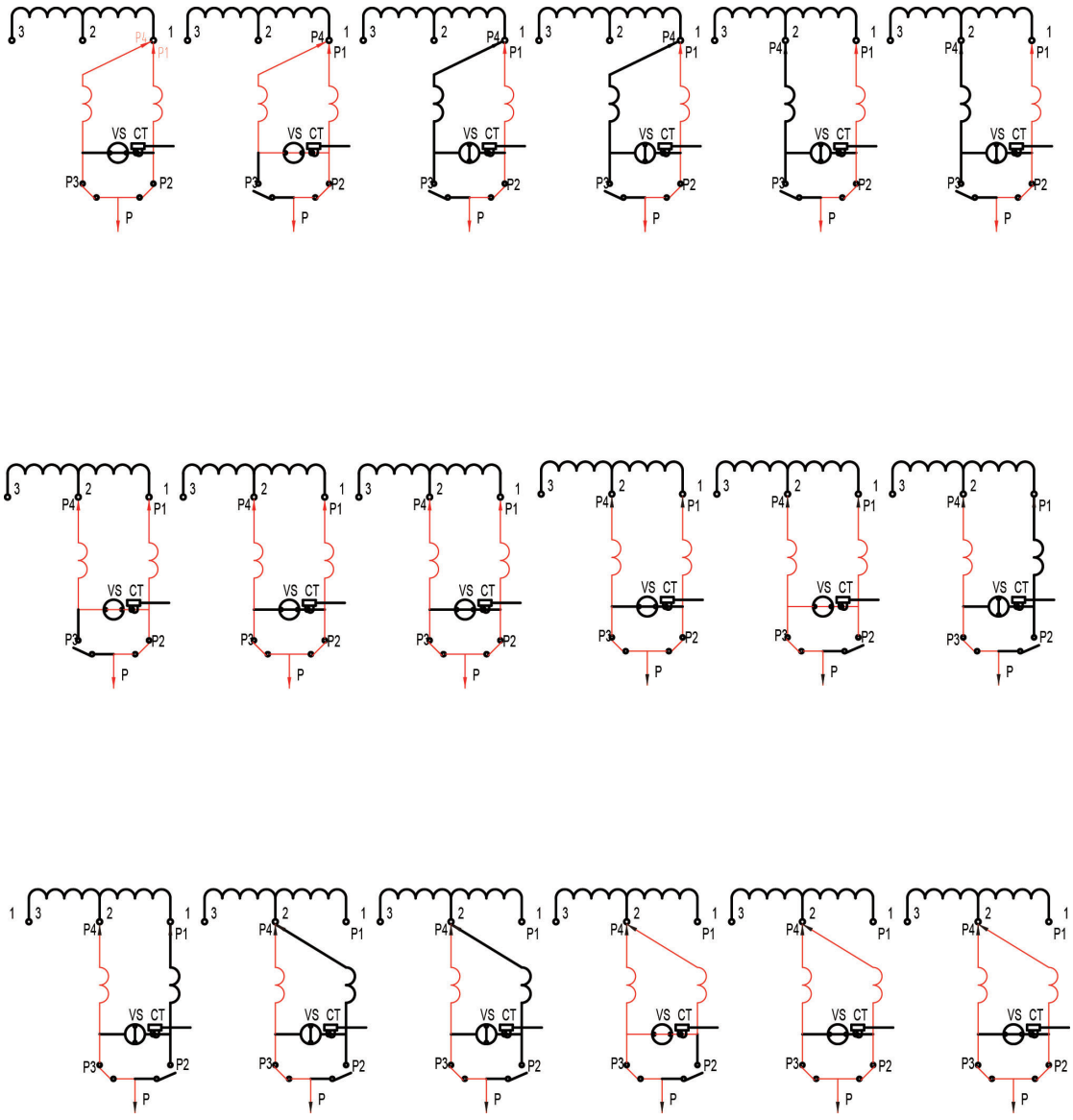


Figure 3 HWDK Structure

3. HWDK Operation Sequence

Below is the HWDK operation sequence. Red lines are current's path.



VI: vacuum interrupter P1, P4: tap selector;
P2, P3: by-pass contact CT: current transformer

Figure 4 HWDK Operation Sequence

4.HWDK Standard Supply

HWDK LTC has two sets of supplies. One is standard as is indicated in Figure 5 (oil conservator prepared by customers) and the other is non-standard indicated in Figure 6.

