



Type HWV

Externally-mounted Vacuum OLTC

Technical data

HM0.154.5002-01.06/2014



SHANGHAI HUAMING POWER EQUIPMENT CO., LTD.

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1. General

Type HWV externally-mounted vacuum on-load tap changer (Hereafter, referred to as OLTC) is of combined structure. It provides the following features:

All parts of Type HWV OLTC including tap selector is installed in an independent oil chamber which is completely separated from the transformer main tank, no oil and gas exchange. The tap changer oil chamber is fixed at the side of transformer oil tank, while motor drive unit as a part of tap changer is integrated with tap changer oil chamber at one side;

It uses vacuum interrupters as arcing contacts. As the arcing generated from the current breaking is extinguished in the vacuum interrupters, it solves the problem of oil carbonization of the extinguishing medium. Therefore, there is no need to equip with online oil filter plant under any conditions;

As a result of no oil carbonization in the tap changer oil chamber, it not only reduces the mechanical wear but also improves the dielectric strength of the transformer oil in the oil chamber. Hence, the insulation property of tap changer is fundamentally guaranteed;

The mechanical contacts are designed to carry long-term through current, while vacuum interrupters only momentarily bear the current in the process of switching. It improves the short circuit current withstand capability.

All the vacuum interrupters are fixed firmly and the movement sequence will not change in the process of high speed switching;

The moving and fixed contact of tap selector adopts multi—point clamping structure, which significantly increases the current-carrying capacity;

The moving contact compression spring of tap selector is changed to combined leaf spring, which effectively reduces the axial size;

The diverter switch adopts new type quick release mechanism;

The tap switching operation process is carried out in the oil chamber. The selection of material and craft process of all the movable mechanical parts are taken into account to avoid mechanical wear as much as possible, but there still be a small amount of mechanical wear. It solves the problem that may affect the insulation property of transformer winding from the structure of tap changer;

Type HWV OLTC if needs maintenance or trouble-shooting, it does not require to drain the transformer oil. As there is a large internal space, it is not necessary to lift up the diverter switch to check or change each component of tap changer. Therefore, it greatly reduces the cost of maintenance or trouble-shooting.

The highest voltage of equipment of Type HWV on-load tap changer is 17.5kV, 40.5kV and 72.5kV; Three-phase max. rated through current is 400A, 800A and 1200A respectively; Maximum operating positions (with change-over selector) is up to 35. Suitable for frequency of 50Hz or 60Hz three-phase Y connection or D connection power and industrial transformer.

Type HWV on-load tap changer is fixed on mounting flange at one side of the transformer oil tank via the flange on the tank. It is driven by the motor drive unit to realize the local or remote operation.

2. Technical specification

2.1 Type HWV OLTC complies with IEC60214-1:2003 Standard, technical data as shown in Table 1.

Table 1 Type HWV OLTC technical data

Model		HWVⅢ			HWVⅠ		
Max. rated through current I _{um} (A)		400	800	1200	400	800	1200
Rated frequency (Hz)		50 or 60					
Phase and connection method		3-phase Y-connection D connection			Single-phase for any selectable winding connection		
Max. rated step voltage U _{im} (V)		3300					
Rated step capacity P _{sin} (kVA)		1200	2200	3200	1200	2200	3200
Short-circuit current test	Thermal(3s)	8	8	12	8	8	12
	Dynamic(Peak)	20	20	30	20	20	30
Max. operating positions		18 without change-over selector; 35 with change-over selector					
Insulation to ground (kV)	Highest voltage for equipment U _m (kV)	Insulation level					
		17.5		40.5		72.5	
	Rated separate source AC withstand voltage (50Hz 1min)	50		85		140	
	Rated lightning impulse withstand voltage (1.2/50μs)	150		200		350	
Mechanical Life		1,500,000					
Electrical Life		500,000					
Oil compartment	Service pressure	0.03MPa					
	Leakage test	No leakage under 0.08MPa for 24 hours					
	Over pressure protection	Rupture disc bursts at 300±20% kPa					
	Protective relay	Set oil flow speed at 1.0m/s±10%					

2.2 Rated through-current

Rated through current I_u : The current flow through an on-load tap changer toward the external circuit, which can transfer from one tap to the other at the relevant rated step voltage and which can be carried continuously while meeting the requirement.

Maximum rated through current I_{um} : The highest rated through current for which the tap changer is designed for and which forms the basis for all current related tests. In the selection, $I_u \leq I_{um}$.

2.3 Rated step voltage

Rated step voltage is the operating voltage to successive taps of the transformer, in the whole regulating range it can be constant or variable. If it is a variable, the value of rated step voltage is determined by the max. step voltage.

Rated step voltage U_i : For each value of rated through current, the highest permissible voltage.

Maximum rated step voltage U_{im} : The highest value of the rated step voltage for which the tap changer is designed. In the selection, $U_i \leq U_{im}$. The maximum rated step voltage for type HWV OLTC is 3300V.

2.4 Rated step capacity P_{stn}

Step capacity is the product of step voltage and load current, that is $P_s = U_i I$. Rated step capacity is the maximum permissible step capacity for the tap changer under continuous working condition, that is $P_{stN} = I_{ux} \times U_i$ (Lower load point) and $P_{stn} = I_{ux} \times U_{im}$ (Upper load point) in the range of envelop curve, to assess whether the selected rated through current and rated step voltage is in the allowed range of the rated step capacity. The rated step capacity of type HWV OLTC (See Fig. 1)

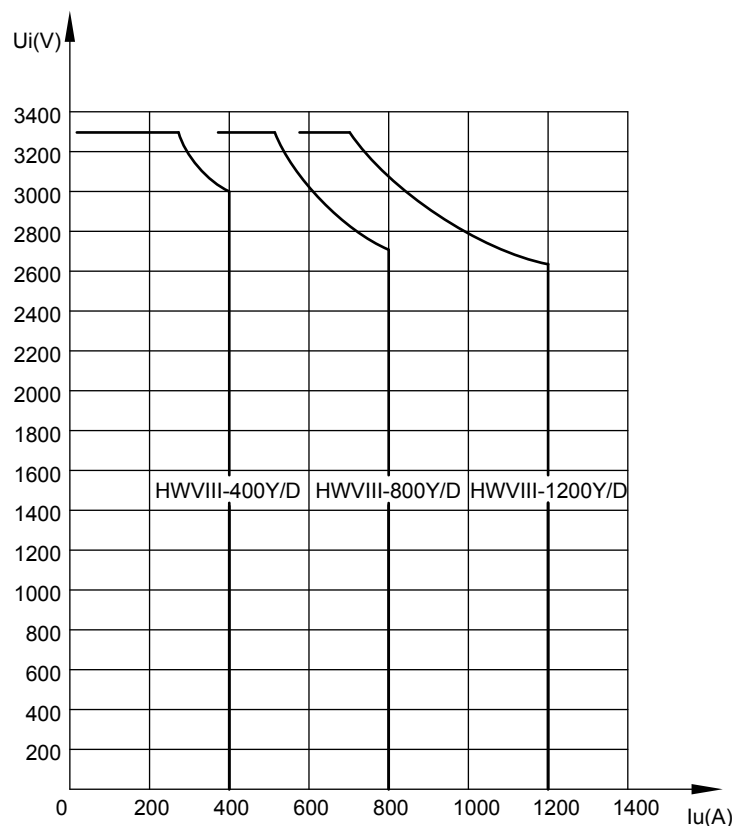


Fig. 1 Rated step capacity of type HWV OLTC

According to stipulations of IEC60214-1, tap changer shall be able to break two times of maximum rated through current and its relevant step voltage for 40 operations. Breaking capacity of type HWV tap changer is $P_{st.max} \approx 2I_{um} \times U_i$.

2.5 Electrical life of vacuum interrupter

The electrical life of vacuum interrupter is not less than 500,000 operations.

2.6 Short-circuit current test

According to IEC 60214-1: 2003, all contacts continuously carrying the current shall be able to withstand 2s ($\pm 10\%$) short circuit test current without melting, deformation or mechanical damage. Meanwhile the starting peak current value shall be 2.5 ($\pm 5\%$) times of the root means square value of rated short circuit test current. For details, please refer to the short circuit test current values in Table Type HWV Series of On-Load Tap Changer Technical Data.

2.7 Tap changer insulation level to earth

Type HWV Tap changer insulation level to earth is the insulation between tap changer live parts and grounding part. It is decided by rated separate source AC withstand voltage (1 min) and rated lightning impulse withstand voltage. The requirement of which correlates to the transformer tap winding location, regulation range & regulation method, winding connection & arrangement and rated voltage of transformer winding. It's decided by the insulation to earth of transformer tap winding. Tap changer insulation level is decided by the highest voltage for equipment U_m , which is selected from the standard value stipulated by IEC-60214-1: 2003 (See Table. 2), in order to use the minimum insulation value to meet the entire range of requirement.

Table 2 Tap Changer Insulation Level to Earth

(Unit:kV)

The highest voltage for equipment U_m	Rated separate source AC withstand voltage (50HZ 1min)	Rated lightning impulse withstand voltage (Full wave 1.2/50 μ s)
17.5	50	150
40.5	80	200
72.5	140	350

2.8 Internal insulation level of tap changer

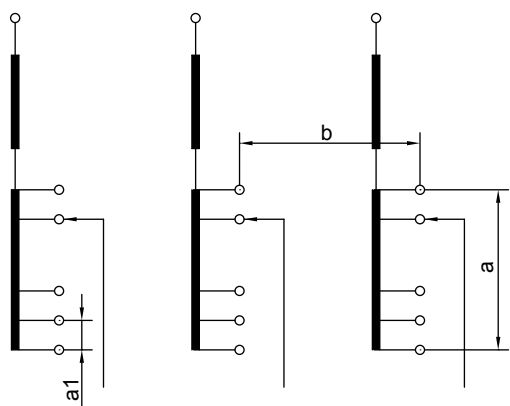
Refer the internal insulation level of Type HWV tap changer to Table 3. Basic connection diagram and insulation distance mark is shown in Fig. 2. Internal insulation must be checked when selecting the proper tap changer, whether it's qualified for the voltage withstanding requirement.

Table 3 Tap Changer Insulation Level

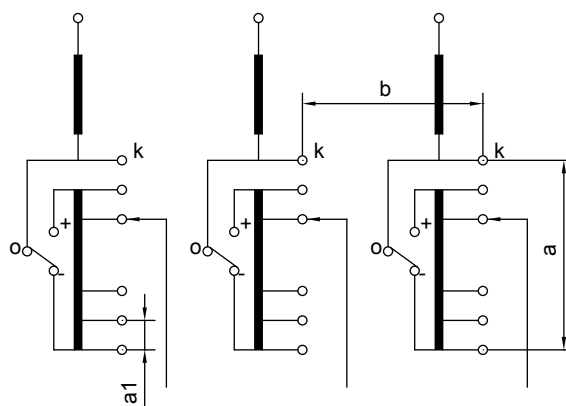
(Unit:kV)

Insulation distance mark		17.5kV		40.5kV		72.5kV	
		1.2/50 μ s	50Hz 1min	1.2/50 μ s	50Hz 1min	1.2/50 μ s	50Hz 1min
a		105	45	135	50	265	50
b	HWV III D	150	50	200	80	325	140
	HWV III Y	105	45	135	50	265	50
a0		65	20	65	20	65	20
a1		150	30	150	30	150	30
C1		500	145	500	145	500	145
C2		500	145	500	145	500	145

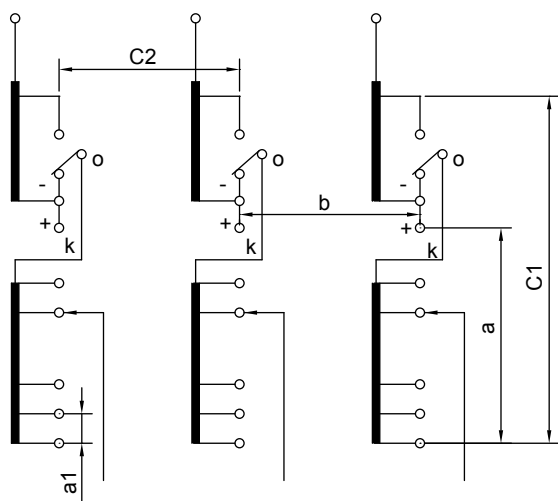
Note: When the insulation distance of a0 represents ZnO gap protection, its insulation is 1.2/50 μ s; 65~70kV,75kV100% responsive.



