60/80KV

Ultra-low Frequency High-voltage Generator

User Manual

Foreword

I. Thank you for selecting the product 0 of our company! You can obtain comprehensive technical support and services from our company.

II. This product manual is applicable to the **80/1.1 0.1Hz ultra-low frequency high-voltage generator.**

III. Before using this product, please read the product manual carefully and keep it properly for future reference.

IV. This product is a high-voltage electrical equipment testing instrument. Please follow the steps required by the product manual when using it, and strictly abide by the relevant national regulations. If it is used improperly, it may damage equipment and endanger personal safety!

V. In the process of reading this product manual or using the instrument, if you have any doubts, please consult our company.

Contents

80/1.1 0.1Hz Ultra-low Frequency High-voltage Generator

I. Overview

The high-voltage withstand test of electrical equipment is one of the most important items specified in the *Preventive Test of Insulation*. The withstand voltage test can be classified into the AC withstand voltage test and the DC withstand voltage test. The AC withstand voltage test can also be divided into power frequency, frequency conversion and 0.1Hz ultra-low frequency test technologies. The 0.1Hz ultra-low frequency technology is the latest technology and is the technology recommended by IEC at present. The new generation series of ultra-low frequency high-voltage generators of our company are core products independently developed with the latest American technology. It adopts an 8-inch touch screen, the latest ARM7 single-chip microcomputer and a high-speed AD acquisition circuit, and it is equipped with background management software. It overcomes many shortcomings (see Table 1) of similar domestic products, and its cost performance is much higher than the similar imported products. It is particularly suitable for the withstand voltage test of electrical equipment (e.g.: power cables, power capacitors, large- and medium-sized generators and Motors, etc.) with large insulation equivalent capacitance, and it meets the requirements of the electric power industry standard *General Technical Specification of Ultra-low Frequency High-voltage Generator DL/T849.4-2004* newly issued by the country in 2004.

Table 1 Comparison on Performance of Mechanical and Electronic 0.1Hz Withstand Voltage Test Equipment

Type of 0.1 Hz Withstand Voltage Equipment	Control Mode of High Voltage	Waveform of High Voltage	Energy Saving	Noise	Mechanical Life	Electrical Life
Mechanical	Use a high-voltage mechanical switch to switch polarity	Square wave	It does not save energy: It uses a high-voltage resistor to consume the excess energy.	High	Short	Short
Electronic	Use a high-voltage electronic switch to switch polarity	Sine wave	It saves energy: It feedbacks the excess energy to the power grid.	Slight	None	Long

II. Advantages of 0.1 Hz Ultra-low Frequency Withstand Voltage Technology

The ultra-low frequency insulation withstand voltage test is actually an alternative method of the power frequency withstand voltage test. When conducting power frequency withstand voltage tests on test products such as large- and medium-sized generators, motors, power cables, etc., as their insulating layers exhibit relatively large capacitance, test transformers or resonance transformers with very large capacity are required. Such huge equipment is not only cumbersome and expensive, but also very inconvenient to use. In order to solve this conflict, the method of reducing the test frequency thereby reducing the test power capacity is generally adopted in the world. Many years of theory and practice at home and abroad have proved that replacing the power frequency withstand voltage test with a 0.1 Hz ultra-low frequency withstand voltage test can not only have the same equivalence, but also the size of equipment is greatly reduced, the weight is greatly reduced, the capacity is about 1/500 of the power frequency theoretically, and it is simple to operate. This is the main reason why developed countries generally adopt this method. According to the actual situation of the power system in our country, the National Development and Reform Commission has formulated the industry standard *Ultra-low Frequency (0.1 Hz) Withstand Voltage Test Method for XLPE Insulated Power Cable of 35kV and Below*. In 2004, the power industry standard *General Technical Specification of Ultra-low Frequency High-voltage Generator DL/T 849.4-2004* was issued, and this latest test method is promoted in our country at present.

Although the DC withstand voltage test equipment has the advantages of small size, light weight, low cost, etc., the DC withstand voltage test is also the most destructive to insulation of the tested product. (See Table 2) Therefore, the latest national regulations on preventive test of electrical equipment have expressly stipulated that DC high voltage is no longer used for conducting withstand voltage tests on electrical equipment, and the AC withstand voltage tests are recommended.

