

ZC-200 5MVA-22KV

Transformer Comprehensive Test System

User Manual V2.0

KVtester Electronics Technology Co.,Ltd.

Address: No.120, Guanggu Road, East Lake New High-tech Development Zone, Wuhan, China

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I. System Overview

This Transformer Comprehensive Test System complies with relevant standards such as IEC 60076-1—2011, IEC 60076-2—2011, and IEC 60076-3—2013.

This test bench is primarily used for testing the no-load and load characteristics of power transformers and distribution transformers. It can also be used for frequency doubling induction and power frequency voltage withstand tests on the tested transformers.

The measurement part of the device is controlled by a high-end microcontroller, with digital display. Test data such as no-load and short-circuit conditions are synchronously sampled by the microcontroller, avoiding errors caused by traditional testing methods where voltage, current, and power meters are read separately and calculated manually.

This equipment set is suitable for the production and maintenance departments of power transformers to conduct factory tests and routine tests on three-phase transformers with a capacity of 5000kVA/22KV and below. It is easy to operate, accurate in measurement, and reliable in operation.

II. Test Items

1. Transformer no-load current and no-load loss testing
2. Transformer short-circuit impedance and load loss testing
3. Power frequency withstand voltage test of transformer
4. Transformer induction withstand voltage test
5. Transformer winding resistance test
6. Measurement of Transformer Voltage Ratio and Connection Group test

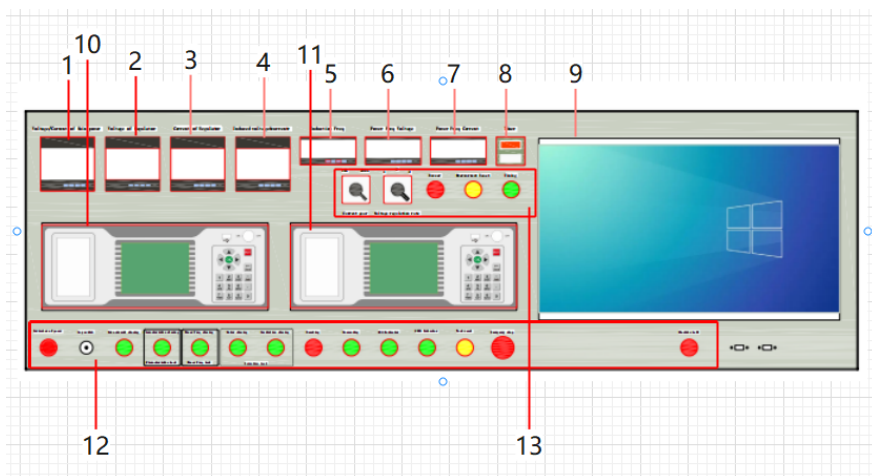
III. Technical parameters

Item	Test range	Relative error
Voltage	0.1~0.65KV	$\pm (0.2\% \text{reading} + 0.1\% \text{range})$
Current	0.1~131A	$\pm (0.2\% \text{reading} + 0.1\% \text{range})$
Power	$U \cdot I$	$\pm (0.2\% \text{reading} + 0.1\% \text{range})$
Power factor	0.01~1.00	± 3 digit
Power input	AC 380V $\pm 10\%$ 50Hz $\pm 2\%$	
Maximum capacity	5000KVA	
Rated output under power frequency withstand voltage	100KV / 50HZ	
Inductive voltage withstand rated output	850V / 150HZ	

Usage environment:

- The installation height should not exceed an altitude of 3000 meters.
- The temperature of the surrounding medium should not exceed +40°C or fall below -10°C.
- The relative humidity of the air is not higher than 85%.
- A place free from conductive dust and corrosive gases that damage metals and insulation.
- A place without explosion hazards.
- A location without vibration and with a vertical inclination not exceeding 5 degrees.

IV. Control panel description



Front Panel description:

- | | |
|--|--------------------------------------|
| 1.Voltage/Current of Main power; | 2.Voltage of Regulator; |
| 3.Current of Regulator; | 4.Voltage/Current of Generator; |
| 5.Frequency of Generator; | 6.Power frequency Voltage; |
| 7.Power frequency Current meter; | 8.Timer; |
| 9.Computer Screen; | 10.ZC-201 Transformer Power Analyzer |
| 11.ZC-208 Ratio & DC resistance tester | 12.Functional Button area; |
| 13.Gear Position area; | |

Description of the Gear Position and Functional Button area:

- Two current settings: 10A and 200A. Select the appropriate setting based on the current level
- Three frequency gears: Gear 1, Gear 2, and Gear 3 are used to adjust the

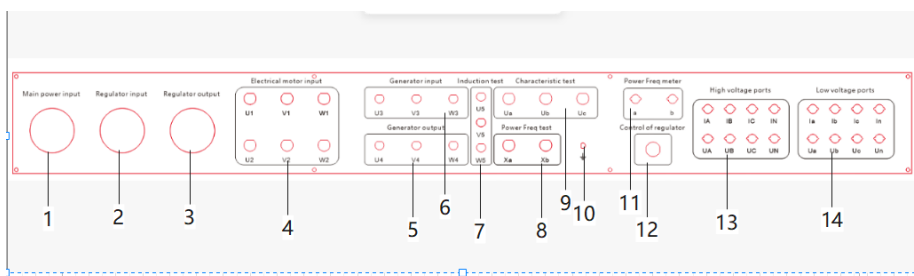
speed of the voltage regulator's rotation

3. Three signal lights: Power Indicator, 10A Indicator, 200A Indicator

4. Three switches: Key switch, Main circuit closing, Motor start

5. Three test buttons: Load & No-Load closing, Power frequency closing, Excitation closing, used for no-load characteristic test, power frequency withstand voltage test, and induced withstand voltage test.