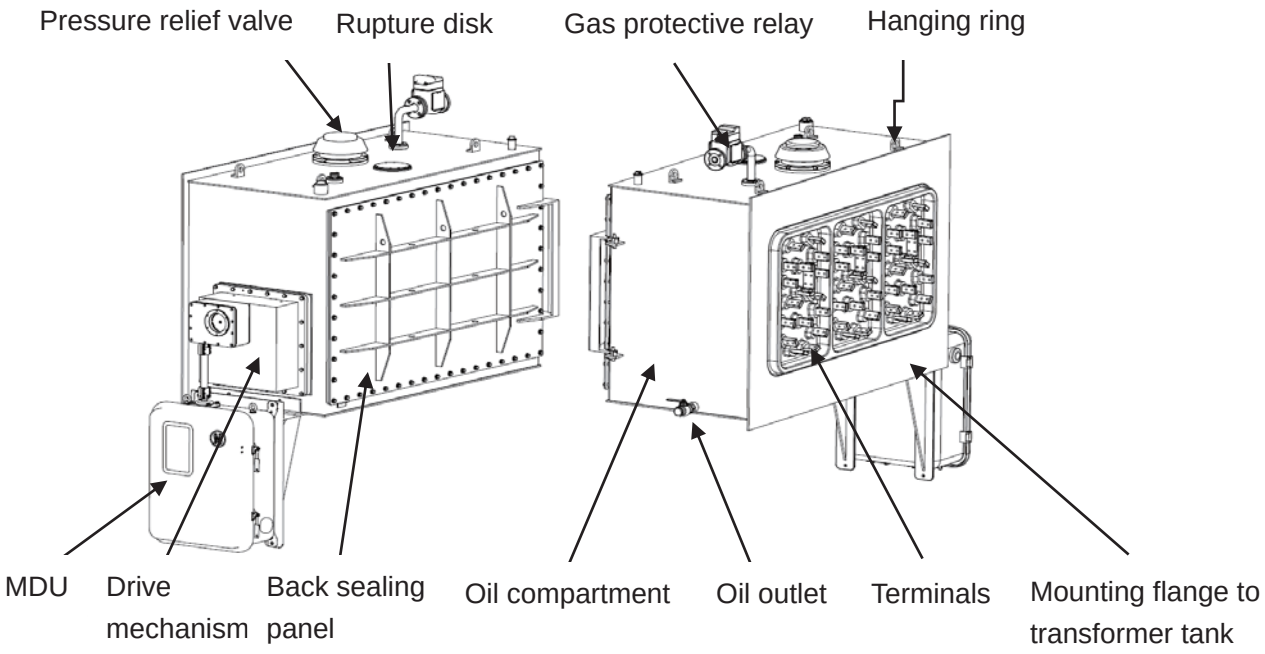


Figure 5 Standard Supply

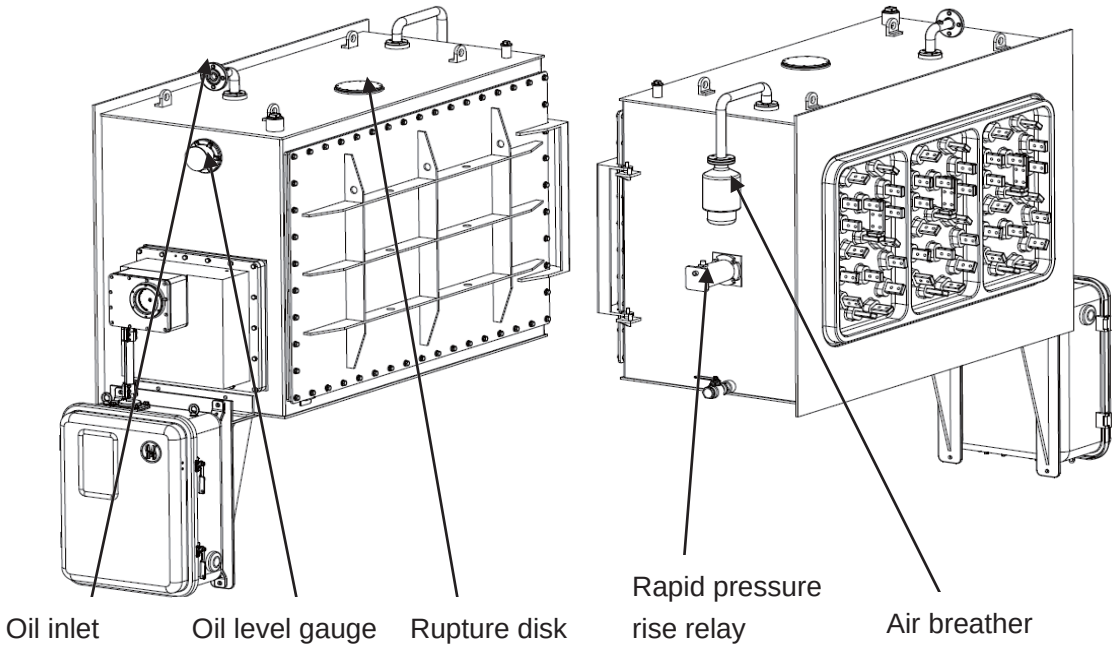


Figure 6 Non-standard Supply

HWDK set supply is composed of:
• Controller and connecting cables
• Pressure relief valve (standard)
• Gas protective relay (standard)
• Rapid pressure rise relay (non-standard)
• Oil level gauge (non-standard)
• Air breather (non-standard)
• Special accessories required by customers
Products is supplied based on the packing list sent before shipment.

5. Transportation and Storage

5.1 Transportation and receiving inspection
5.1.1 Package for delivery can be used for various transportation methods. When stored, appropriate stacking is allowed. The load bearing of the top of packing cases shall not exceed 100lb/sq. ft.
5.1.2 During transportation, packing crates should be arranged appropriately with the gravity center marking. Lift the crates according to the lifting identification on packages.
5.1.3 The package is filled with high-purity nitrogen, whose purity is ≥99.9%, dew point ≤-40℃, and pressure 0.05±20% MPa.
5.1.4 Warning label on packages (Figure 7)

Figure 7 Warning Label on Packages

5.1.5 Acceptance
Consignee should only sign to accept the goods once each package has been checked. Actual quantity should be compared according to the shipping list, check whether the packaging of received goods is intact or not.

If the packing is found damaged (if possible, please take photos of the damaged packing crates and goods) or if there is any discrepancies between the goods information and the packing list, please refuse to sign for acceptance and contact the transportation company to report the problem immediately. If the problem remains, please contact Huaming immediately (export@huaming.com).

The above steps are also suitable for goods corroded due to moisture (rain, snow, water).

All components and accessories must be stored in dry place before installation.
LTC must be kept in the sealed packing cases and only open during installation.

Transportation and hoisting of packing crates must be done by qualified personnel. The bearing capacity of transportation tool and crane should exceed 7000lbs weight.

Danger of fatal and serious injury!
Danger of load falling and flipping over!

Equipment damage !
Falling and dumping will damage on-load tap changer !

Crates should be securely attached during transport and lifting. Handle with care to avoid vibration. Falling, dumping, bumping, and shaking may cause damage to products and shall be reported. In case of falling or severe impact on the packing cases, there may be damages. It is requested to conduct a comprehensive inspection. Please contact the professional and technical personnel of the product manufacturer for inspection if necessary.

1. Avoid damaging the original equipment cases when unpacking for inspection.
2. In case that equipment and its accessories are not in line with the packing list, please contact the manufacturer in time.

5.2 Storage
5.2.1 Immediate inspection should be done to HWDK upon it's delivery. It should only be mounted and put into operation after it is being confirmed that it is dry. If not mounted right away, HWDK must be stored in a proper place.

5.2.2 When stored, HWDK should be filled with high-purity nitrogen.
5.2.2.1 First check if the nitrogen pressure inside HWDK meets 5.1.3. There should be no oil left in the LTC compartment for nitrogen storage

5.2.2.2 With the above listed requirements met, the HWDK can be stored with nitrogen for up to two months. When stored under nitrogen, records of inside pressure and nitrogen need to be kept daily. If the pressure reduces quickly, it means there is gas leakage. Immediate inspection must be done to ensure no water of moisture has entered the HWDK.
5.2.2.3 If requirements listed in 5.2.2.1 cannot be met, inspection needs to be done for leakage and moisture ingress. If nitrogen filling is not available and HWDK will not be put into use soon, please contact Huaming for other solutions. If there is no leakage, please dry the tap-changer in line with Item 6.