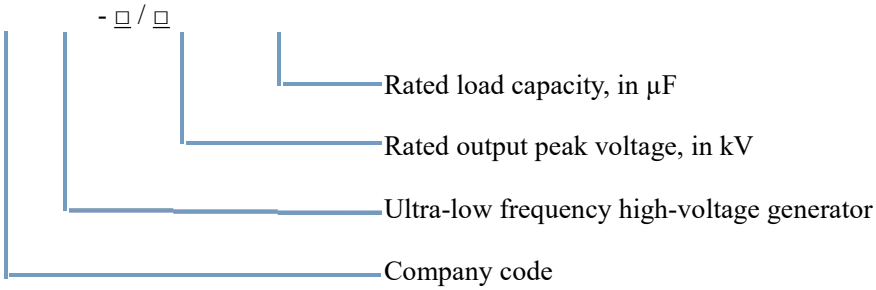
The new generation of 0.1 Hz ultra-low frequency high-voltage generator researched and developed by our company adopts the latest power electronic components and the latest ARM7 single-chip microcomputer technology, which further reduces the size and weight of equipment, and with the fully automatic operation, it is more stable in performance, which overcomes the shortcomings of short service life, high fault rate and large size for the first generation of boosters. Through years of practice, a large number of user feedbacks show that: The 80 kV ultra-low frequency high-voltage technology is in the lead in the country, and it is the most cost-effective!

Table 2 Comparison on Performance of Various Withstand Voltage Test Equipment

Comparison Content	Power Frequency Withstand Voltage	Frequency Conversion Withstand Voltage	0.1 Hz Withstand Voltage	DC Withstand Voltage
Equivalence	Good	Good	Good	Poor
Insulation destructiveness	Low	Low	Low	High
Operation safety	Relatively low	Relatively low	High	Relatively low
Test wiring	Complicated	Most complicated	Simplest	Complicated
Equipment size	Maximum	Relatively large	Small	Minimum

III. Technical Parameters of Product

1. Description of product naming



2. Technical parameters

1) Output rated voltage: see Table 3

2) Output frequency: 0.1 Hz, 0.05 Hz, and 0.02 Hz

3) Load capacity: 0.1 Hz max. 1.1 μF

0.05 Hz max. 2.2 μF

0.02 Hz max. 5.5 μF

4) Measurement accuracy: 3%

5) Voltage positive and negative peak error: ≤3%

6) Voltage waveform distortion: ≤5%

7) Service conditions: Indoors and outdoors; temperature: -10℃ ～+40℃; humidity: ≤85％ RH

8) Power fuse: see Table 3

9) Power supply: voltage 220 V ± 5%, 50 ± 5 Hz

Note: If a portable generator is used for power supply, the output voltage and frequency of the generator are required to be stable (generally it is required that power is greater than 3 kW, the frequency is 50 Hz, and the voltage is 220 V ± 5%

10) The capacitance of the tested product shall not exceed the maximum value for the rated capacitance of the instrument, and the values are shown in Table 3;

Table 3 Main Technical Parameters of Series Ultra-low Frequency High-voltage Generator

Model	Rated Voltage	Load Capacity	Power Fuse	Product Structure and Weight
30/1.1	30 kv (peak value)	0.1Hz,≤1.1μF	20A	Controller: 6 kg Booster: 20 kg
		0.05Hz,≤2.2μF		
		0.02Hz,≤5.5μF		
50/1.1	50 kv (peak value)	0.1Hz,≤1.1μF	20A	Controller: 6 kg Booster: 45 kg
		0.05Hz,≤2.2μF		
		0.02Hz,≤5.5μF		
80/0.5	80 kv (peak value)	0.1Hz,≤1.1μF	30A	Controller: 4 kg Booster: 50 kg
		0.05Hz,≤2.2μF		
		0.02Hz,≤5.5μF		

11) When choosing a product of appropriate specifications according to the tested object, the capacitance of the tested product shall not exceed the rated capacitance of the instrument. If the capacitance of the tested product is too low, it will affect the output waveform. If it is less than 0.05 μF, the instrument will not be able to output normally. At this time, a 0.05 μF capacitor (provided by our company) can be connected in parallel for auxiliary output. Refer to Table 4 and Table 5 for the estimation of electric capacitance of common electrical equipment