6. Seven control buttons: Boosting for voltage boosting, Descending for voltage reduction, Emergency Stop for emergency stop, Test reset and Overcurrent Reset for resetting, Electric bell and Buzzer for warning to keep away during the test.



Rear Panel description:

- | | |
|---------------------------|--------------------------------|
| 1.Main power input; | 8.Power Freq test; |
| 2.Regulator input; | 9.Characteristic test; |
| 3.Regulator output; | 10.Grounding post; |
| 4.Electrical motor input; | 11.Power frequency meter port; |
| 5.Generator output; | 12.Control of regulator port; |
| 6.Generator input; | 13.High voltage ports; |
| 7.Induction test; | 14.Low voltage ports; |

V. Introduction of Operation

This test system consists of a control console, voltage regulator, medium-frequency generator set, and high-voltage test transformer, and can be used for factory tests of power transformers up to and including 22kV.

After turning the "Key switch" on the operation console, the "Indicator of power" light will illuminate, indicating that the secondary circuit power is connected. If the voltage regulator is not at zero position, it will automatically return to zero. Once the voltage regulator returns to zero, the following tests can be conducted:

- 1). DC resistance test;
- 2). Transformation ratio test;
- 3). Low Voltage Test;
- 4). High Voltage Test;
- 5). AC High Voltage Test;
- 6). Induced voltage withstand test;

Before conducting any tests, please read the manuals for the DC resistance tester, transformation ratio tester, transformer parameter tester, voltage regulator, and medium-frequency generator set in detail. Strictly follow the wiring instructions before proceeding with the various tests.

A. No-load test of transformer

1. Cable Wiring: Connect the wires according to Figure 1, ensuring the phase sequence is correct.

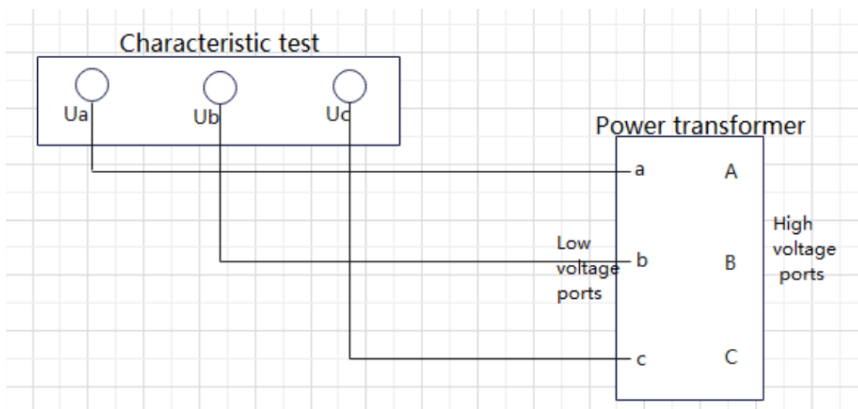


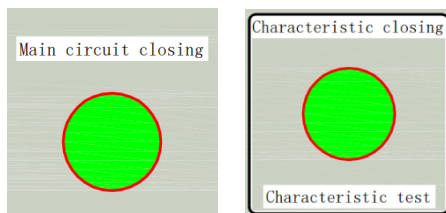
Figure 1 Wiring for transformer no-load test

2. Gear selection: Select the appropriate current gear based on the transformer capacity. The current gear is adjusted through the "Current gear" setting, and the corresponding signal light will illuminate after selection.

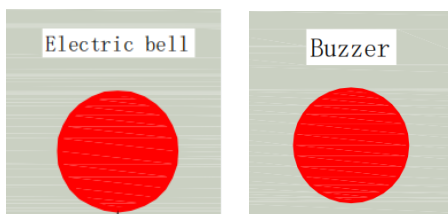
Note: The current gear should be selected based on the rated current of the low-voltage side of the tested transformer. For example, for a S11 type 200kVA, 10kV/0.4kV transformer, the national standard stipulates that its no-load current percentage should not exceed 1.5%. If the rated current on the low-voltage side is $I=288.7A$, then the no-load current $I=4.33A$. Therefore, the current gear should be selected to be greater than 4.33A, and the 10A Indicator gear can be chosen. Set the current transformation ratio $I_K=1$ in the screen; voltage transformation ratio $I_K=1$.

Note: Do not switch while the device is on line, otherwise it will be damaged.

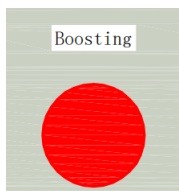
Closing: Pressing the "Main circuit closing" and "Characteristic test" buttons indicates that the main circuit contactor for the no-load test is engaged and self-locked. At this time, the "Main circuit closing" and "Characteristic test" lights are illuminated.