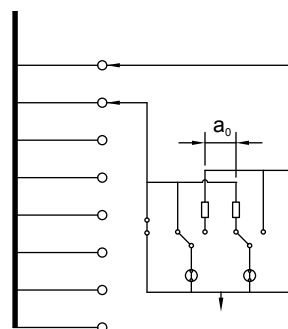
Linear Regulation



Reversing Regulation



Coarse/Fine Regulation



Internal insulation of diverter switch

- a: between start and end of a fine tap winding; also between start and end of coarse tap winding;
b: between any tapping of different fine tap windings, or between ends of different coarse windings;
a0: between selected and preset diverter switch tapping;
a1: between any selected and preselected taps of the tap selector (Connected or unconnected);
c1: between the start of coarse tap winding and the current take-off terminal for the same phase;
c2: between start contacts (-) of coarse winding for different phases.

Fig. 2

3 OLTC structure

Type HWV tap changer is composed of three parts: oil compartment and its accessories, tap changer body and motor drive unit, as shown in Fig. 3.

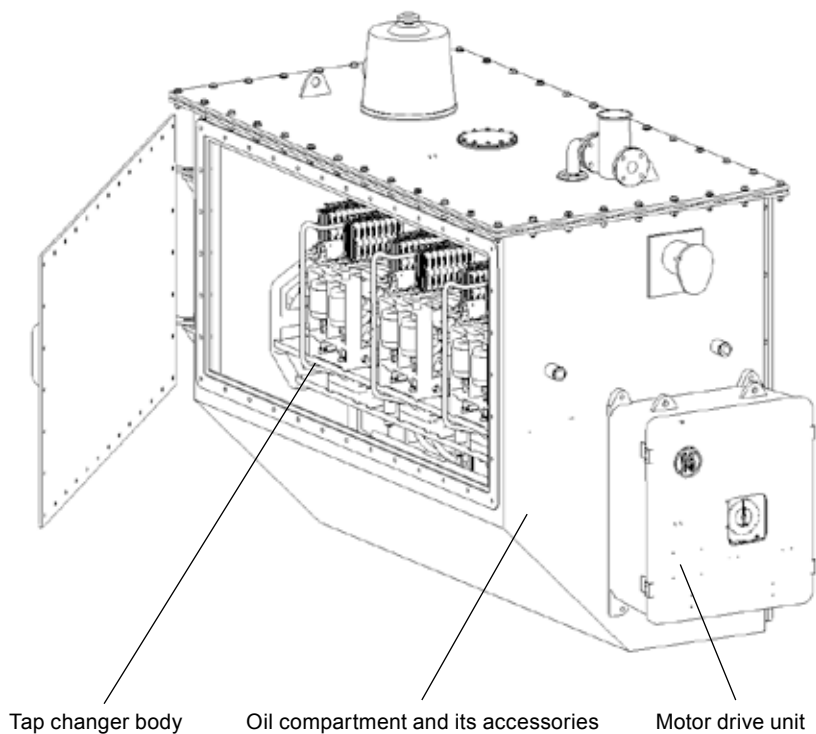


Fig. 3

3.1 Tap changer body

Tap changer body is composed of three parts: tap selector, diverter switch and drive unit. (See Fig. 4)

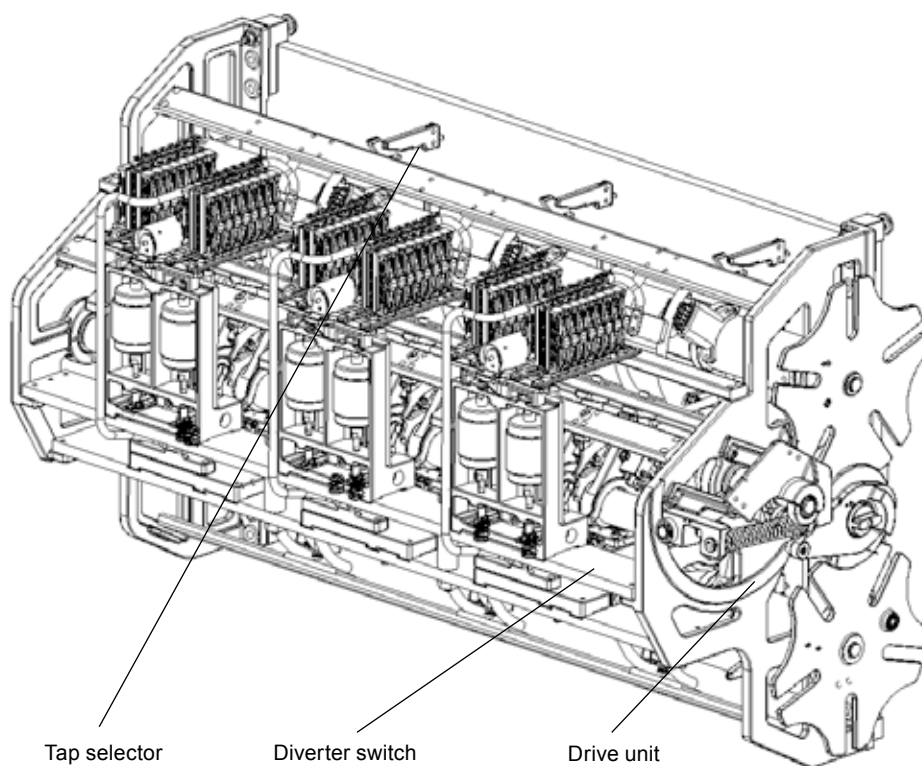


Fig. 4

3.2 Oil compartment and its accessories

3.2.1 Standard type oil compartment and its accessories

Standard type oil compartment means tap changer oil compartment is connected with one independent oil conservator and separated from the oil in the transformer. The accessories mainly include pressure release valve, protective relay, rupture disk, oil filling pipe, oil outlet valve. (See Fig. 5) Tap changer oil compartment is always filled with oil. The tap changer oil compartment can be fixed with one side of transformer oil tank by bolts or directly welding with one side of transformer oil tank.

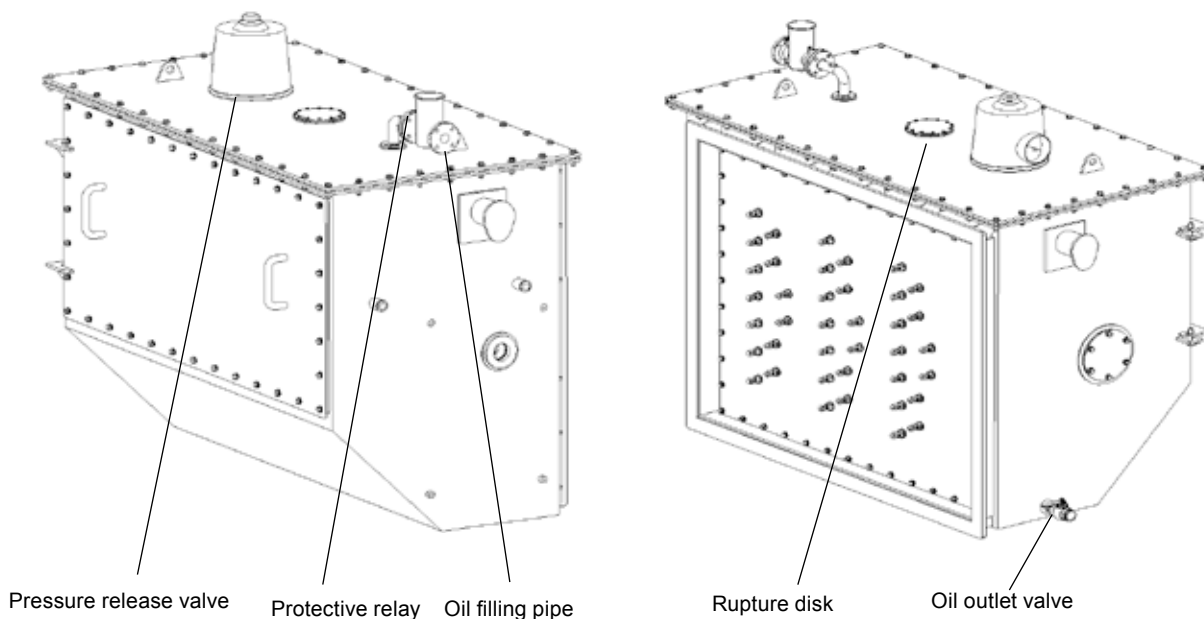


Fig. 5 Standard type oil compartment and its accessories

3.2.2 Non-standard type oil compartment and its accessories

Non-standard type oil compartment means tap changer oil compartment is not connected with independent oil conservator. The space between the oil level of tap changer oil compartment and its top cover is 100~150mm. The accessories includes pressure release valve, rapid pressure rise relay, breather, oil gauge, oil filling pipe, oil outlet valve, etc. (See Fig. 5) The tap changer oil compartment can be fixed with transformer oil tank by bolts or directly welding with transformer oil tank.

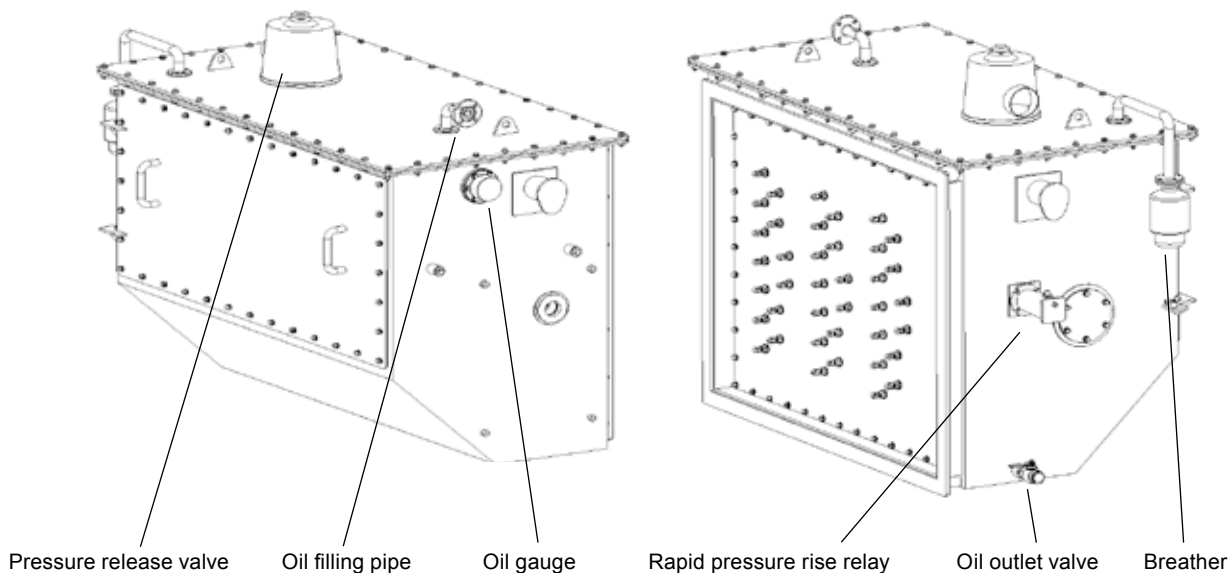


Fig. 6 Non-standard type oil compartment and its accessories

3.3 Motor drive unit

Type HWV OLTC is equipped with new model motor drive unit (SHM-DA).

4. Type designation

4.1 Model designation

Due to the different combinations of number of phases, maximum rated through current, the highest voltage for equipment and connections, type HWV comes with various models. Hence, the type designation shall provide all the above technical parameter and below is its detailed explanation in Fig. 7.

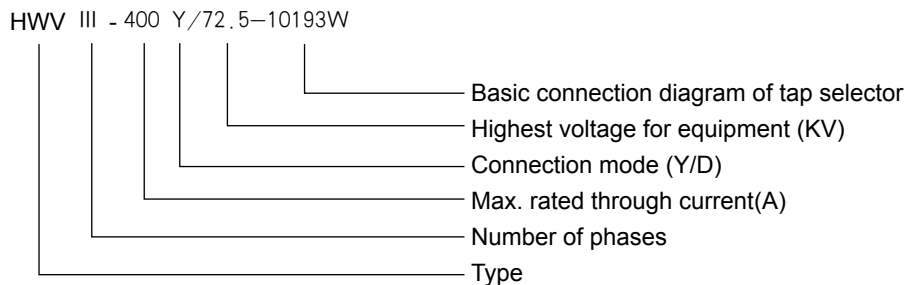


Fig. 7

4.2 Designation of basic connection diagram

The tap selector may have different specifications 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 positions, the number of mid-positions and type of change-over selector. The designation of the basic connection diagram is according to Fig. 8.