Table 4 Single-phase to Ground Capacitance of Different Types of Generators

	Turbo-generator			Hydro Generator			
Generator capacity (MW)	200	300	600	85	125-150	300	400
Single phase to ground capacitance(μF)	0.198	0.18-0.26	0.31-0.34	0.69	1.8-1.9	1.7-2.5	2.0-2.5

Table 5 Capacitance (μF/km) of XLPE Insulated Single-core Power Cable

Sectional area (mm²) / Capacitance (μF/km) / Voltage (KV)	16	25	35	50	70	95	120	150	185	240	270
10	0.15	0.17	0.18	0.18	0.21	0.24	0.26	0.28	0.32	0.38	---
35	---	---	---	0.11	0.12	0.13	0.14	0.15	0.16	0.17	0.18

12)Estimation method for current of tested product: calculation formula: I=2πfCU

IV. Product Features

☆ Advanced technology: By adopting digital frequency conversion technology and microcomputer control, the test procedures of boosting, voltage reduction, measurement, protection, etc. are fully automated.

☆ Convenient operation: Simple wiring, and fully automatic operation.

☆ Comprehensive protection: Multi-protection (over-voltage protection, over-current protection on high- and low-voltage side), rapid action (action time ≤ 10 ms), the instrument is safe and reliable.

☆ Safe and reliable: The controller and the high-voltage generator are in low-voltage connection and under photoelectric control, which are safe and reliable to use.

☆ By adopting high- and low-voltage closed-loop negative feedback control circuit, the output has no capacitive rise effect.

☆ Complete configuration: 8-inch capacitive touch screen, LCD Chinese character display, manual storage, and manual printing.

☆ Large test range: Multi-frequency selection of 0.1Hz, 0.05Hz and 0.02Hz, a large test range.

☆ Small size and light weight: Very conducive to outdoor operations.

V. Instrument Structure and Function Description

This instrument consists of two parts: i.e. the controller and the booster. The structures and functions of the two parts are as follows:

1. The layout for the components of the controller panel is as shown in Figure 1. The functions of each component are as follows:

Figure 1 Schematic Diagram of Controller Panel

"⏚" —Grounding terminal: Connect to the earth when in use.

"Switch" - Power switch: With a built-in indicator light, it is illuminated when it is ON, and it is put out when it is OFF "AC220V" - power input socket, with a built-in fuse.

"Printer" - Print the test report.

"Capacitive touch display" - 8-inch display screen, it displays test data and output waveform, and it can be directly operated on the screen with fingers.

"Output I" - Connect to the 30 KV booster.

"Output Ⅱ" - Connect to the 50 KV booster.

"RS232" - Its function is used to communicate with the upper computer.