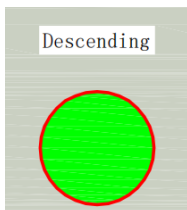
Warning: Press "Electric bell" and "Buzzer", the light will turn on, and non-test personnel should evacuate from the tested transformer.



3. Boosting: Press the "Boosting" button, the light will turn on, and the voltage regulator will start to boost the voltage. When the average output voltage displayed by the voltage regulator reaches the rated voltage of 415V on the low-voltage side of the tested transformer, stop boosting. During the boosting process, it is necessary to closely monitor the three-phase power supply. If one or two of the three-phase currents rise abnormally, it indicates that the tested transformer is abnormal (it is normal for the three-phase currents to be slightly inconsistent). The voltage should be reduced and the power cut off for inspection.



4. Voltage Reduction: Press the "Descending" button, the light will illuminate, allowing the voltage regulator to return to zero.



Opening: Follow the sequence, first press "Characteristic test", then press the "Main circuit closing" button. At this point, the "Characteristic test" and "Main circuit closing" lights will turn off, indicating that the experiment is complete.

B. Transformer load test

1. Cable wiring: Connect the wires according to Figure 2, ensuring the phase sequence is correct.

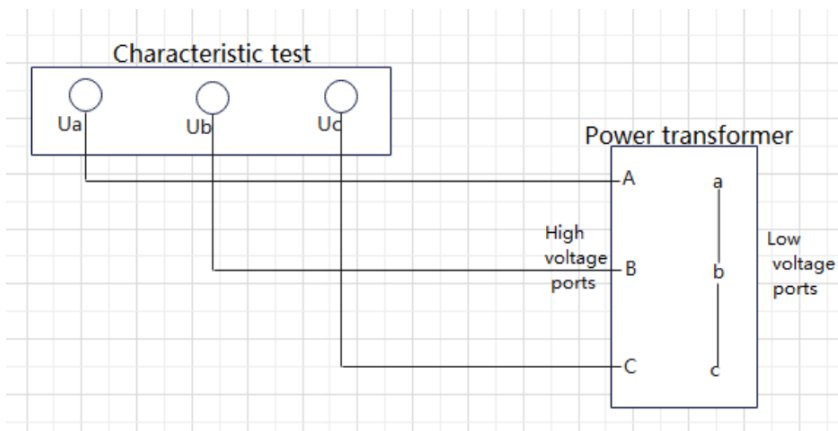


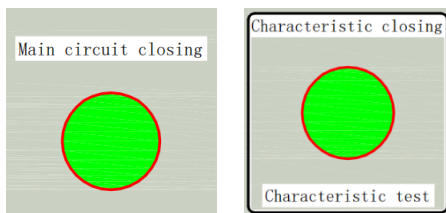
Figure 2: Wiring for Load Test

2. Selecting the current gear: Choose the appropriate current gear based on the transformer capacity. The current gear is adjusted using the 10A Indicator and 200A Indicator. After selection, the corresponding signal light will illuminate.

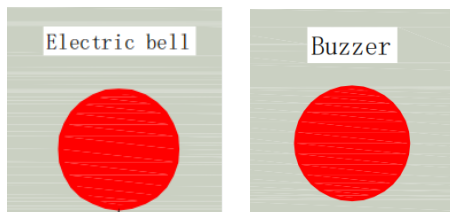
Note: The current range should be selected based on the rated current of the low-voltage side of the tested transformer. For example, for a S11 type 5000kVA, 22kV/0.4kV transformer, the national standard specifies a short-circuit impedance percentage of 6%. The load current I is 131.2A. Therefore, the current should be set to the 200A Indicator range, with the current transformation ratio $I_K = 20$ and the voltage transformation ratio $I_K = 1$ in the settings screen.

Note: Do not switch while the equipment is on line, otherwise it will be damaged.

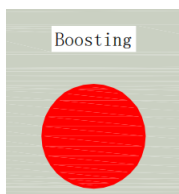
3. Switching on: Pressing the "Main circuit closing" and "Characteristic test" buttons indicates that the main circuit contactor for the load test has been engaged and locked. At this point, the "Main circuit closing" and "Characteristic test" lights will be illuminated.



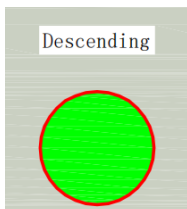
4. Warning: Press "Electric bell" and "Buzzer", the light will turn on, and non-test personnel should evacuate from the tested transformer.



5. Boosting: Press the "Boosting" button, the light will turn on, and the voltage regulator will start boosting. When the average output current of the voltage regulator displays the rated current of the low-voltage side of the tested transformer, stop boosting. During the boosting process, the three-phase power supply must be closely monitored. If one or two phases of the three-phase current rise abnormally, it indicates that the tested transformer is abnormal (it is normal for the three-phase currents to be slightly inconsistent). The voltage should be reduced and the power cut off for inspection.



6. Pressure Reduction: Press the "Descending" button, the light will illuminate, indicating that the pressure regulator has returned to zero.



7. Opening: First, press "Characteristic test"; then press the "Main circuit closing" button. At this point, the "Characteristic test" and "Main circuit closing" lights will turn off, indicating that the experiment is complete.