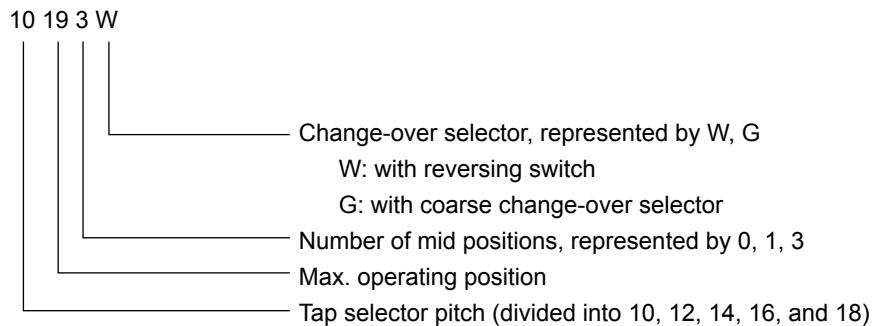


Fig. 8

5 Service condition

5.1 Service temperature range of tap changer in oil is $-25^{\circ}\text{C} \sim 105^{\circ}\text{C}$.

5.2 Service ambient air temperature range of tap changer is $-25^{\circ}\text{C} \sim 40^{\circ}\text{C}$.

5.3 There shall be no serious dust, explosive gas or corrosive gas on service site.

Remark: Please contact us if special application required.

6. Voltage regulation mode

Tap changer can be used for any selectable winding connections for a three-phase D connection transformer and Y connection at neutral point. The basic voltage regulation mode includes three models: linear regulation without change-over selector; reversing regulation with reversing switch or coarse and fine regulation with coarse tap selector. As shown in Fig. 9.

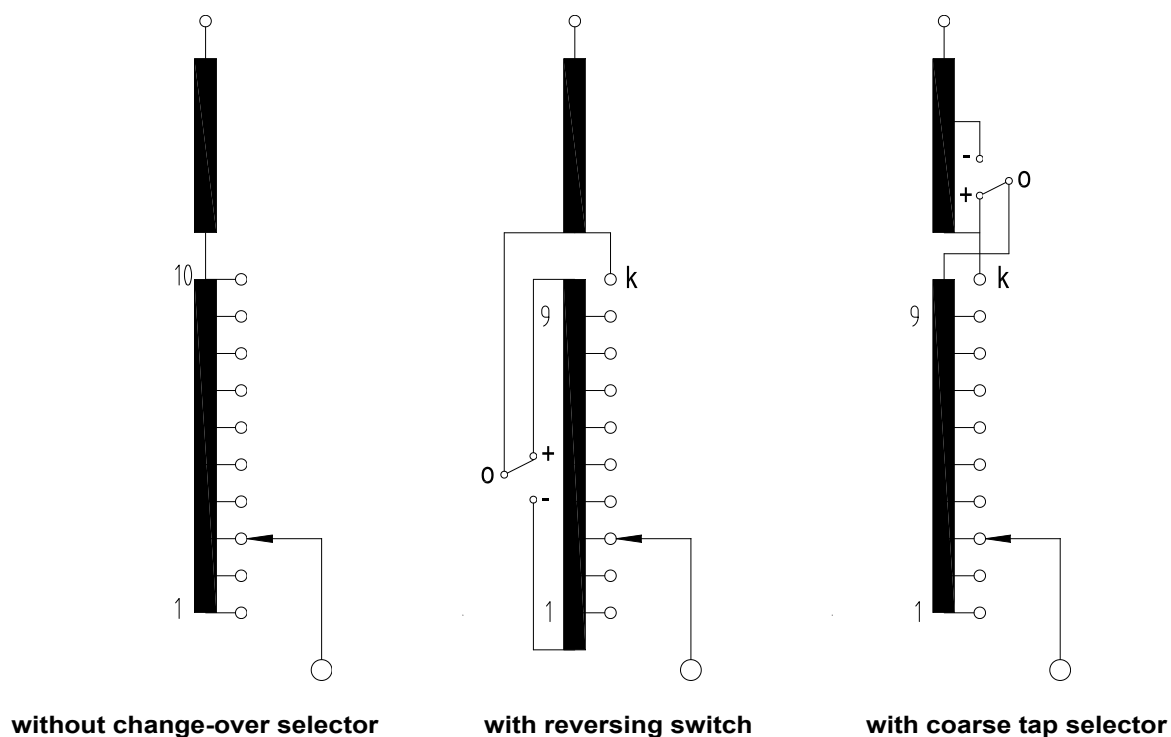


Fig. 9 Basic Connections of Tap Winding

7. Motor drive unit

Type HWV OLTC is driven by SHM-DA motor drive unit. Please refer to Table 4 for technical data. Table 4.

Table 4 Technical Data of Motor Drive Unit

Item		Specifications
Step motor & Subdivision driver	Rated voltage (V)	220V/AC
	Max. output current (A)	6
	Frequency (Hz)	50 or 60
Rotary torque on output shaft (N·m)		35
Revolution of the drive shaft per switching operation (Circle)		33
Revolution of the hand crank per switching operation (Circle)		33
Running time per switching operation (S)		About 5
Max. operation positions		107
Insulation level kV (50Hz, 1min)		2
Weight (kg)		80
Protective degree		IP66
Controller	Model	SHM-K
	Rated voltage (V)	220V/AC
	Frequency (Hz)	50 or 60

8. Controller

SHM-K controller (hereafter referred as controller) is a controlling device used to combine with SHM-DA motor drive unit by its controlling operation mechanism to realize electrical control of switching operation for on-load tap changer. Controller can indicate the operation status of tap changer and tap positions.~

Technical specifications of SHM-K

Power supply	AC 85~264V AC:50/60HZ, DC 100V~250V
Power	About 7W
CPU	ARM9, 32-bit, Basic Frequency 400M
Bus architecture	AMBA
Internal memory	256MB FLASH,64MB SDRAM
Operating system	Linux 2.6.30.4+QT4.5
Switch output	Passive, relay output ,contact rating: 5A220VAC,3A30VDC One route running signal (motor rotation signal) One route 6-bit BCD code position (8421 code); The output can be defined as other content of dry contact output according to customer's requirements.
State signal input	External "raise", "lower" and "stop" signals; Photoelectric isolation >2500V
*Analog input	The bus voltage acquisition: 0~100V or 0~380V,ABC three phases The current acquisition: 0~5A, ABC three phases
Statistical function	Action time, "raise", "lower" record, failure logging, log space: 800 items
Communication function	One route optical fiber: multimode, 62.5/125μm, ST connector, wavelength 820nm, the maximum transmission distance 1KM; One RS485 communication interface (RJ45) Above two interfaces can be used for local control module communication and alternate each other. One route RS485,600~9600bps can be used to communicate with position transducer and other IDE. One routine RS232 is maintenance interface. One TCP/IP 100M RJ45 network interface. Support protocol: IEC60870-5-101,104;SC1801;MODBUS;CDT, etc.
LCD	4.3 inch touch screen, 16-bit true color, 320*240pixel, 96dpi Position display: 1~107 positions (determined by SHM-DL local control module) Alarm function, communication failure, local side equipment fault. Status display: local/digital control status, hand crank status, position operation status, temperature, etc.
Service condition	Operating temperature: -20℃ ~70℃ ,Relative humidity ≤RH95% Non-condensation
Installation method	Screen cabinet
Anti interference level	III degree

9. Installation method

There are two methods to connect type HWV OLTC and transformer.

9.1 Type HWV OLTC directly welded with transformer oil tank. (See Fig. 10)

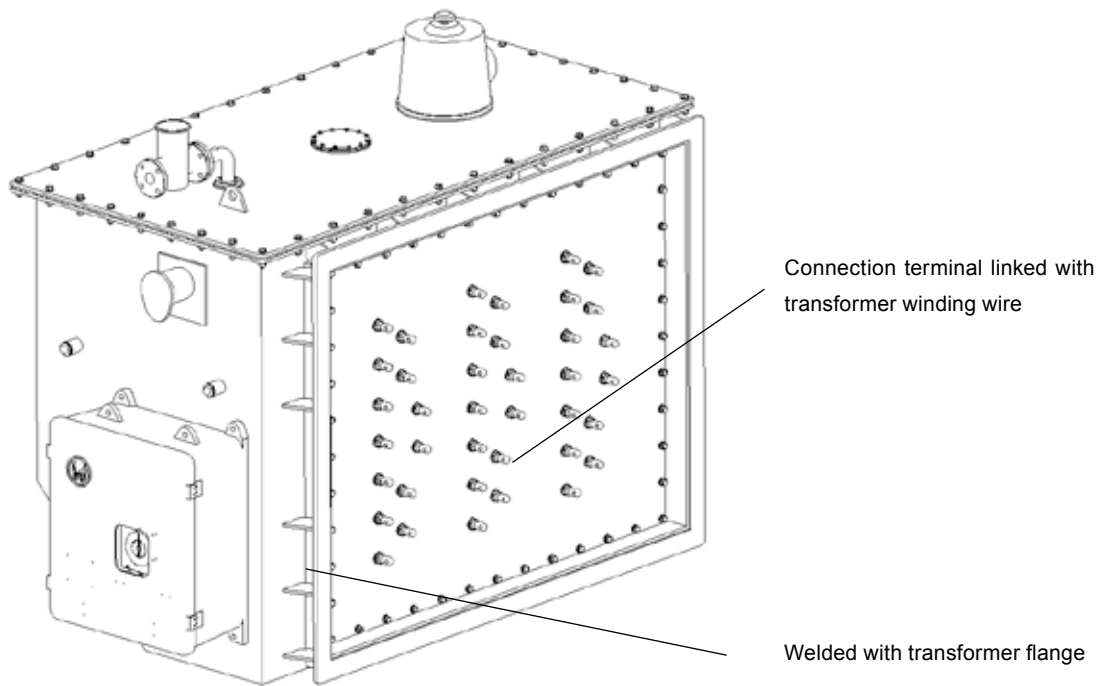


Fig. 10

9.2 Connect Type HWV OLTC and mounting flange of transformer oil tank with screw thread. (See Fig. 11)

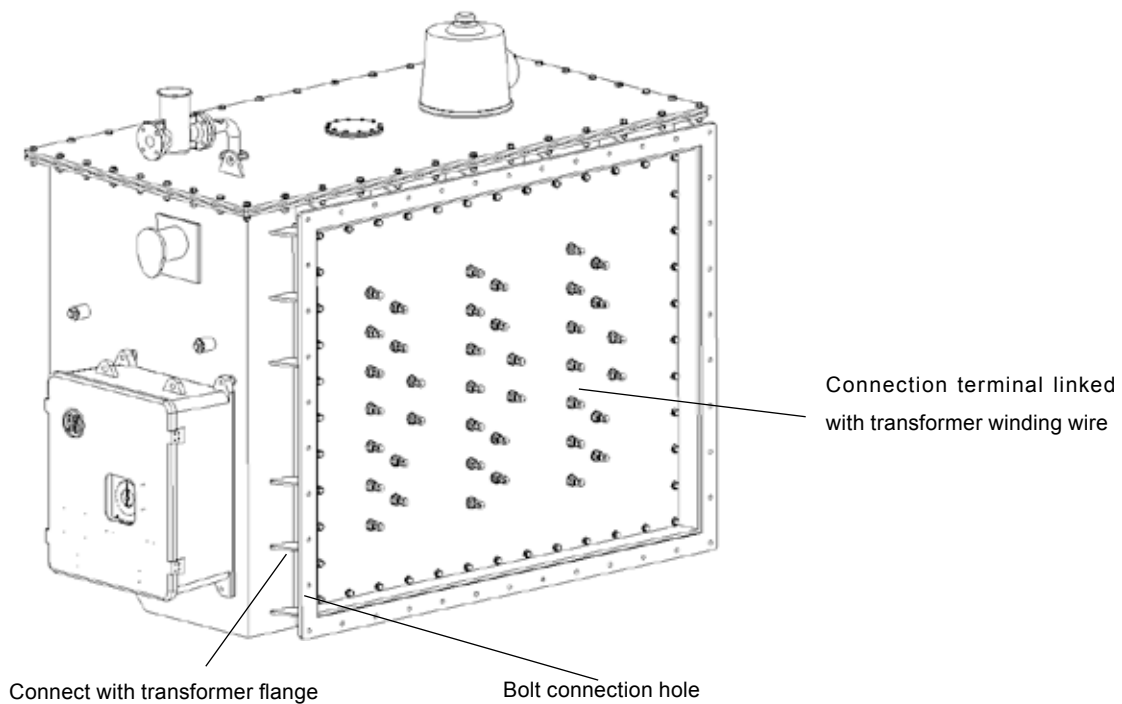


Fig. 11

10. Drying

If the tap changer is transported or stored without moisture, generally it does not require drying. If drying treatment is necessary, please refer to the installation instructions.