2. Schematic diagram of booster structure

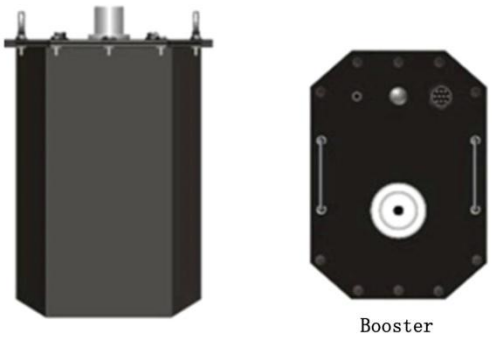


Figure 2 Schematic Diagram of Booster Structure

VI. Operating Instructions

1. 80 KV ultra-low frequency output wiring method

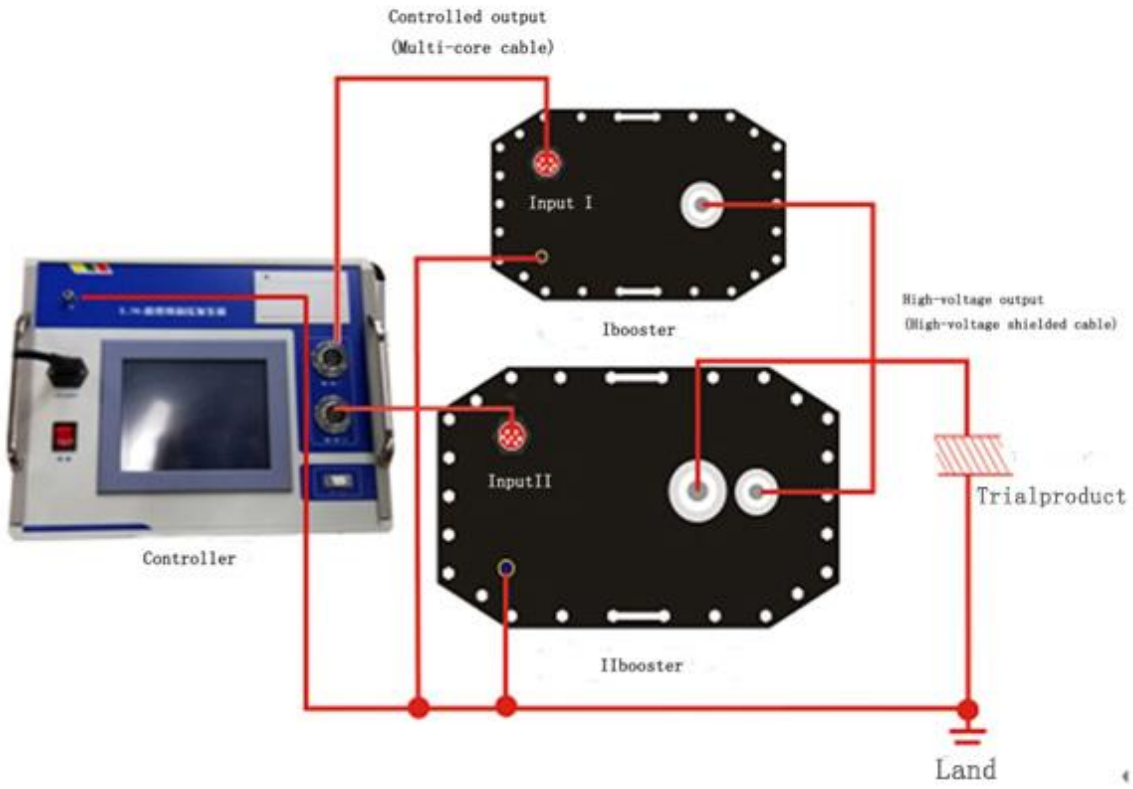


Figure 3 Schematic Diagram of Wiring

Wiring instructions: Use the controlled output private wire, the high-voltage output private wire and the grounding wire enclosed with the product to connect as shown in Figure 3. Use the power cord to connect the power socket to alternating current of 220V/50Hz.

2. Operating procedures

(1) Turn on, turn off and reset

After connecting all the lines according to the above method, you can turn on the power switch. After the microcomputer is powered on or reset, the instrument automatically enters the interface as shown in Figure 4. Turn off the power when the instrument is wired, disconnected or temporarily not in use. The power socket shall be installed with a fuse. If there is no display on the boot screen, check whether the fuse is blown first, and the fuse shall be replaced according to the data provided in Table 3.