C. AC voltage withstand test of transformer

1. Wiring: Connect the wires as shown below, set the withstand voltage time to 60s, and evacuate non-test personnel from the tested transformer.

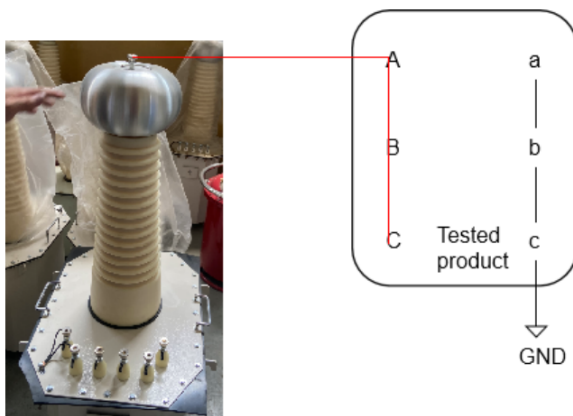
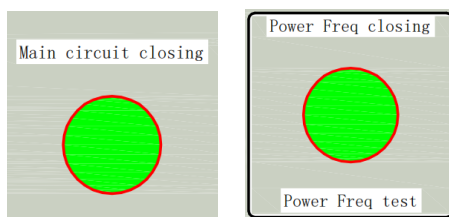


Figure 3 Connection between the test transformer and the tested object

2. Closing: Press the "Main circuit closing" button, then press the "Power Freq closing" button, and the main contactor of the test circuit will engage and self-lock.



3. Press the "Boosting" button and closely monitor the tested transformer, power frequency output current, and power frequency output voltage during the boosting process. Stop boosting when the "Power frequency Voltage" reaches the specified value.

4. Turn on the time relay. If everything is normal, the voltage regulator will automatically return to zero after timing for 60 seconds.
5. Press the "Power Freq closing" and "Main circuit closing" buttons to complete the voltage withstand test.

D. Induced voltage withstand test

1. Wiring: Connect the corresponding low-voltage side (a, b, c) of the tested transformer as shown below, with the high-voltage side open-circuited. Ensure the phase sequence is correct.

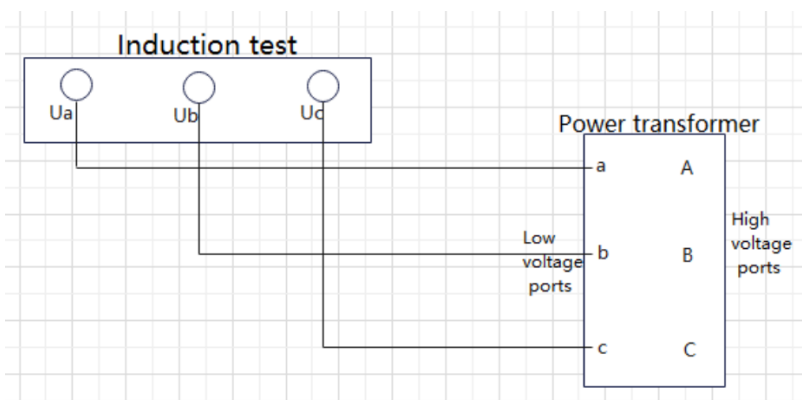
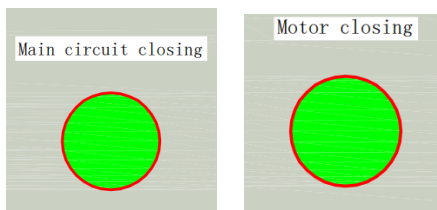
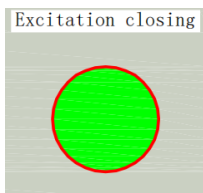


Figure 4: Wiring for Induced Voltage Withstand Test

2. Closing: Press the "Main Circuit Closing" button, and then press the "Motor Start" button.



3. Excitation: Press the "Excitation Closing" button to input excitation current to the generator. Monitor the excitation ammeter, generator output voltage, and output current. When the low-voltage induction withstand voltage meter reaches 850V, stop increasing the voltage. Set the time to 40s, turn on the time relay, and start the withstand voltage timing. When the time is up, the buzzer sounds, and the voltage regulator automatically returns to zero.



4. Press "Excitation Closing" to proceed with the voltage withstand test on the second transformer without stopping the motor.

5. Circuit Breaking: First, press the "Descending" button to reduce the voltage of the voltage regulator to zero. Then, press the "Excitation Closing" button to disable the excitation output. After that, press the "Main Circuit Closing" button to shut down the motor. If the corresponding lights go out, the circuit breaking is successful.

E. Transformer Ratio & DC resistance test

Please refer to the User Manual of ZC-208 Transformer Winding Resistance and Ratio Comprehensive Tester.

VI. Precautions on Generator set and HV Transformer

1. Generator set

1.1 Check before installation

- 1) Carefully check the data on the nameplate to confirm that the motor model meets the usage requirements.
- 2) Use a 500V megohmmeter to measure the insulation resistance of the motor winding to the casing, which should be greater than 0.5M.