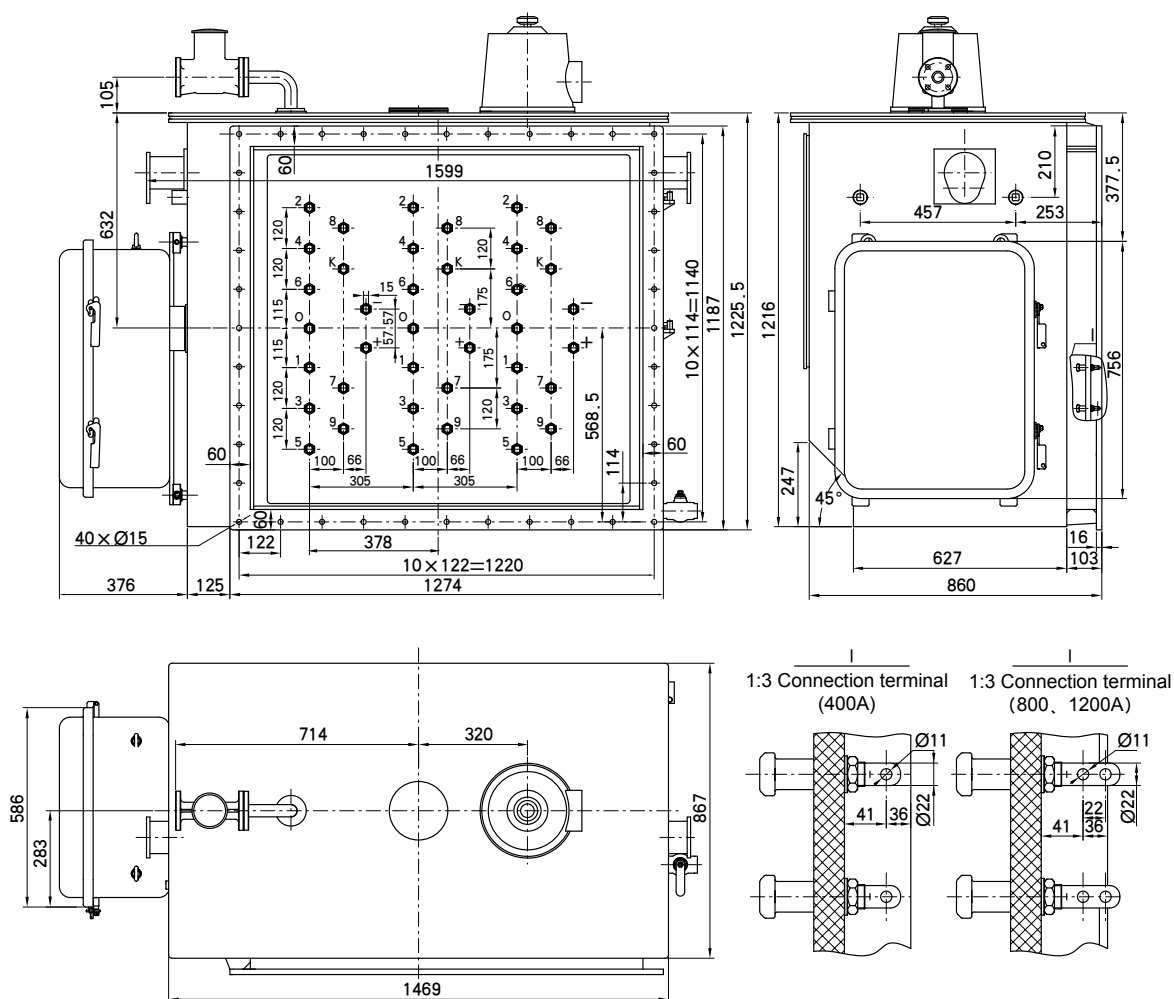
11. Painting

Type HWV OLTC and its motor drive unit can be coated with a variety of paint color according to customers' requirements when ordering. Standard paint color is RAL7040.

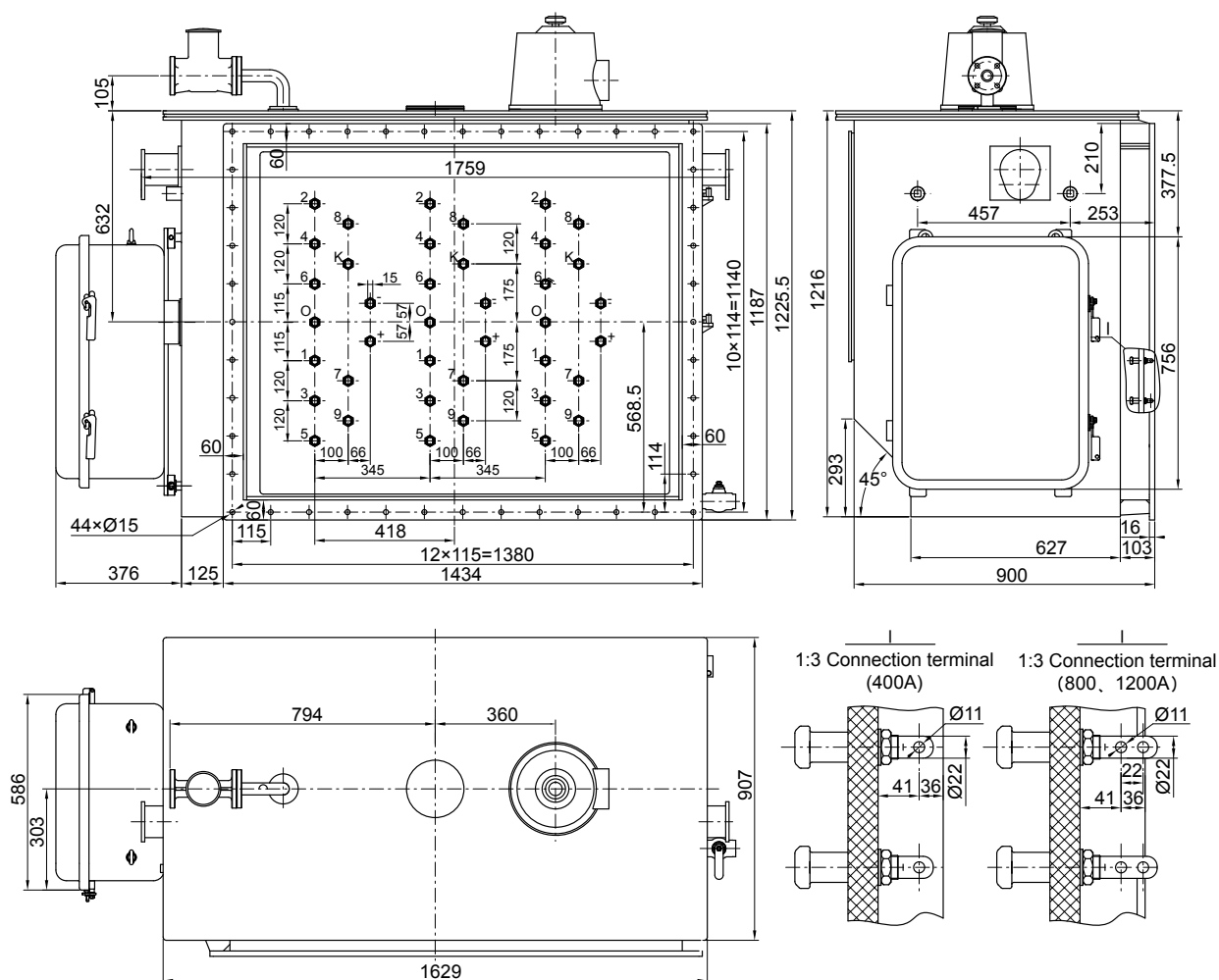
12. Appendix

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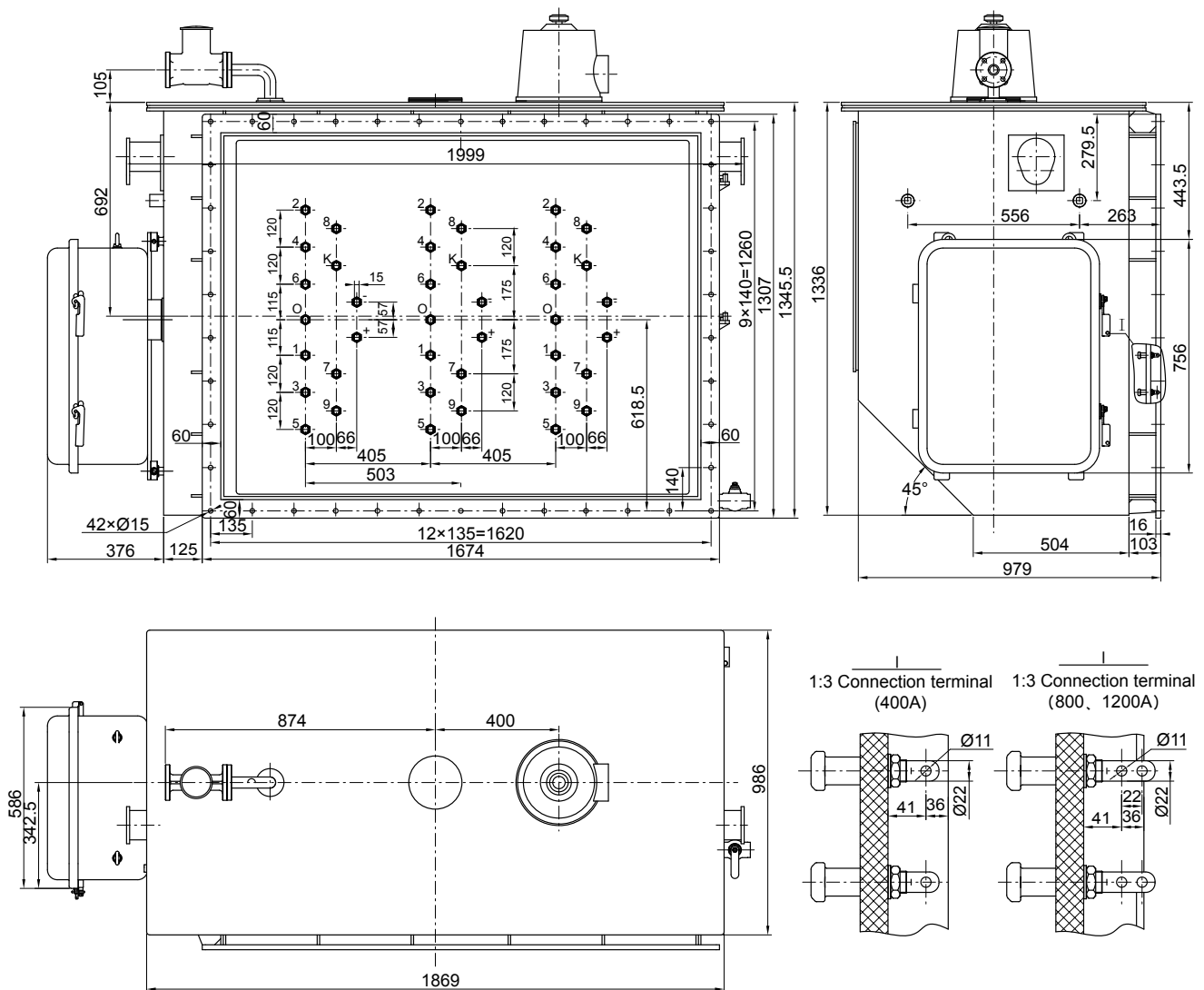
Appendix 1: HWV III -400-800-1200 /17.5KV-10 series star connection and delta connection overall dimensions (10193W)



Appendix 2 HWV III -400、800、1200 /40.5KV-10 series delta connection overall dimensions(10193W)



Appendix 3 HWV III -400、800、1200 /72.5KV-10 series delta connection overall dimensions(10193W)