Figure 4 Schematic Diagram for Start Page of Touch Screen

(2) Select the connection mode

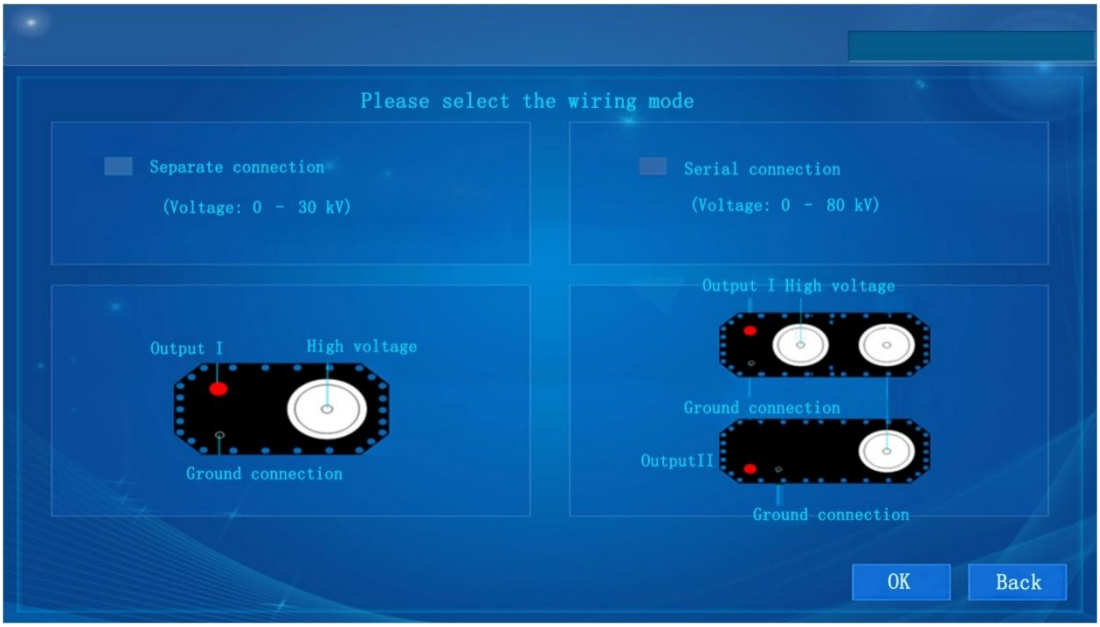


Figure 5 Selection Interface of Connection Mode

(3) Parameter setting

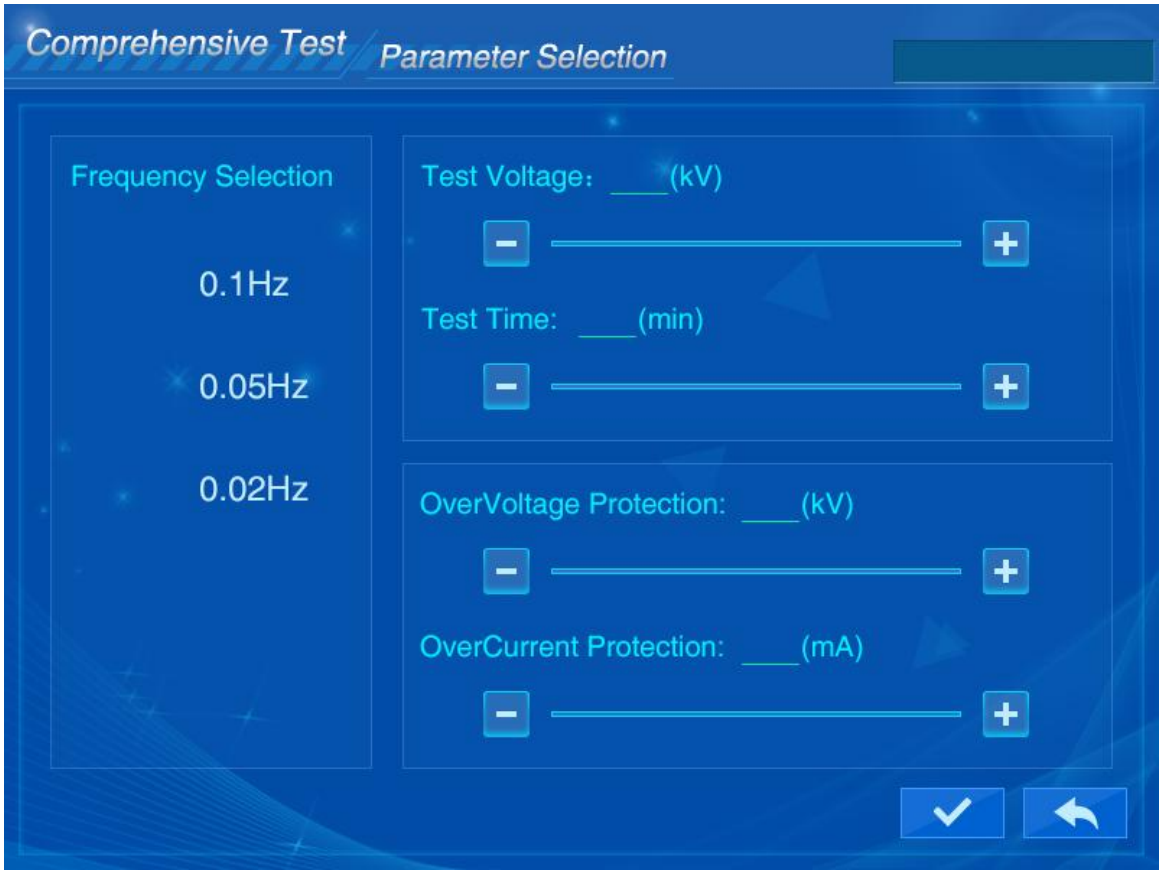


Figure 6 Parameter Selection Interface

First, click the "System Test" button on the screen in Figure 4, and the connection mode selection interface as shown in Figure 5 will appear. In Figure 5, you can choose separate connection or serial connection. After selecting, press "OK" to enter the parameter selection interface as shown in Figure 6. The frequency, voltage, test time, the over-voltage protection value and the over-current protection value can be set.