5.2.3 Storage with oil
When stored for more than 2 months, HWDK must be filled with transformer oil. The working procedure is:
5.2.3.1 Drain the existing oil left at the bottom of the tap-changer if any.
5.2.3.2 Fill in oil to release nitrogen. Open the gas outlet valve on top of the tap-changer tank and at the same time fill in standard transformer oil through the valve at bottom of the tank (oil characteristics should be at least breakdown voltage ≥350kV/inch and water content ≤30ppm).The oil should be tested before filling the tap changer.
5.2.3.3 Before the LTC is taken out of storage, some oil sample should be taken to verify breakdown voltage and water content. The minimum oil characteristic must be breakdown voltage ≥350kV/inch and water content ≤30ppm. If not, first check if there is leakage or water ingress. Then dry the tap-changer according to Item 6.

5.2.3.4 The place for storage must meet the following requirements:
• Ambient temperature is not lower than -13℉ and not higher than +104℉.
• The equipment shall not be stored in an environment with flammable, explosive and corrosive gases.
• There must be corresponding protection to avoid moisture, dust, as well as the harm from rodents, ants, etc.
• Check regularly whether for any abnormality.
• If the equipment is kept for a long time, the desiccant must be replaced regularly, and the packing should remain sealed.

6. Drying Procedure

Under normal circumstances, there is no need to dry the HWDK. If the packing is wet, the tap-changer must be dried before installed on the transformer. Vacuum drying at ambient temperature or vacuum drying with temperature not exceeding 230℉ and vacuum ≤133Pa are acceptable drying method. Duration shall be determined based on the actual moisture content.

7. HWDK Installation

7.1.HWDK Connection with Transformer

HWDK is directly welded or bolted onto the transformer tank (see Figure 8): Prepare a mounting flange (refer to the appendix for detailed dimension) on the transformer and weld or bolt it to the HWDK mounting flange. See Figure 9 for requirements on the weld throat.

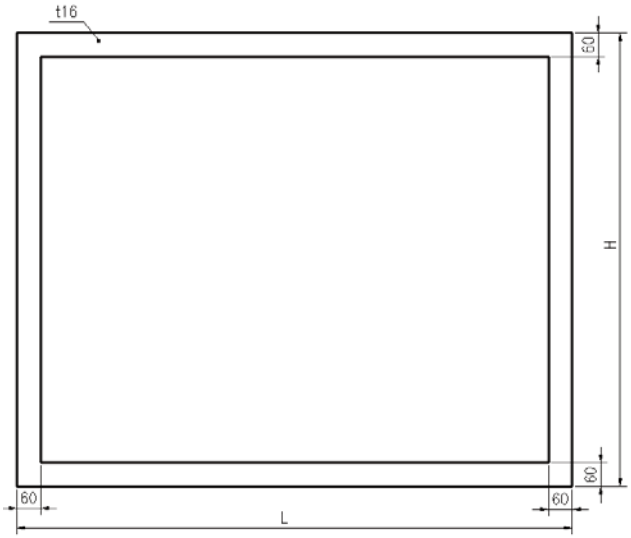


Figure 8 HWDK directly welded onto the transformer

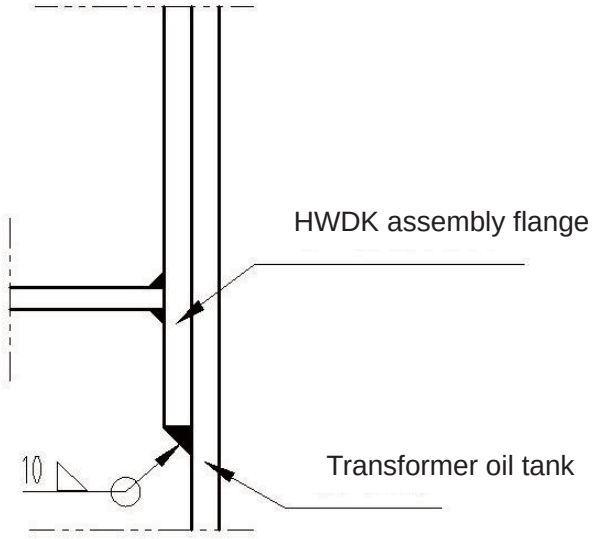


Figure 9 Picture of Welding

7.2 Connection between HWDK terminals and transformer tap winding

The connection of tap winding taps should be in accordance with the wiring connection diagram. HWDK terminal board is labeled with contact position indication. Tap winding must be corresponding to the labeled codes on the tap-changer terminal board.

Careful

All lead wires connected to tap-changer must be reliably fastened. These lead wires should not produce a pull force on the tap selector terminals.

7.2.1 HWDK terminals are provided with a through-hole for M10 bolt, which is convenient for connecting transformer tap winding lead to the tap-changer connection terminals (tightening torque is about 30±10％Nm). The screen caps provided are used for shielding M10 bolts and connecting nuts. (See Figure 10)

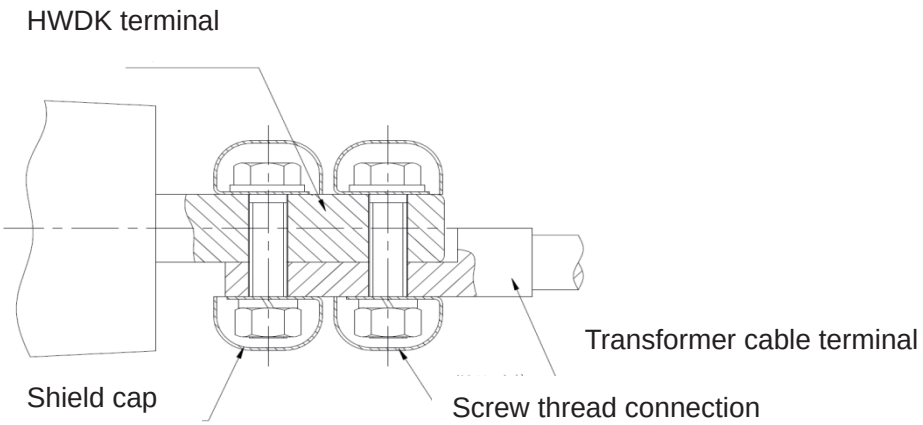


Figure 10

7.2.2 HWDK terminal leads should not engender stressed, deformation or damage to the terminal board.

7.2.2.1. To avoid tension to the plate, the lead connected to the HWDK terminals must be of the right length and present a bend.