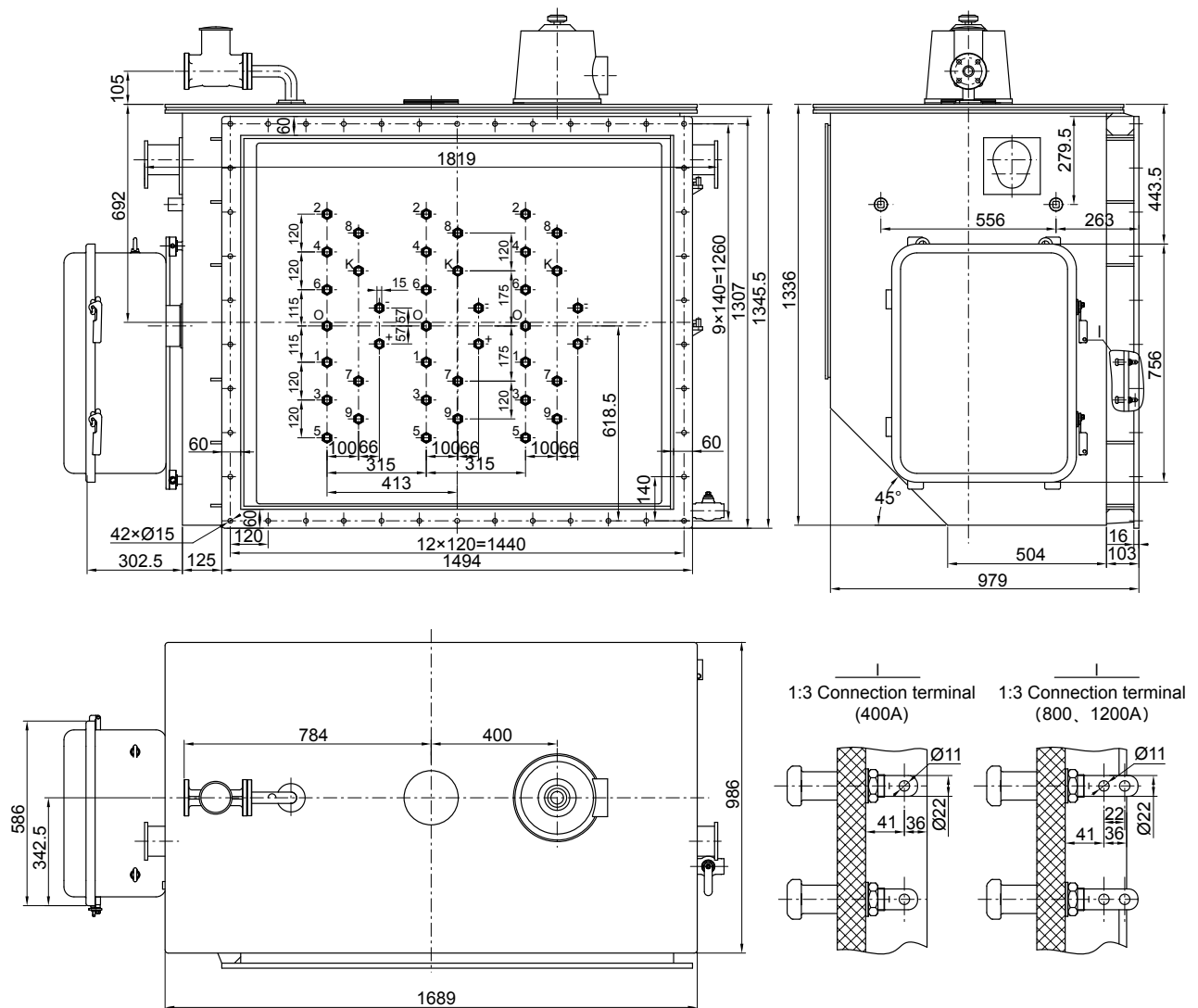


TYPE HWV EXTERNALLY-MOUNTED VACUUM OLTC TECHNICAL DATA

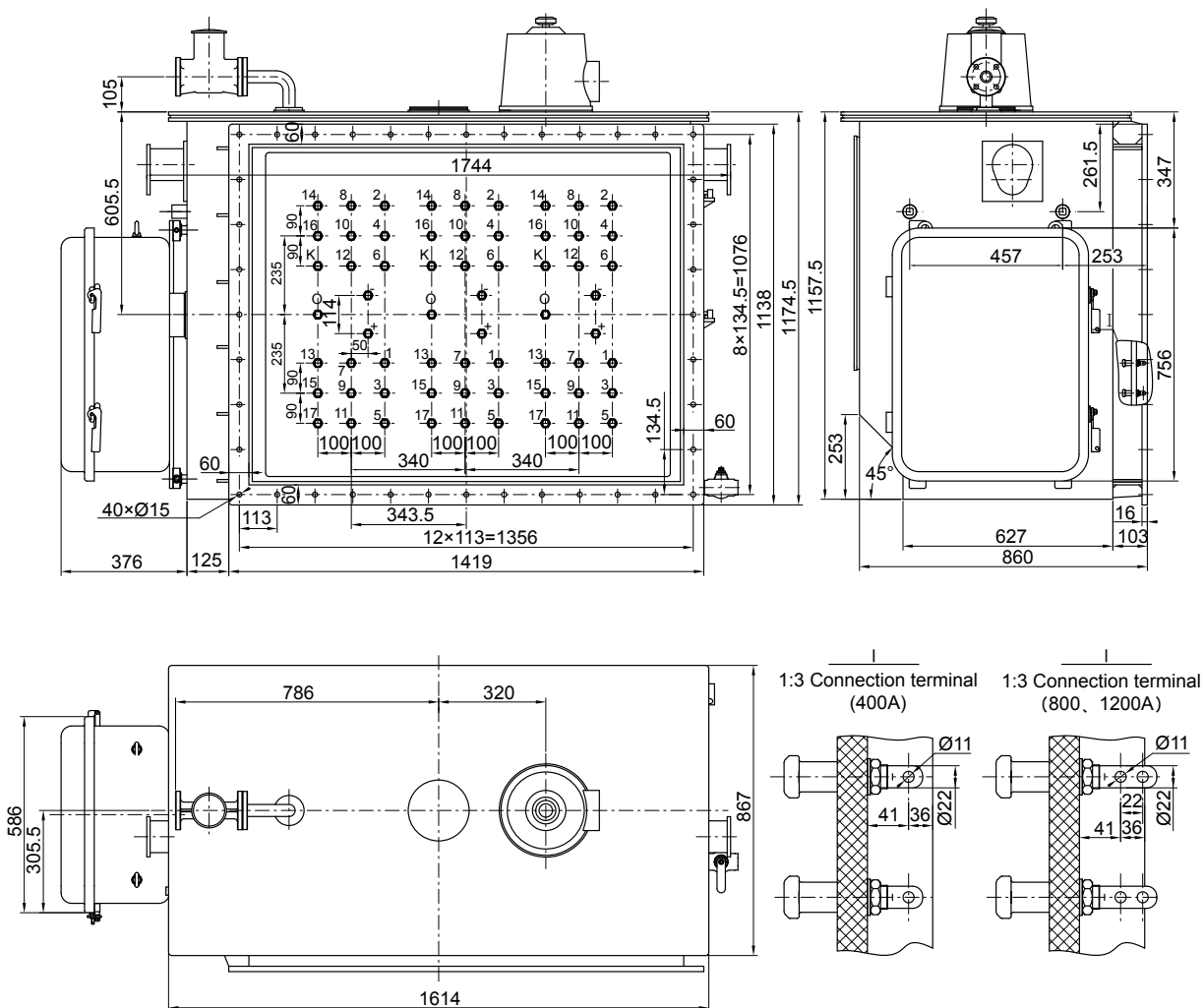


Unit: mm

**Appendix 5 HWV III -400、 800、 1200 /72.5KV-10 series star connection
overall dimensions (10193W)**

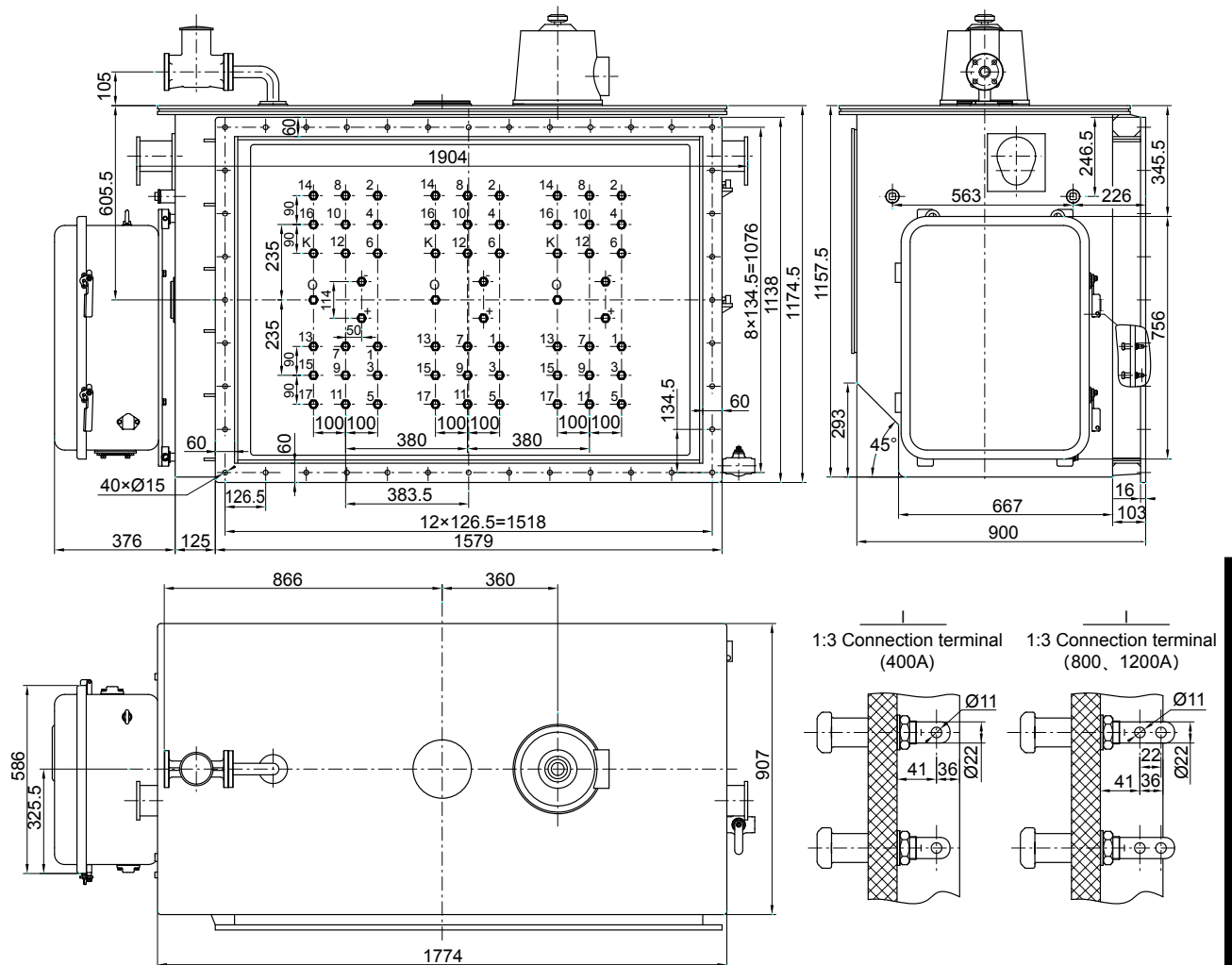


Appendix 6: HWV III -400、800、1200A /17.5KV-18 series star connection and delta connection overall dimensions (18353W)