★ There are three options of: 0.1, 0.05 and 0.02 for frequency, which is measured in Hz.

★ Timing modification range: 0-99 minutes. It specifies the length of the test time in minutes.

★ Set voltage: It ranges from 0 to the rated value, and it is measured in kV. It sets the test voltage to be boosted. When the instrument rises to this set voltage limit value, it will no longer boost, and it will maintain at this peak value to carry out constant-amplitude sine wave output.

★ Over-voltage protection value: The setting range of the voltage protection value is from 0 to the rated value, and it is measured in kV. It specifies the upper limit of voltage for the tested product. When voltage exceeds this setting, the instrument automatically cuts off the output.

★ Over-current protection value: The setting range of the current protection value is from 0 to the rated value, and it is measured in mA. It specifies the upper limit of current for the tested product. When current exceeds this setting, the instrument automatically cuts off the output.

(Note: The above voltage, current and measured data displayed by the instrument are all peak values.)

(4) Auto boost

After pressing the "OK" button in Figure 6, the instrument enters the next interface as shown in Figure 7.

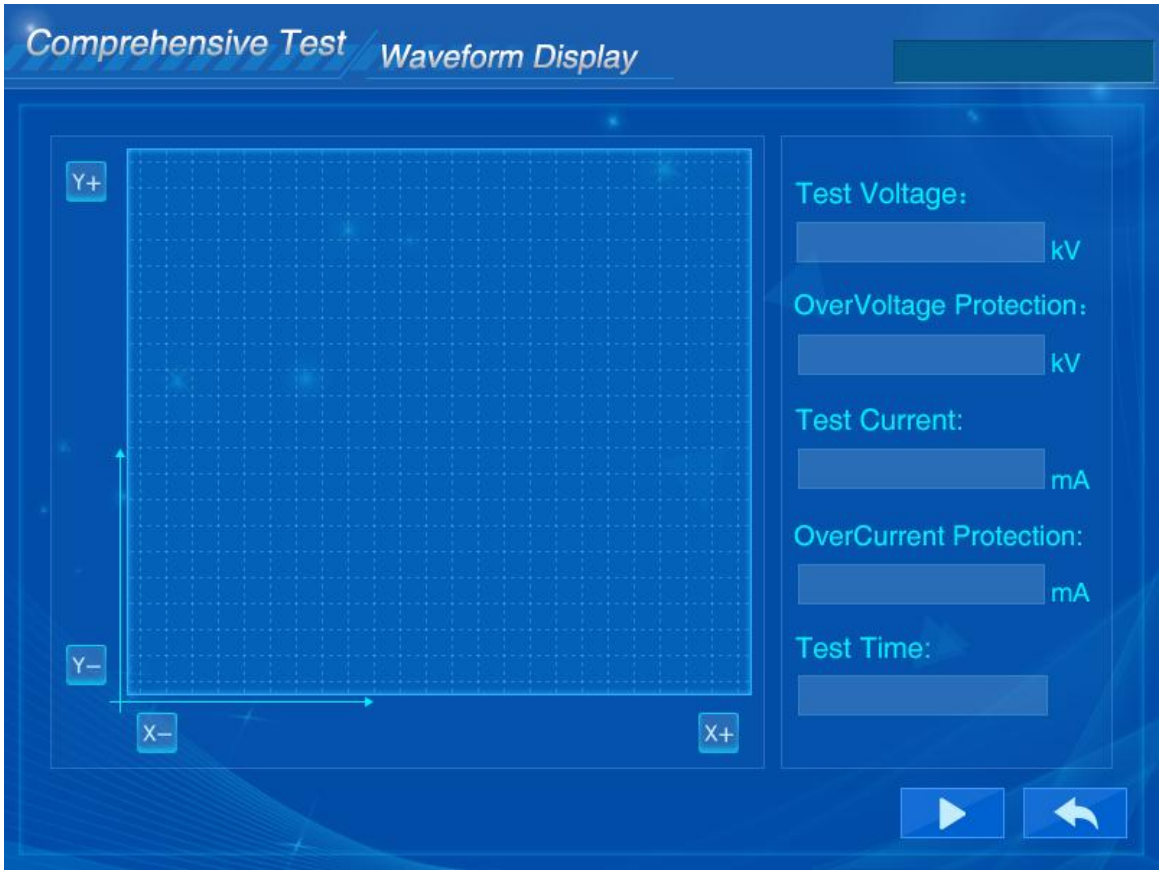


Figure 7 Ready-to-boost Stage

After pressing the "Start" button in Figure 7, the instrument enters the boosting stage of Figure 8, and the instrument starts boosting to the set target voltage.