7.3 Installation of Gas Relay

Please refer to the separate Operation Instruction of gas relay for installation.

7.4 Use of Pressure Release Valve

Before operation, remove the Red Cross bar on top of pressure release valve.

7.5 Connection between MDU and HWDK

7.5.1. Mounting of MDU Support Shelf

The support shelf is assembled with 5 pieces of M12 bolts at the lower left side of the HWDK tank. (See Figure 11)

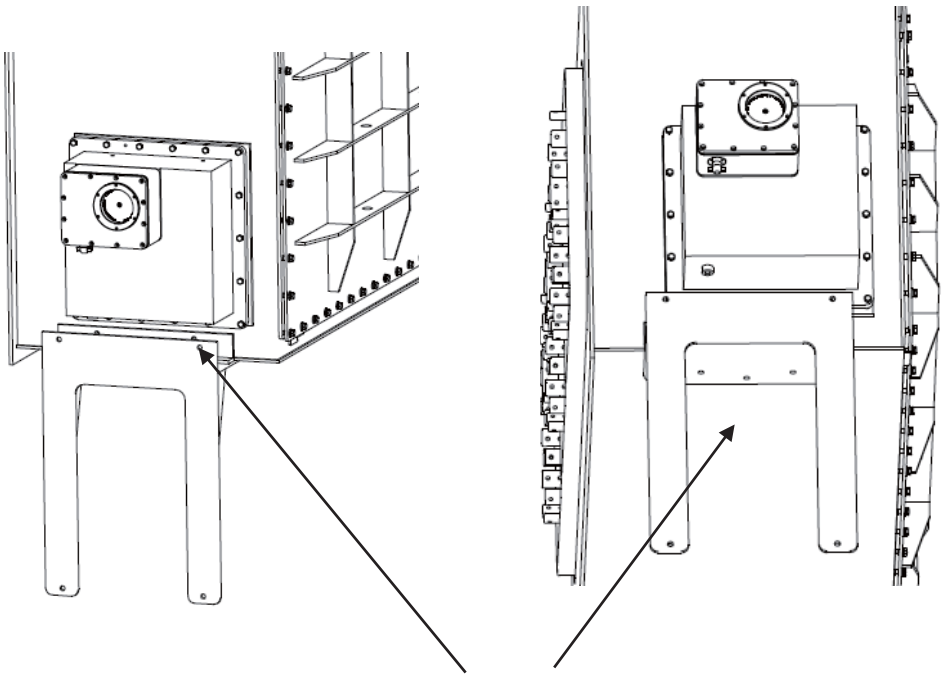


Figure 11 Connection screws of MDU support frame

7.5.2. Mounting of MDU

The MDU is mounted beneath the drive mechanism with 4 pieces of M12 bolts. See Figure 12.

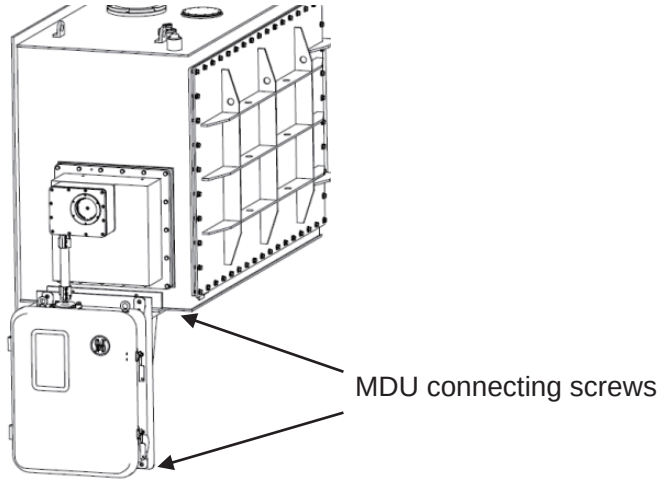


Figure 12

7.5.3 For assembly of the shaft connection between the MDU and the drive mechanism. See Figure 13.

Note: The tap position of the drive mechanism and the MDU must be the same before connecting the shaft. Adjust the MDU position with hand crank if necessary. See Figure 14.