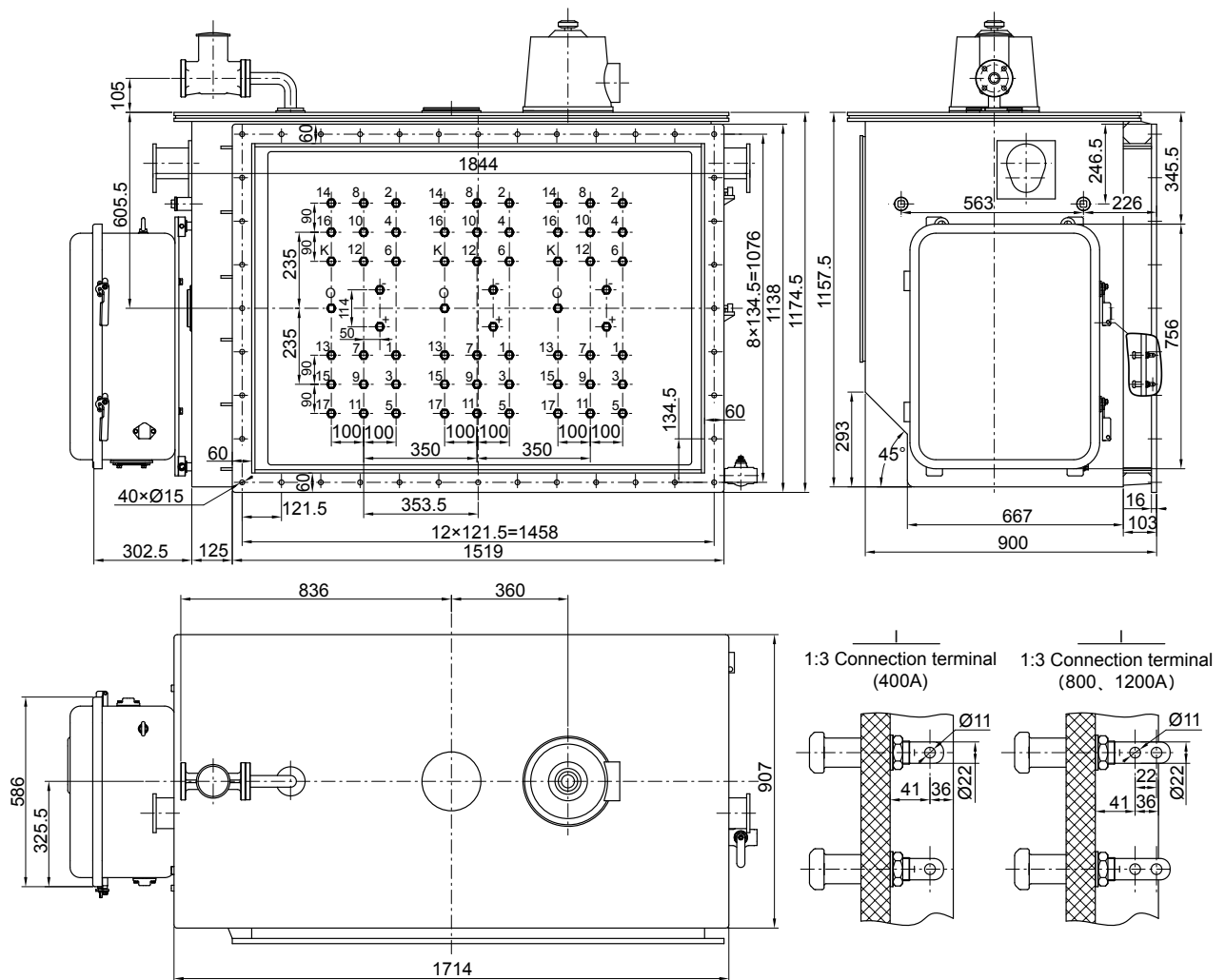


Unit: mm

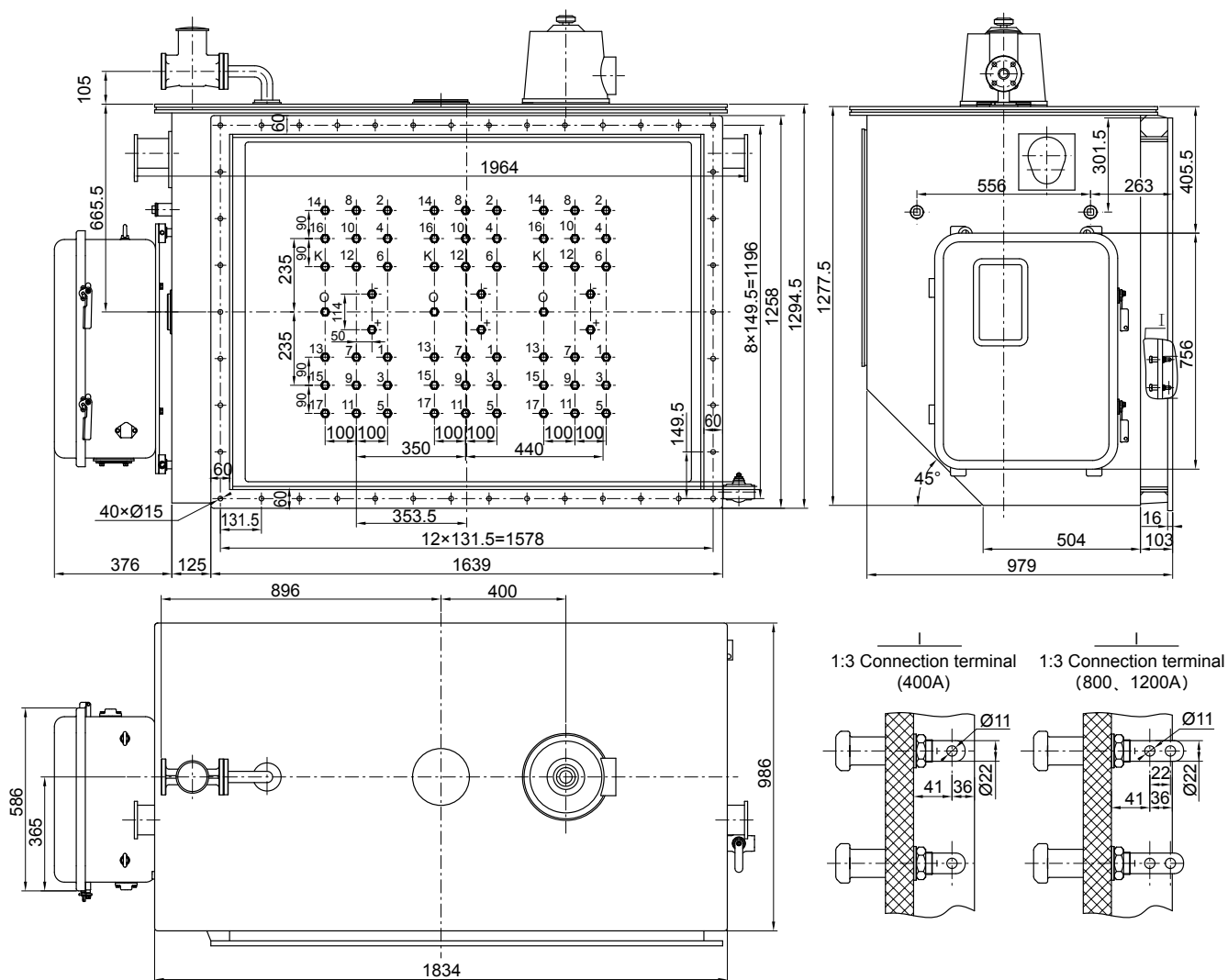
Appendix 7: HWV III -400、800、1200A/40.5KV-18 series delta connection overall dimensions (18353W)



Appendix 9: HWV III -400、800、1200A /40.5KV-18 series star connection overall dimensions (18353W)

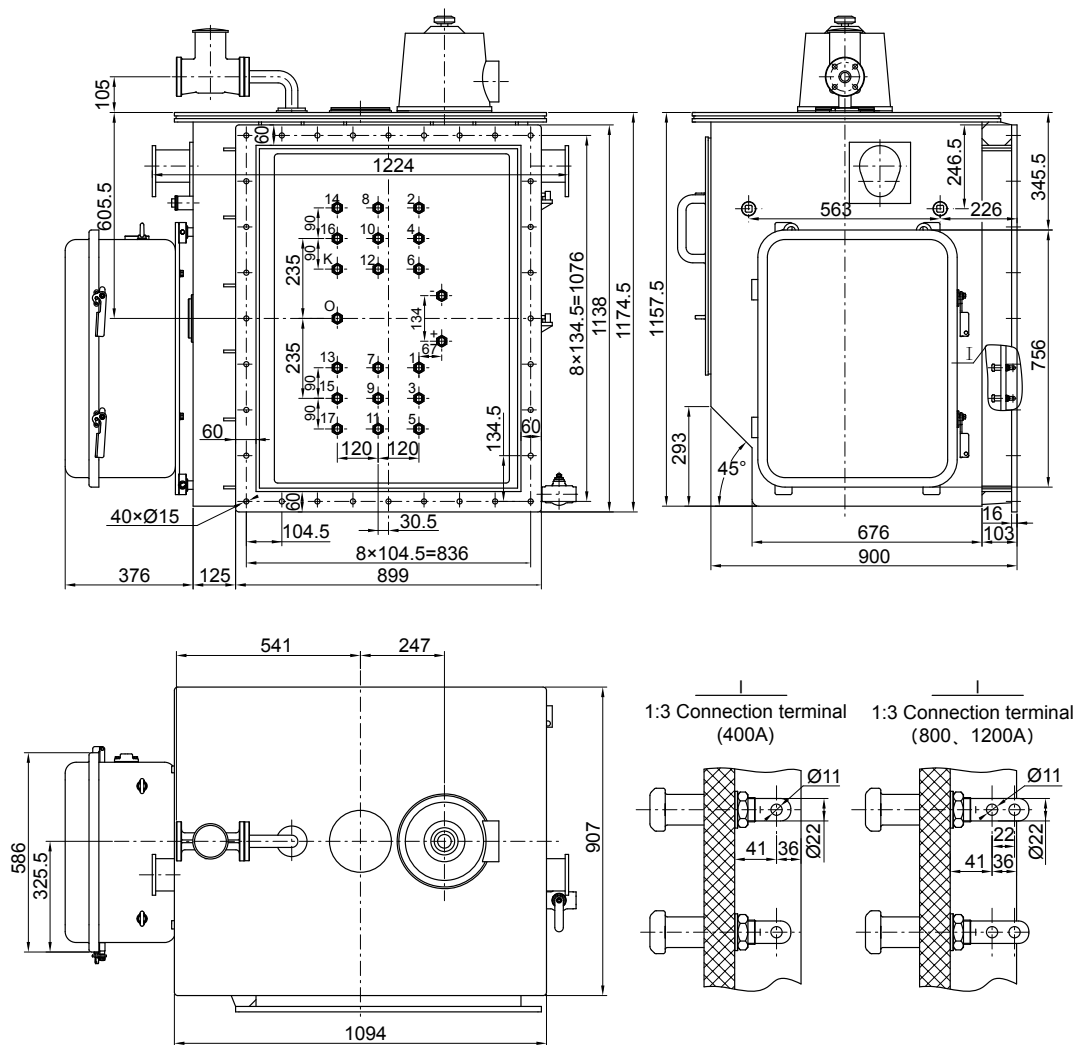


Appendix 10: HWV III -400、800、1200A /72.5KV-18 series star connection overall dimensions (18353W)

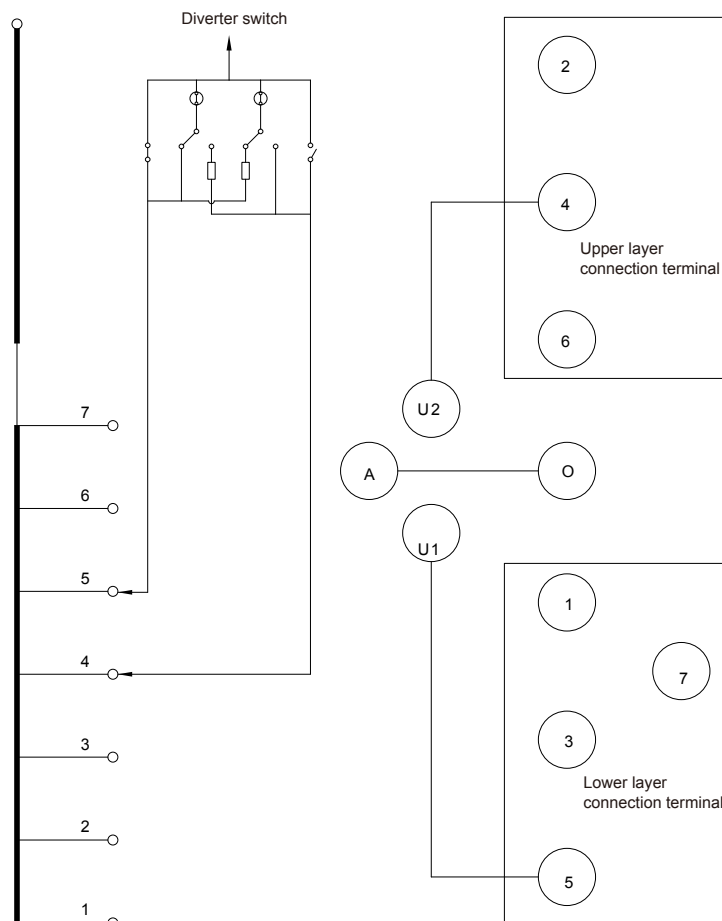


Unit: mm

Appendix 11: HWV | -400/800/1200 A/40.5KV-18 series overall dimensions (18353W)