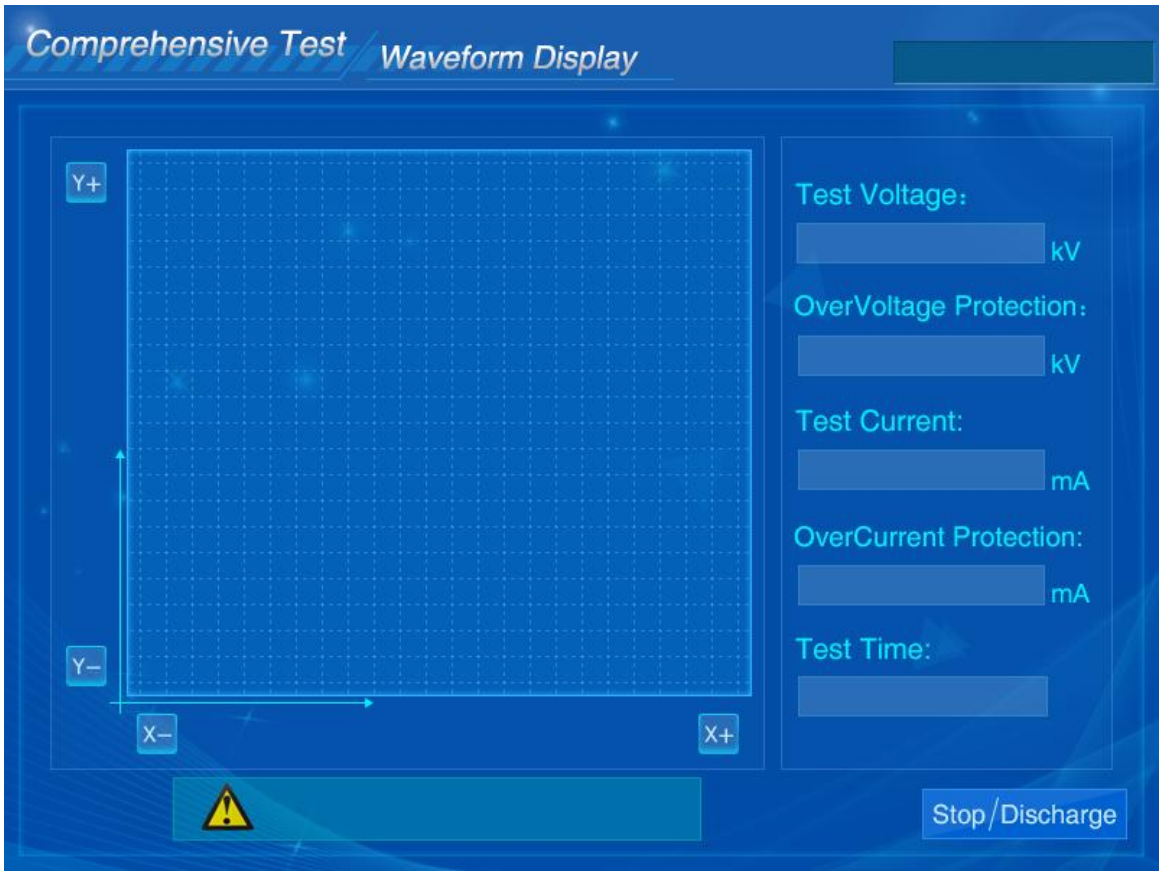


Figure 8 Boost Interface

1)The display frame at the bottom of the screen has the prompt words of "High voltage test, caution!"

2) Boosting process

After the instrument is boosted to the set voltage, the timing starts

3) Shutdown

When the timer reaches the set time, the instrument will automatically stop and discharge. When voltage drops below 0.8 KV, the instrument will skip to the next interface as shown in Figure 9.