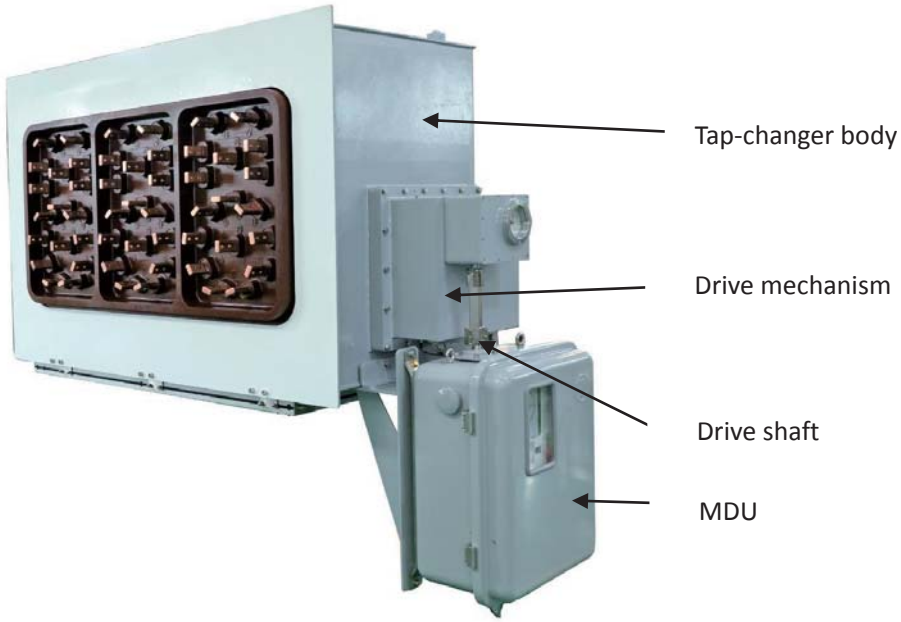


Figure 13 Drive shaft connection between MDU and drive mechanism

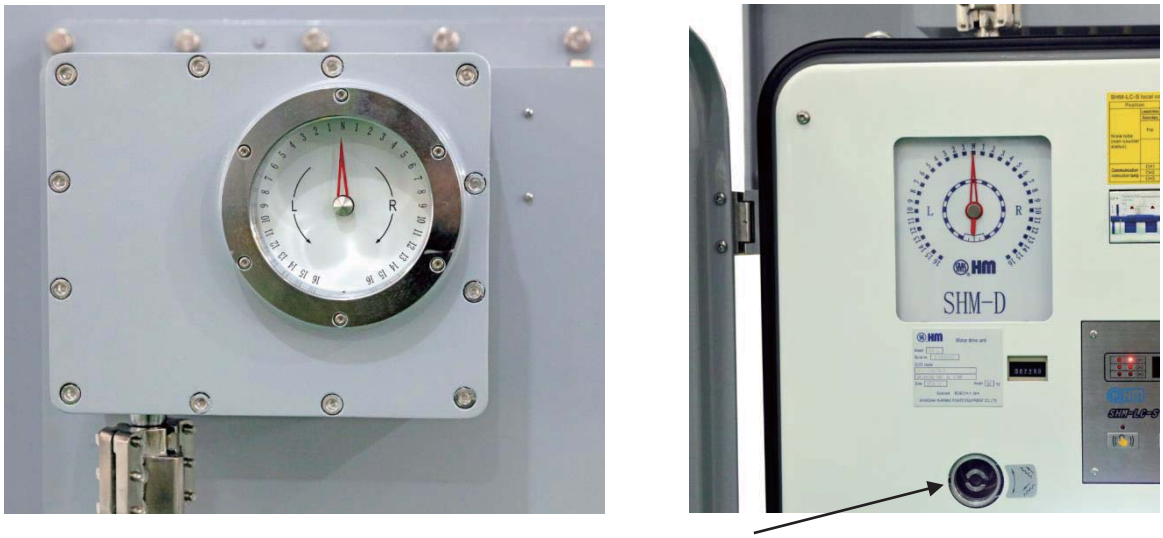


Figure 14 Aligned position on MDU and drive

7.5.4. HWDK Commissioning

Insert the hand crank into the MDU. Rotate the crank clockwise for 33 cycle in line with the HWDK operation sequence diagram. Make sure you can hear the sound of the diverter switch opening and closing. Record the number of turns. Then perform 33 cycles anti-clockwise in the same way. The difference between indicators should not exceed 1/4 cycle. If there is a higher deviation, unbolt the screws connecting the MDU and the drive shaft. Slightly adjust the shaft clockwise or anti-clockwise to bring the difference between indicators within 1/4.

8. Transformer Ratio Test and DC Resistance Measurement

8.1 Transformer ratio test

Insert the hand crank into the manual input shaft sleeve. Turn the hand crank to perform one step tap change. The sound of switching should be heard clearly. After the switching starts, the crank must continue to be rotated in the same direction for another two and a half turns to complete one tap change. Frequently check the operating position indicated by the MDU to avoid exceeding the end

In case no oil is present in the LTC compartment, the HWDK's should not be operated for more than 6 cycles.

8.2 DC resistance measurement

The tap-changer is not filled with oil when measuring the transformer DC resistance, so limit the tap changer operation as much as possible. The LTC must be set back to the middle position after the transformer ratio test and DC resistance measurement.

9. HWDK Oil Filling

In general, the oil compartment's top cover and door seal plate must be kept close. Meanwhile, to avoid excessive moisture, the oil tank should be refilled as soon as possible. Oil filling can be done under normal air pressure or under vacuum.

9.1 Oil filling of standard oil compartment

9.1.1 Oil filling under atmospheric pressure with the transformer equipped with a conservator. The conservator and HWDK gas relay are connected through an oil conservator valve (See Figure 15).