Appendix 12: Type HWV OLTC operating position table and connection diagram (10070)



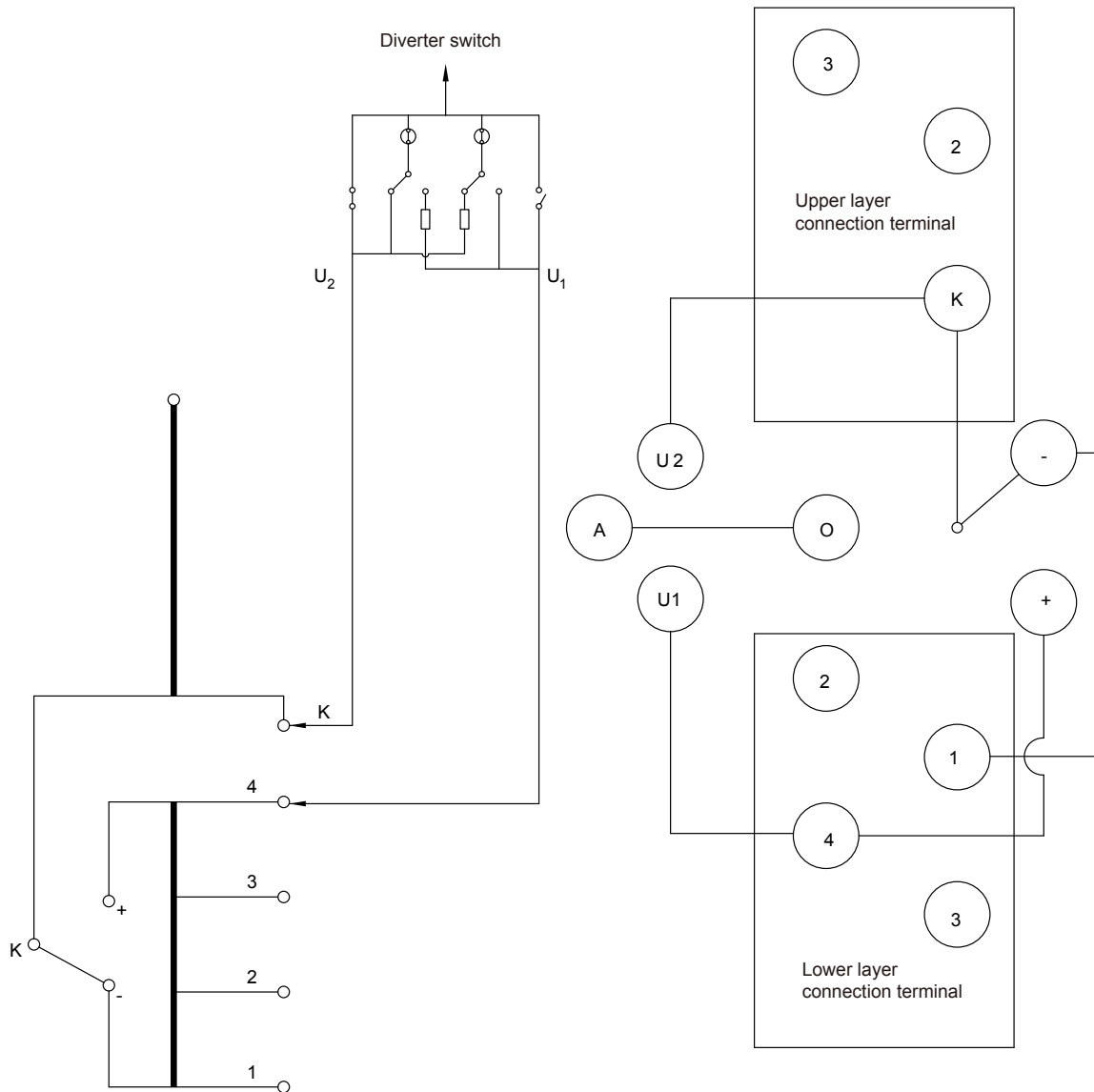
Operation position number	7
Different voltage number	7
Set position ○	4

Tap position display	1	2	3	4	5	6	7
Tap position display	1	2	3	4	5	6	7

○ ←

○ Drawing is shown at the set position

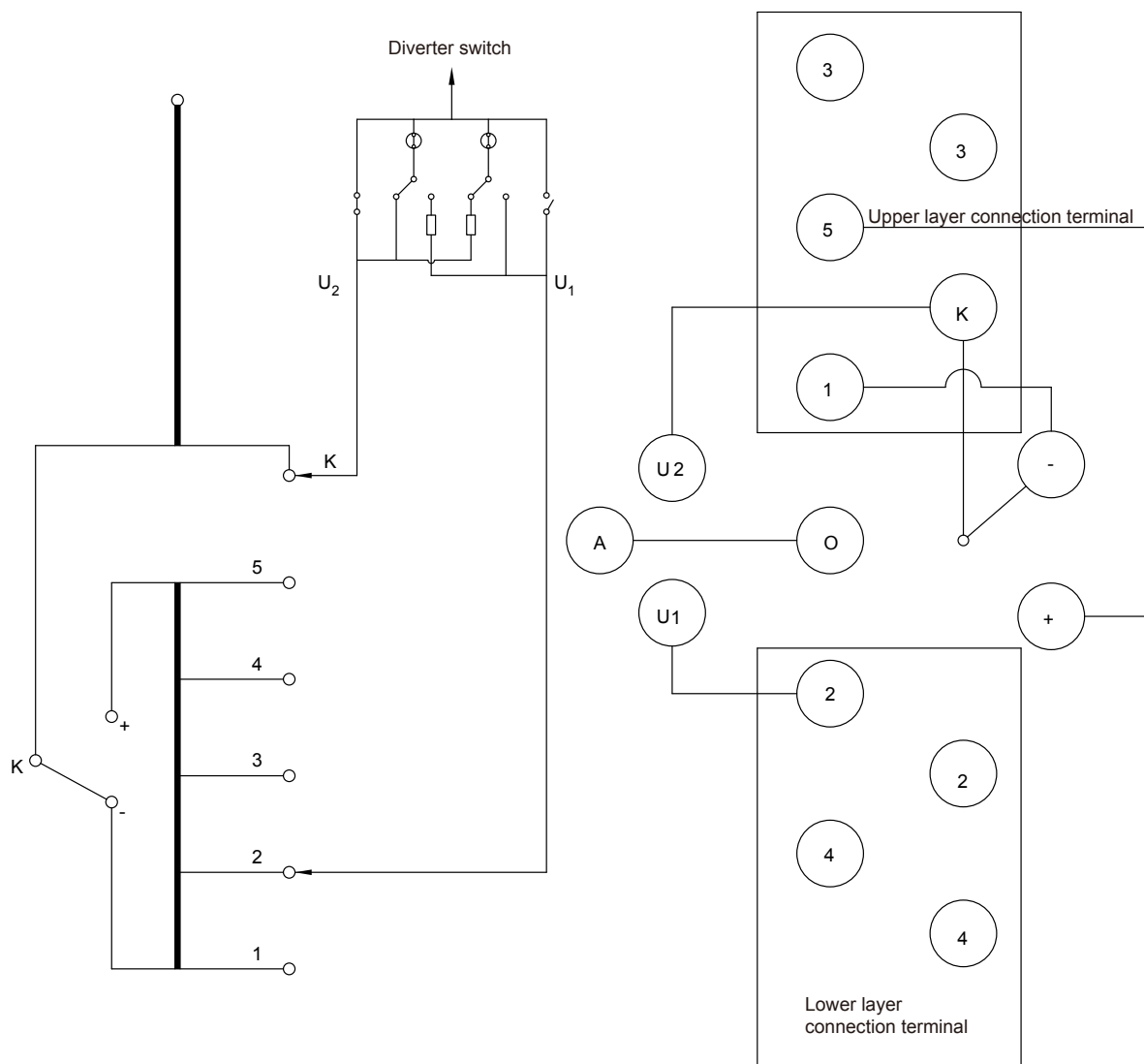
Appendix 13: Type HWV OLTC operating position table and connection diagram (10071)



Please connect 1 and "-", 4 and "+", 2 and 2, 3 and 3 with wires

Operation position number	7
Different voltage number	7
Set position ○	4

Appendix 14: Type HWV OLTC operating position table and connection diagram (10091W)

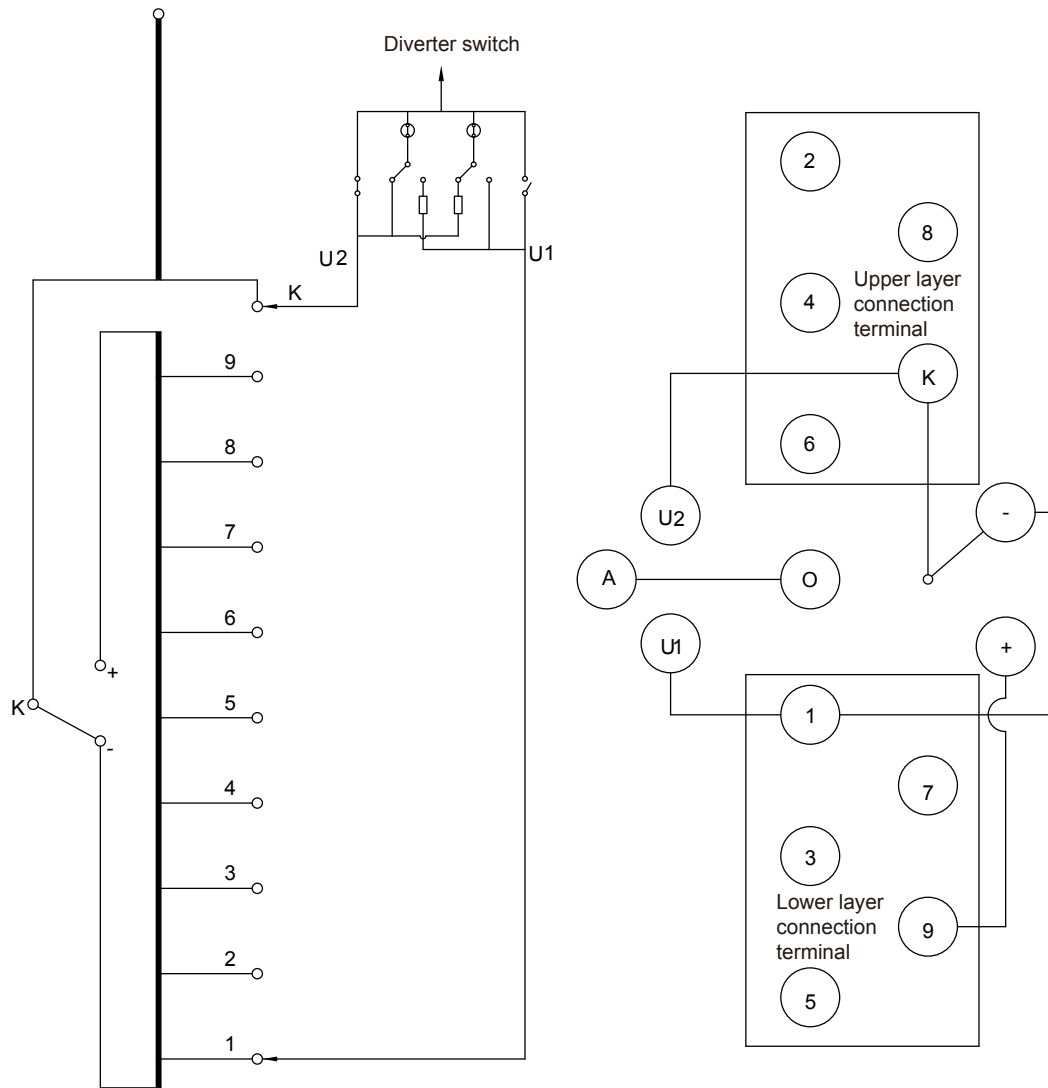


Please connect 1 and "-", 5 and "+", 2 and 2, 3 and 3, 4 and 4 with wires

Operation position number	9
Different voltage number	9
Set position ○	5

Tap selector contact	<div style="display: flex; align-items: center;"> <div style="flex: 1; text-align: center;">← K +</div> <div style="flex: 1; text-align: center;">← K - →</div> </div>								
Tap position display	1	2	3	4	K	2	3	4	5
Drawing is shown at the set position	1	2	3	4	5	6	7	8	9