1.2 Installation

- 1) Electric motors are generally installed indoors in clean and dry locations with good ventilation. The maximum ambient air temperature should not exceed 40℃, and the minimum temperature should not be lower than -15℃. Strong thermal radiation should be avoided.
- 2) The motor control apparatus is equipped with phase loss protection and overload thermal protection devices. For YA series increased safety motors, appropriate overload thermal protection devices must be selected based on the tE time on the nameplate and the starting current ratio I_A/I_N .
- 3) Connect the power cord according to the wiring diagram. The connection of the wiring terminal should be secure. For motors with outgoing cables and wires, they can be directly connected to the power cord, and the joint should be insulated and sealed.
- 4) When the phase sequence of the power cord corresponds to the markings on the motor terminal, the motor rotates clockwise when viewed from the shaft end. To change the direction of rotation, simply swap the positions of the two power cords.
- 5) The YD series variable-pole multi-speed asynchronous motors utilize the method of changing the outgoing line connections to control speed variations. To

ensure the reliability of multi-speed motor operation, attention should be paid during the design and operation of the control device. When switching from high speed to low speed, the neutral point of the 2Y wiring must be disconnected simultaneously with the power supply being cut off, to avoid causing a power short circuit when the low-speed winding is connected. During the process of switching from high speed to low speed, the power supply to the low-speed winding must be connected only after the motor has stopped rotating, in order to reduce the impact on the motor and load. When switching speeds, attention should be paid to the direction of rotation of the motor.

6) Electric motors can be connected to load machinery through couplings, gears, or belts. For 2-pole motors above 4kw and 4-pole motors above 30kw, belt drive is not recommended. The second shaft extension of dual-shaft extension motors can only be driven by couplings. The fit between the coupling, pulley shaft hole, and motor shaft should be properly tightened or loosened, and it is strictly prohibited to use a heavy hammer to strike during installation.

7) When using a coupling for transmission, the centerline of the motor shaft should coincide with the centerline of the load machinery shaft, with a 1PRI3mm axial gap reserved for the coupling.

8) When using belt transmission, the centerline of the motor shaft should be parallel to the centerline of the load machinery shaft, and the centerline of the belt should be perpendicular to the centerline of the shaft.

1.3 Grounding

The electric motor must be reliably grounded, and the grounding method, grounding resistance, etc. should comply with the provisions of electrical safety management such as the "Grounding Design Code for Industrial and Civil Power Installations" and the "Technical Code for Factory Power Design". The grounding resistance should be less than 4 ohms.

1.4 Trial run

- 1) After switching on, the motor should start immediately, reach normal speed, and operate smoothly. Otherwise, the power should be cut off immediately to check and eliminate the fault.
- 2) After starting, pay attention to observing the motor, transmission device, load machinery, voltmeter, and ammeter. If any abnormalities are observed, shut down the machine immediately.
- 3) The no-load continuous starting of an electric motor should generally not exceed 4 times, and after running to thermal state and stopping, the continuous starting should not exceed 2 times, otherwise the electric motor is prone to burnout.
- 4) Based on factors such as grid capacity, load size, and motor power, the starting method should be reasonably selected. For high-power motors, it is advisable to use the star-delta connection method or a reduced-voltage starting method.

1.5 Precaution when run the generator set

- 1) The unit requires no-load confirmation of its direction of rotation, which is verified by detecting the output frequency. When the output frequency is 150HZ, the direction of rotation and rotor phase sequence are correct. When the output frequency is 50HZ, the unit must be shut down to adjust the phase sequence of the prime mover or the rotor phase sequence of the generator, so that the output frequency can be adjusted to 150HZ for load operation. It is strictly prohibited to operate the unit at 50HZ with load.
- 2) When the unit is under load, it must be loaded slowly by adjusting the input voltage of the generator rotor. When unloading, it must be gradually reduced to a light load state. Instantaneous heavy load changes are strictly prohibited, as they may cause torsional vibration in the unit, endangering the main shaft system.
- 3) The deviation between the source voltage and the rated voltage should not

exceed +5%, and the imbalance of the three-phase voltage should not exceed 1.5%.

4) The operating current of the motor should not exceed the rated current indicated on the nameplate, and the imbalance of the three-phase current should not exceed 5%. Otherwise, it may cause the motor to heat up or even burn out.

5) The temperature measured by a thermometer on the surface of the motor housing should not exceed 80℃, and the temperature of the bearing should not exceed 95℃.

6) The motor should be kept clean, dry, and well-ventilated, and the air inlet and outlet must be kept unobstructed.

7) If the motor emits smoke, vibrates violently, produces abnormal noise, emits a special odor, or experiences a significant decrease in speed: the load equipment has malfunctioned; in the event of personal electric shock, the power should be immediately cut off and the machine stopped.

8) It is strictly prohibited to operate under overload conditions for extended periods.

1.6 Bearing lubrication

1) The motor bearing should be well lubricated. Generally, after operating for 3000~5000 hours, the machine should be stopped for maintenance, replenishment, or replacement of lubricating grease. The brand of lubricating grease is ZLPRI3 lithium-based grease.

2) Before using electric motors that have been stored or not in use for more than two years, the lubrication condition of the bearings should be inspected, and the lubricating grease should be replenished or replaced if necessary.