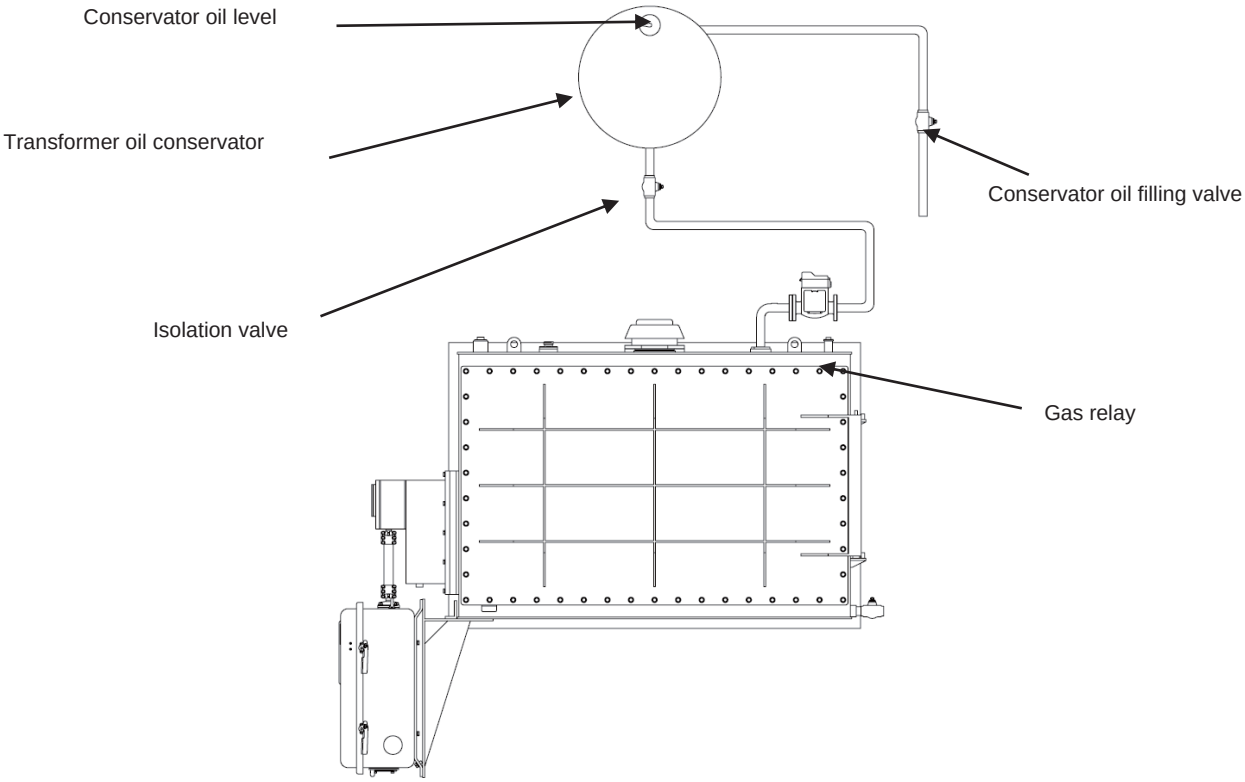


Figure 15

1. Open the conservator oil filling valve.
2. Remove the pipe connecting the air breather.
3. Connect the oil pump, open the isolation valve and start oil filling until the correct oil level is reached.
4. Turn off the oil pump, close the conservator oil filling valve and remove the oil pump.
5. Re-assemble the air breather's pipe.

Attention

When the oil is filled at atmospheric pressure, air bubble may be present inside the LTC compartment. A minimum of 5 hours resting time must be observed before the transformer can be energized.

9.1.2 Vacuum oil filling

Usually, vacuum oil filing is not needed, but if necessary, please follow the following instruction:

1. Close the conservator oil filling valve and open the oil compartment valve.
2. Remove the pipe connecting the air breather.
3. Vacuum the tap-changer oil compartment (vacuum degree ≤133pa).
4. Connect the oil filling pipe with the oil inlet pipe of the conservator.
5. Open the valve on the oil filling pipe and start oil filling until the correct oil level is reached.
6. Close the oil conservator valve.
7. Re-assemble the air breather's pipe.

9.2 Oil filling of non- standard oil compartment

9.2.1 Oil filling under atmospheric pressure. When the transformer is not equipped with a conservator (N2 blanket), oil filling is performed directly through the tap-changer oil inlet pipe through the oil conservator valve (See Figure 16).

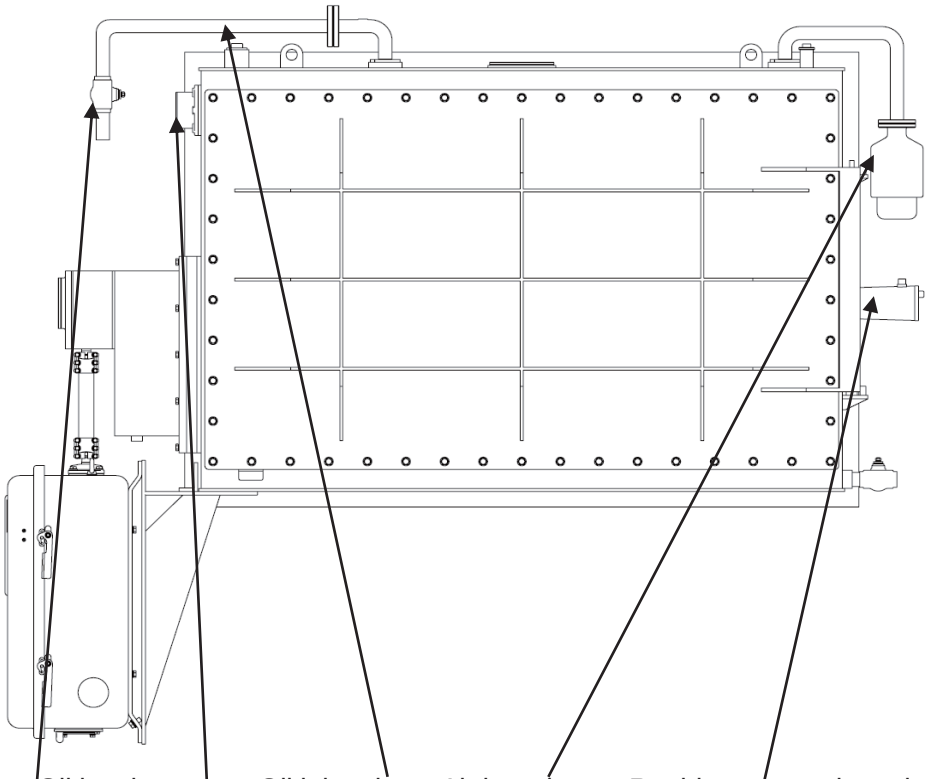


Figure 16

1. Open the oil filling valve.
2. Remove the air breather and the pipe connecting it.
3. Connect the oil pump and start oil filling until the correct oil level (See Figure 17)
4. Turn off the oil pump, close the oil inlet valve and remove the oil pump.
5. Re-assemble the air breather and its pipe.

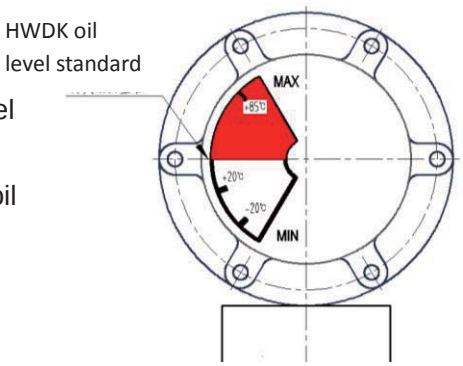


Figure 17 Oil level

Attention

When the LTC is not connected to a conservator there will be air between the oil level and the top cover. For a temperature of + 20℃ (68F), the oil level should be at the middle of min and max. oil levels.

9.2.2 Please refer to 9.1.2 for vacuum filling.

10. HWDK Routine Test and Pre-test Preparation

10.1 Preparation before test

10.1.1 Complete HWDK air bleeding

Before being put into operation for the first time, HWDK must be completely degassed via the stopper on top.

1. Use No. 36 wrench to remove the M30 screw cap on stopper E1.
2. Use a screwdriver to lift the valve stem for degassing (See Figure 18)
3. Tighten the screw cap on stopper E1 (Torque 9 to 12Nm).