Appendix 15: Type HWV OLTC operating position table and connection diagram (10191W)



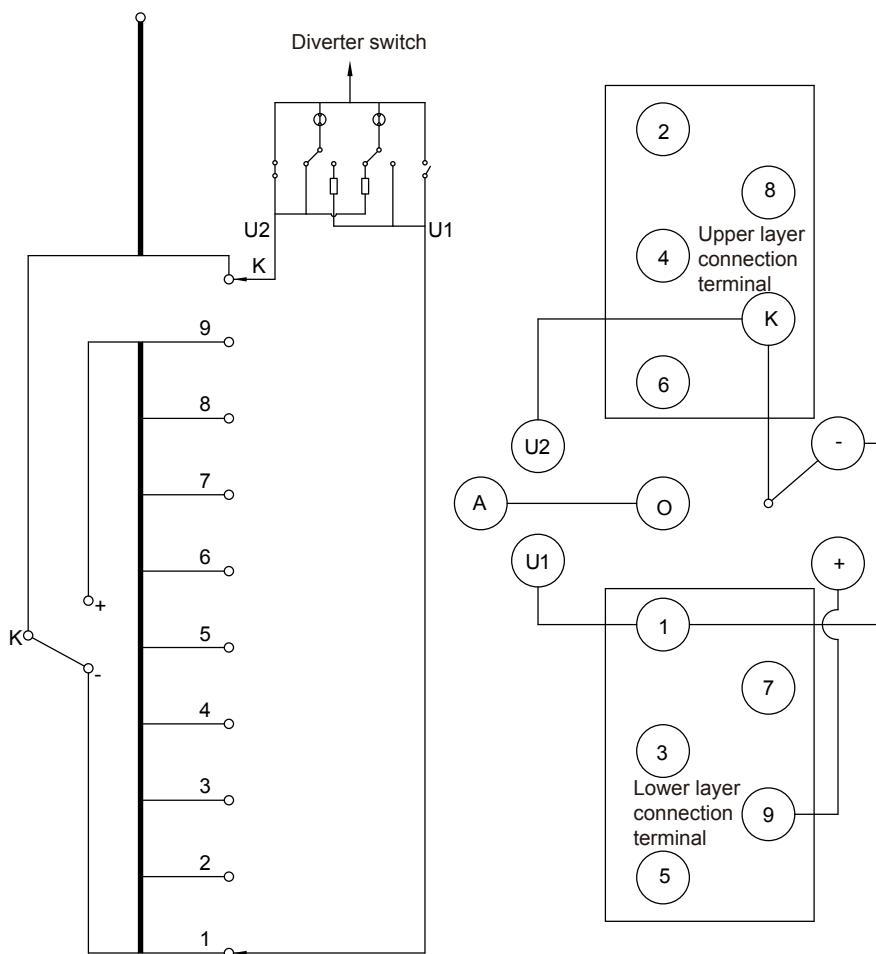
Operation position number	19
Different voltage number	19
Set position	○

Tap selector contact	<div><div>←K+</div><div>→</div></div>										<div><div>←K-</div><div>→</div></div>								
Tap position display	1	2	3	4	5	6	7	8	9	K	1	2	3	4	5	6	7	8	9
Drawing is shown at the set position	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19



○ Drawing is shown at the set position

Appendix 16: Type HWV OLTC operating position table and connection diagram (10193W)



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

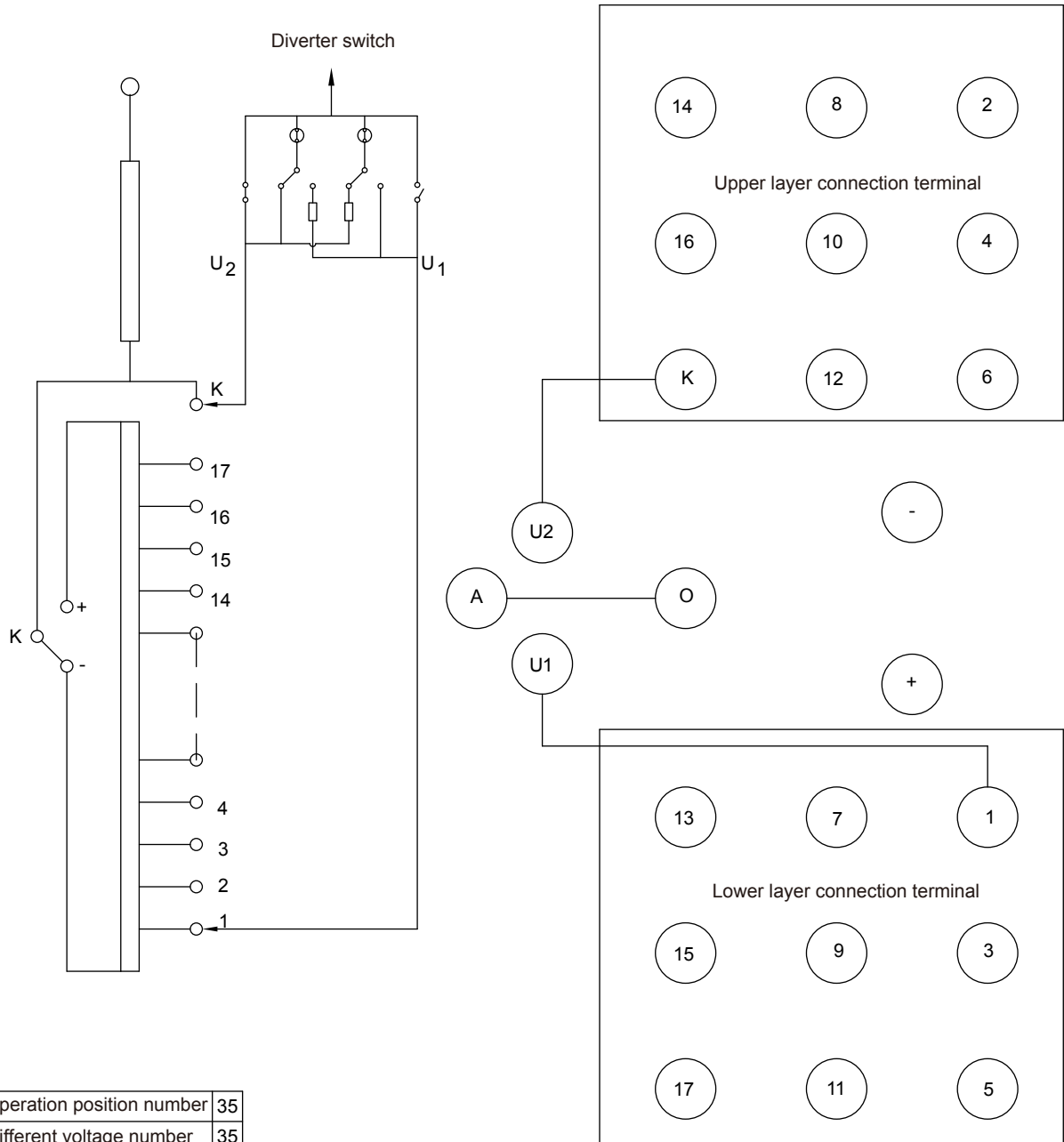
Please connect 1 and "-", 9 and "+" with wires

Tap selector contact																				
Tap position display	1	2	3	4	5	6	7	8	9	K	1	2	3	4	5	6	7	8	9	
Drawing is shown at the set position	1	2	3	4	5	6	7	8	9a	9b	9c	10	11	12	13	14	15	16	17	

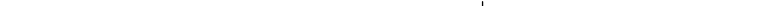
○ Drawing is shown at the set position

○ Drawing is shown at the set position

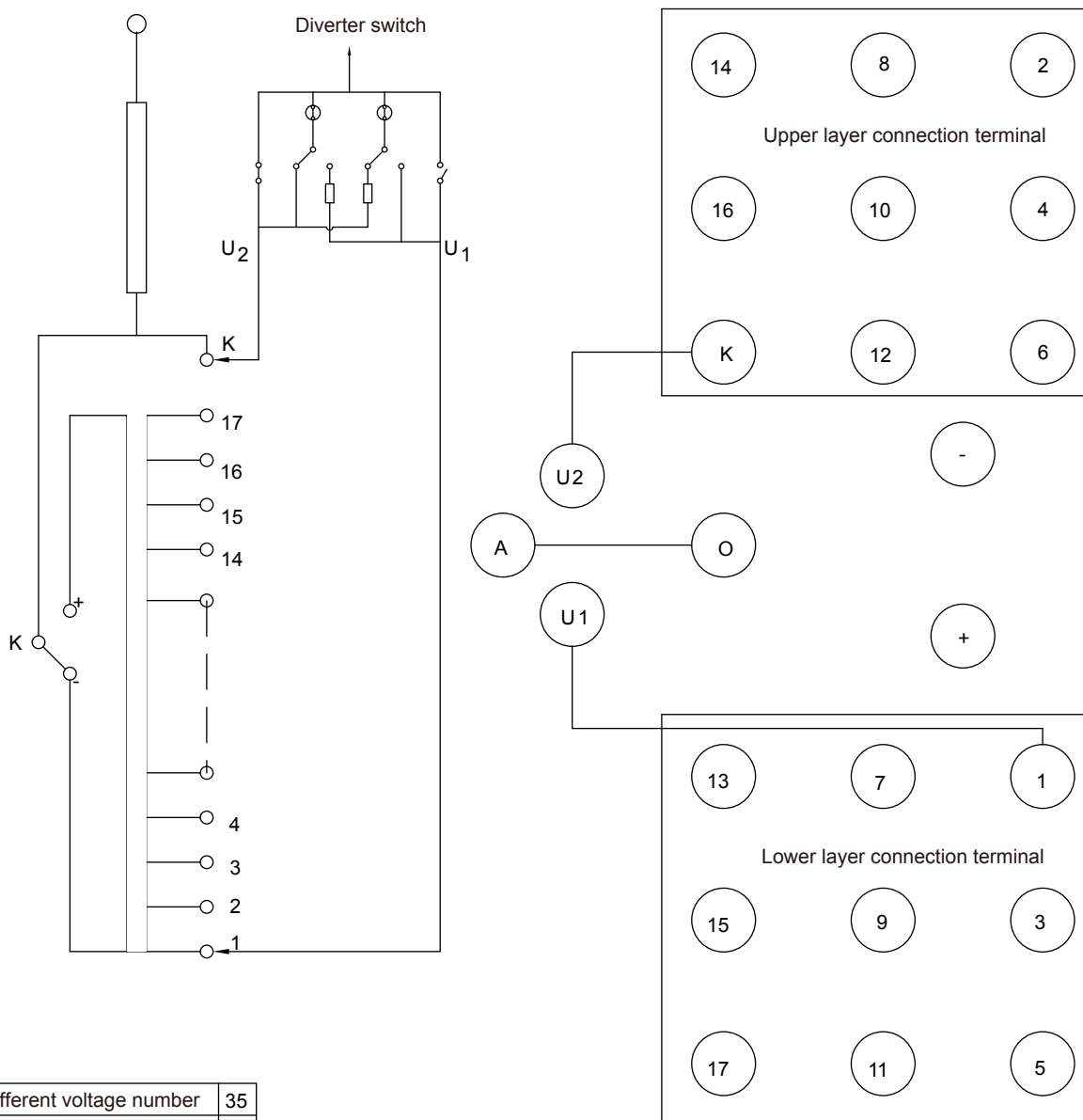
Appendix 17: Type HWV OLTC operating position table and connection diagram (18351W)



Operation position number	35
Different voltage number	35
Set position °	18

Tap selector contact																																			
Tap position display	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	k	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Drawing is shown at the set position	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

Appendix 18: Type HWV OLTC operating position table and connection diagram (18353W)



Different voltage number	35
Operation position number	33
Set position °	17b

Tap selector contact	<div><div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div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