3) The amount of lubricating grease to be added should be appropriate, generally filling 1/3 to 1/2 of the cavity between the inner and outer rings of the bearing. For

motors equipped with a grease injection device, use a lubrication gun to add 3 to 4 drops of grease. Before adding, open the drain hole or cover plate at the bottom of the bearing cover. After the motor has run for 20 minutes, block the drain hole or replace the cover plate. When disassembling or assembling the drain hole plug or cover plate, power off and shut down the motor.

2. HV Transformer

1) Set the overcurrent and overvoltage protection values for the measurement meter head. The overvoltage protection value is set at 121kV and the overcurrent protection value is set at 135A at the factory, based on the rated operating voltage and current of the equipment. Users can reset these values according to their testing needs, and can refer to the instrument manual provided later.

2) Connect the working circuit according to the wiring diagram. The casing of the test transformer and the casing of the operating system must be reliably grounded. The X terminal (high-voltage tail) of the high-voltage winding of the test transformer must also be reliably grounded.

3) Before connecting the power supply, the voltage regulator of the operating system must be adjusted to zero before connecting the power supply, closing the switch, and starting to increase the voltage.

4) Press the voltage increase button from zero. The methods of voltage increase include: rapid voltage increase method, which involves continuously pressing and holding the voltage increase button; slow voltage increase method, which involves intermittently pressing the voltage increase button; after the voltage is increased from zero to 75% of the required rated test voltage according to a certain voltage increase method and speed, the required rated voltage is increased using the jog voltage increase method, and then timing begins. During the voltage withstand test, pay close attention to the indications of the measuring instruments, as well as the condition of the tested object and the on-site situation. If any abnormalities are found in the indications of the measuring instruments or the condition of the

tested object during the voltage increase process or the test process, the voltage should be immediately reduced, the power supply should be cut off, and the situation should be investigated.

5) After the test is completed, press the pressure reduction button to return the pressure regulator to zero position within a few seconds, and then cut off the power supply.

6) This product must not be used beyond its rated parameters. Except for necessary testing, it is strictly prohibited to be powered on or powered off at full voltage.

VII. Instructions for using the testing software

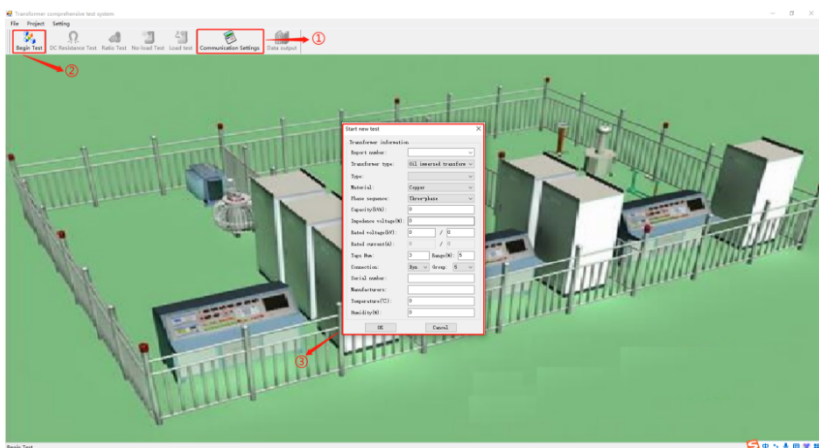
The computer software can achieve control testing, data analysis and export, and automatic judgment of winding test status through serial port connection, which is particularly suitable for multi-tap transformers.

1. Open this icon on the computer desktop to enter the detection interface.



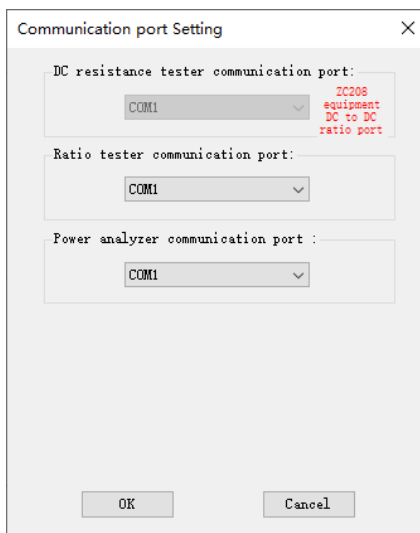
Main interface of testing software

2. Before starting the test, establish a test archive for the test subject according to the following sequence



To use the software for the first time, you need to connect to the instrument by setting up the serial port. Here's how:

2.1 Click on [Communication Settings] in the software interface (as in step ① of the main configuration interface), and select the serial port number corresponding to the experimental project to complete the communication settings; as shown in the figure below.



2.2 Click on [Begin Test] (as in step ② of the main configuration interface) to enter the parameter settings before the experiment, as shown in the figure below.

Start new test

×

Transformer information

Report number: 0111111

Transformer type: Oil immersed transform

Type:

Material: Copper

Phase sequence: Three-phase

Capacity(kVA): 100

Impedance voltage(%): 4.5

Rated voltage(kV): 10 / 0.4

Rated current(A): 5.773503 / 144.3376

Taps Num: 3 Range(%): 5

Connection: Dyn Group: 5

Serial number:

Manufacturers:

Temperature(°C): 0

Humidity(%): 0

OK

Cancel

Input the corresponding parameters based on the actual parameter information of the tested object. After inputting the tested object's parameters, the menu of test items on the main interface becomes editable. The main interface is shown below.