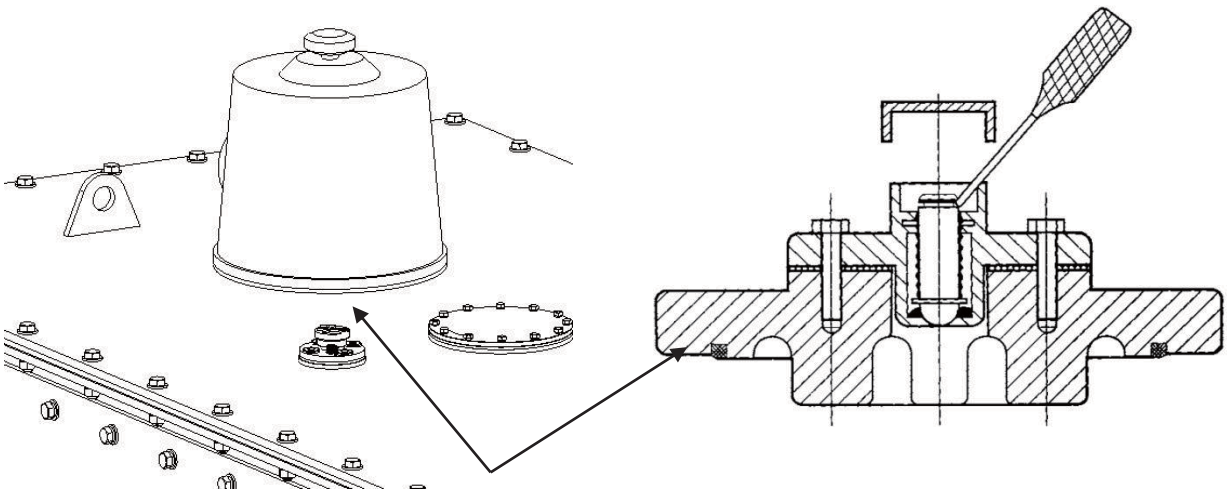


Figure 18 Stopper

10.2 Test in transformer factory

10.2.1 Operation test

Before the transformer is energized, an operation test must be carried out to check the LTC and its MDU's mechanical function.

1. The LTC oil compartment shall be filled with transformer oil.
2. During the operation test, the LTC must go through one complete tap range.
3. Check the mechanical and electrical limit switches at both max. and min. positions (Detail operation can be found in the MDU operating instruction).

1. Continuous operation without oil will cause damages to HWDK!
2. After the transformer drying process and before the first operation of HWDK, the tap selector must be completely immersed in oil and LTC oil compartment should be full of oil.

11. Transportation and Commissioning on Site

11.1 Transportation of transformer filled with oil

11.1.1 Transportation of transformer equipped with the conservator: HWDK must be filled with oil and connected to the oil conservator.

11.1.2 Transportation of transformer not equipped with conservator: Drain 20% of the oil in the HWDK oil compartment. Seal the oil tank with provided plate, and then transport

11.2 Transportation of transformer with no oil

If the transformer is transported or stored without oil, HWDK oil compartment must also be completely discharged. Instead, the same method should be used to protect as the one used for transformer, such as nitrogen filling.

11.3 Transformer commissioning on site

Open fire, heat source or electric spark should not be present or possible near the LTC.

11.3.1 Before putting the transformer into operation, make sure the LTC oil compartment is filled with oil. When the transformer is energized for the first time, oil should have a minimum voltage withstand of 400kV/inch (minimum) and maximum water content of 12ppm.

11.3.2 Follow the instruction in 10.1.1 for HWDK air bleeding.

11.3.3 Follow the instruction in 10.2.1. for trial operation.

11.3.4 Make sure the min. oil level signal of HWDK's conservator is wired to the circuit breaker's tripping circuit.

11.3.5 Inspect whether the protective relay functions normally or not by following HM protective relay QJ-25 instruction.

11.3.6 Before operation, remove the Red Cross bar on top of pressure release valve.

11.3.7 Refer to Chapter 9 for oil filling

Do not operate the LTC until the inrush current from energization has subsided. The inrush current is several times higher than the transformer rated current and can overload HWDK during tap changing.

Observe other safety instructions during all functional checks and tests during operation.

12. HWDK Operation Monitoring and Maintenance

12.1 Operation monitoring
To ensure normal operation of HWDK, it is necessary to conduct regular visual inspection along with the transformer inspection. The following should be done:

12.1.1 Top cover: Check whether there is leakage around the connection of the protective relay and piping.
12.1.2 Check the seal of the drive mechanism.
12.1.3 Test oil in the oil compartment according to the user's operation regulations.
12.1.4 Confirm the heater and other devices in the drive mechanism are in good condition.
12.1.5 Regularly take oil samples from the oil compartment. Please refer to the following table for oil sample requirements:

Voltage regulation mode	Breakdown voltage	Moisture level
At neutral point	≥300kV/1 inch	＜40ppm
Others except at neutral point	≥400kV/1 inch	＜30ppm

12.1.6 During continuous transformer overload, LTC should not be continuously operated. The LTC controller must be equipped with an overcurrent self-close contact to prevent operation when the load current is more than 2 times of IU.
12.1.7 Failure inside the LTC will generate a large amount of gas. The gas relay's baffle plate will operate and the trip contact will close The gas relay trip contact is set to work when the oil speed is 3.3ft/s ± 10%.. It should be connected to the transformer breaker's trip circuit to cut the power supply off and avoid further damage. Once the gas relay acts, it is mandatory to inspect the LTC before restarting to operation.

12.1.8 The HWDK cover is fitted with an overpressure rupture disk, which will not operate during normal operation. If during a internal failures the pressure in the LTC compartment exceeds 0.3 ± 20% MPa, the rupture disk will break to avoid deterioration When installing and inspecting HWDK, be careful not to step on or hit the rupture disk with heavy objects.

12.2 HWDK maintenance
Reminder:
In order to guarantee the reliability of HWDK, end user should perform regular maintenance. Lack of maintenance may cause damages to tap-changer and transformer.