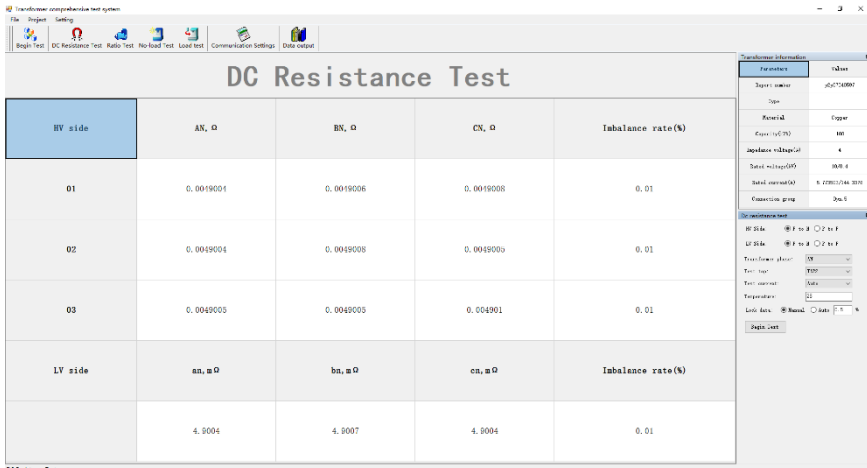
A. DC Resistance test

After setting the parameters for the experiment, click on [DC Resistance Test] to enter the DC resistance test interface shown below.

DC Resistance Test				
HV side	AN, Ω	BN, Ω	CN, Ω	Imbalance rate(%)
01				
02	0.003744	0.0037441	0.0037442	0.00
03				
LV side	an, mΩ	bn, mΩ	cn, mΩ	Imbalance rate(%)

DC resistance test setting interface

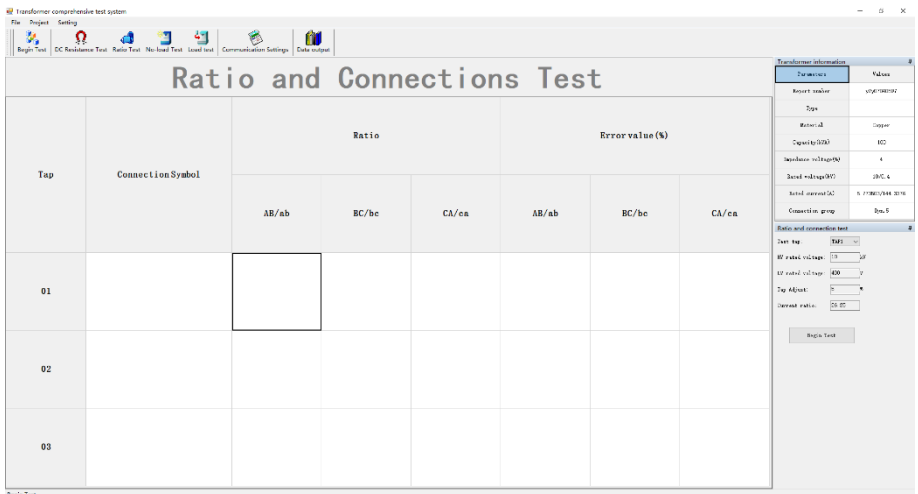
After confirming that the instrument wiring and software settings are correct, click [Begin Test] to start the test. Note: The test levels are Auto, <2mA, 20mA, 200mA, 1A, 5A, and 10A, which can be selected according to the range corresponding to each current level. After the test is completed, the measurement results of the current group will be automatically displayed. After adjusting the group, you can directly click "Start Test" to continue the test without changing any settings. The results displayed after the test are shown in the following figure:



DC resistance test result interface

B. Transformer Ratio test

Clicking on [Ratio Test] in the main software interface will bring you to the ratio test interface shown below.



Transformation ratio test setting interface

After confirming that the instrument wiring and software settings are correct, click [Begin Test] to start the test. After the test is completed, the measurement results of the current group will be automatically displayed. After adjusting the group, you can directly click [Begin Test] again without changing any settings to continue the test. The results displayed after the test are shown in the figure below.

Tap	Connection Symbol	Ratio			Error value (%)		
		AI/ab	BI/bc	CI/ca	AI/ab	BI/bc	CI/ca
01	3	0.99989	0.99992	0.99992	-0.76	-0.76	-0.77
02	3	0.99990	0.99990	0.99989	-0.76	-0.76	-0.76
03	3	0.99991	0.99990	0.99988	-0.76	-0.76	-0.76

Parameters table:

Parameters	Values
Report number	101029
Sign	
Material	Copper
Temperature(°C)	40.0
Impedance voltage(%)	4
Rated voltage(kV)	10/0.4
Rated current(A)	25 000/1077.1125
Connection on site	Yyn0

Ratio and connection test

Test mode: Auto

Impedance voltage: 0.1 - 20

Temperature: 40.0

Test voltage: 0.1 - 20

Current ratio: 0.1 - 20

Begin Test

Transformation ratio test result interface

C. No-load Test

Clicking [No-load Test] in the main software interface will bring you to the no-load test interface shown below.

No-load Test

Voltage (V)				Average
Valid values				
Average value				
Current (A)	Ia	Ib	Ic	Average
Power (kW)	Ps			
No-load data	No-load loss (kW)	No-load current (A)	Frequency (Hz)	Strategy factors

Parameter information

Parameters	Value
Report number	121029
Type	
Material	Copper
Capacity (kVA)	4.0
Appliance voltage (V)	0
Rated voltage (V)	1275.4
No-load current (A)	83.7484, 87.74, 90.03
Connection group	Yyn0

No-load test data

Test method:

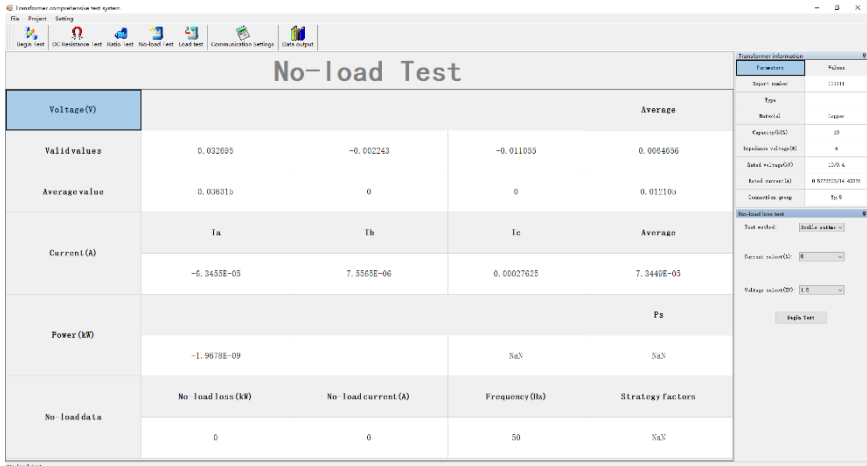
Current selector:

Voltage selector:

No-load test setting interface

After confirming that the instrument wiring and software settings are correct, click [Begin Test] to start the test. Note: Current gear

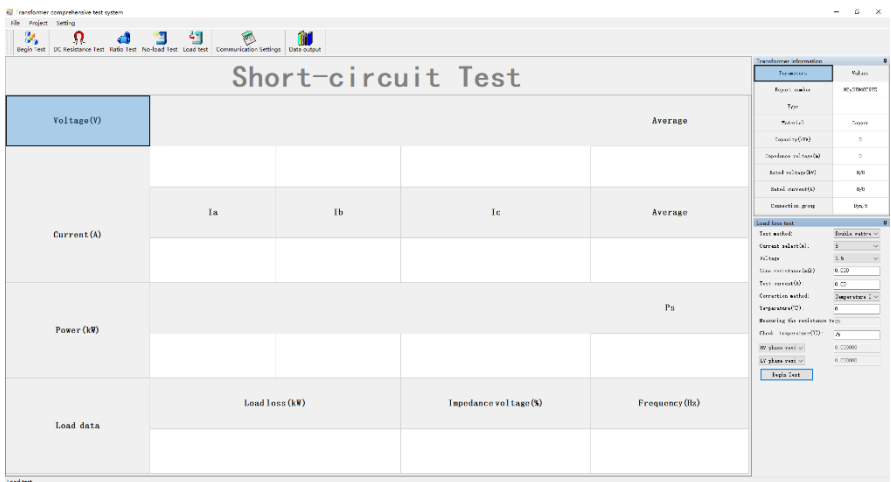
The gear positions include options of 10A and 200A, which are selected based on the corresponding range of the current gear position. These gear positions are in a one-to-one correspondence with the 10A and 200A test surfaces on the test bench. After the test is completed, the measurement results of the current group will be automatically displayed. The results displayed after the test are shown in the figure below.



No-load test result interface

D. No-load Test

Clicking [Load test] in the main software interface will bring you to the load test interface shown below.



Load test setting interface

After confirming that the instrument wiring and software settings are correct, click [Begin Test] to start the test. Note: Current gear

The gear positions include options of 10A and 200A, which are selected based on the corresponding range of the current gear position. These gear positions are in a one-to-one correspondence with the test bench, CT10A, and CT200A respectively. After the test is completed, the measurement results of the current group will be automatically displayed. The results displayed after the test completion are shown in the figure below.



Load test result interface

VIII. After Sales Service

This test system can be repaired free of charge for any quality defects within one year from the date of delivery. But for quality problems caused by improper operation, or instrument damage caused by improper storage and transportation, our company will only provide the possible repair service, and will charge based on repair cost.

The lifetime repair and technical services will be provided on reasonable charges. For any abnormality or malfunction, please contact our company in time so that we can arrange the most convenient solution.

KVTESTER ELECTRONICS TECHNOLOGY CO., LTD.

- Web site: WWW.KVTESTER.COM
- Address: No.120, Guanggu Road, East Lake New High-tech Development Zone, Wuhan, China
- Email: sales01@kvtester.com
- Tel: 0086-27-81778799
- Fax: 0086-27-81778799
- Mobile: 0086-13638621649
- Whatsapp: +86-13638621649