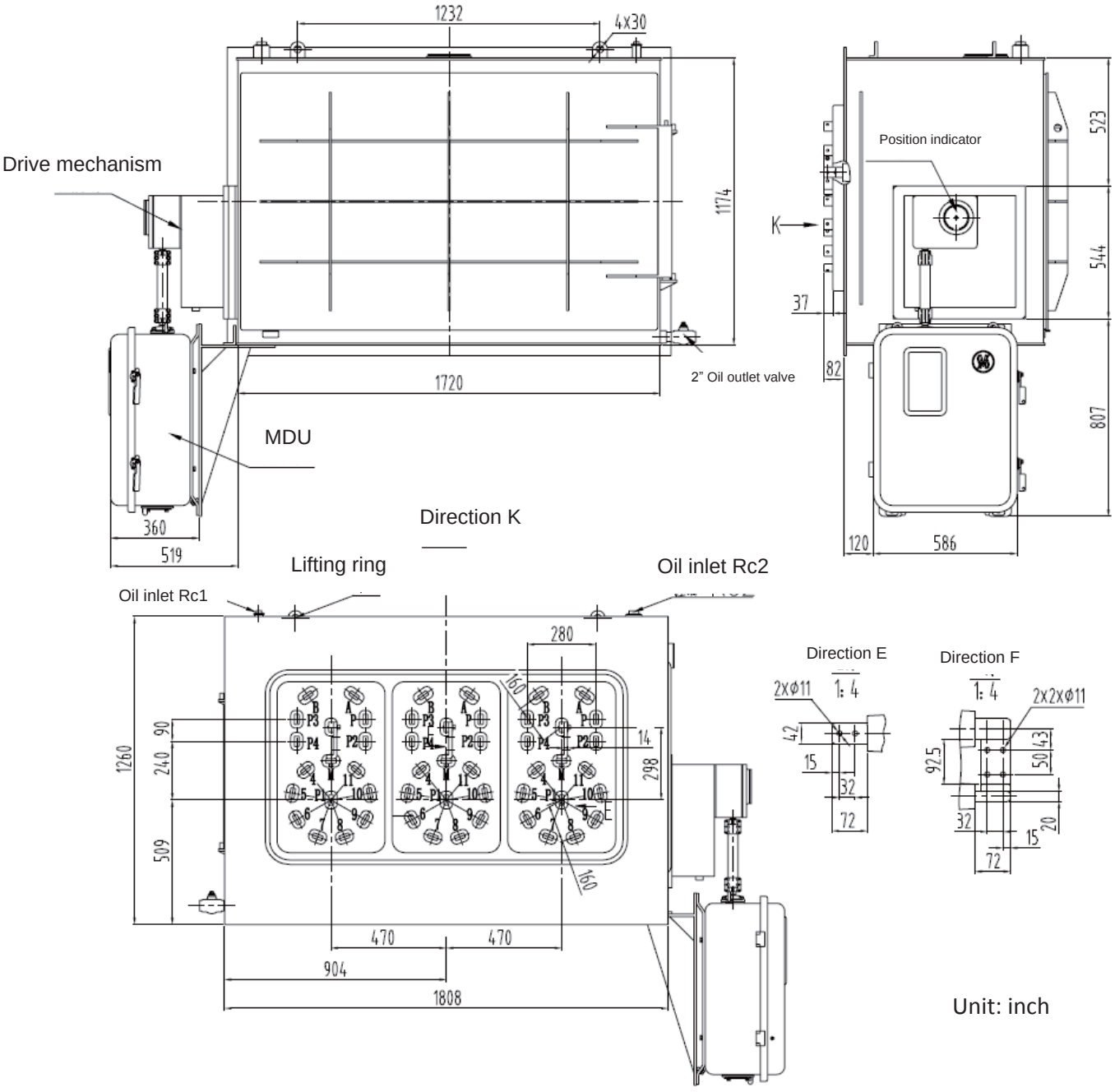
12.2.1 HWDK must be inspected after every 100,000 operations.
12.2.2 Maintenance shall be performed after 500,000 operations.
Reminder:
The maintenance of HWDK is generally carried out by Huaming and can be done within one day.

13. Appendix

Appendix 1：HWDK dimension

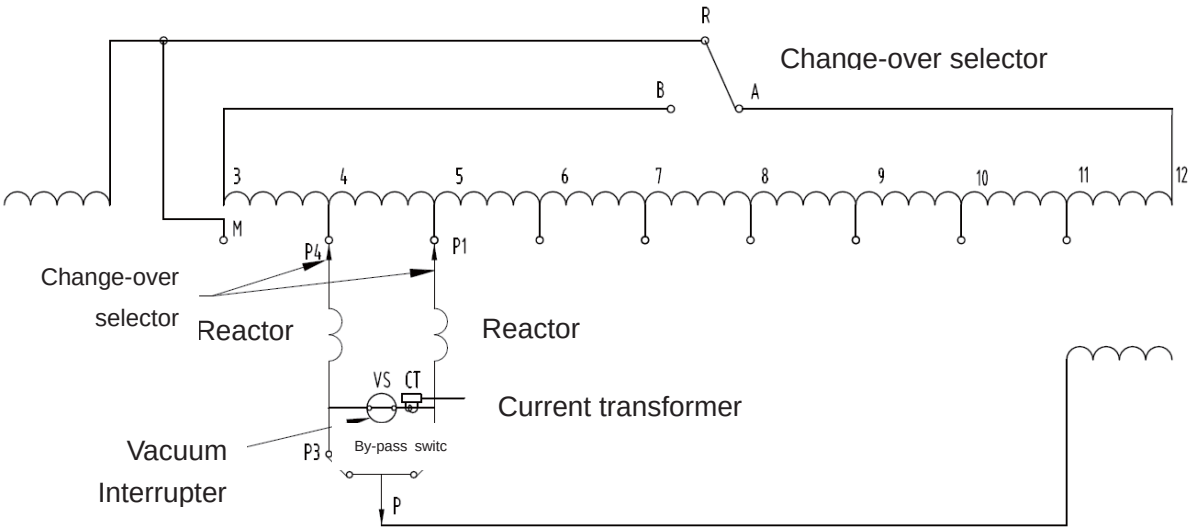
Appendix 2：HWDK connection diagram

Appendix 1：HWDK Dimension



Unit: inch

Appendix 2：HWDK Connection Diagram



Shanghai Huaming Power Equipment Co., Ltd.

Address: No 977 Tong Pu Road, Shanghai 200333, P.R.China
Tel: +86 21 5270 3965 (direct)
+86 21 5270 8966 Ext. 8688 / 8123 / 8698 / 8158 / 8110 / 8658
Fax: +86 21 5270 2715
Web: www.huaming.com E-mail: export@huaming.com

01.12/2019.500