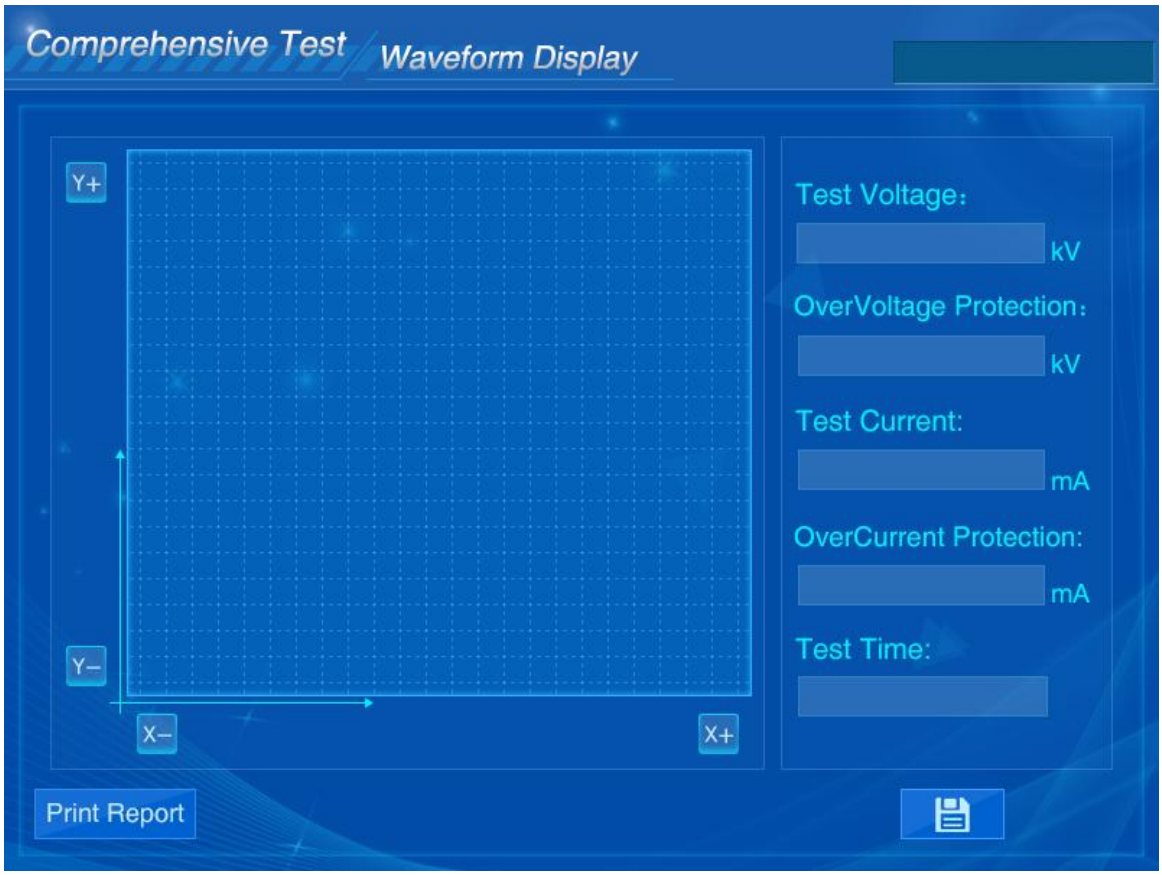


Figure 9 Report Printing and Data Storage

Press the "Save" button to save the test data

Press the "Print report" button to print the test data

Note: In the test process, if there is no abnormality in voltage, and there is no discharge of the test product or over-current protection, it can be considered as passing the test.

The instrument provides two shutdown modes:

★ Timing shutdown: When the timing reaches the set time, the instrument will automatically shut down

★ Manual shutdown: Click the "Stop" button to shut down.

These two shutdown modes are normal shutdowns.

★ In addition, there are also three types of non-normal shutdowns: over-voltage protection shutdown, over-current protection shutdown, and flashover protection shutdown.

★ Over-voltage protection shutdown

When the output high voltage exceeds the set limit during the test, the instrument will automatically cut off the output after triggering the shutdown command.

The textbox at the bottom of the screen has the prompt words of "Over-voltage protection!"

★ Over-current protection shutdown

When the output current exceeds the set limit during the test, the instrument will automatically cut off the output after triggering the shutdown command. The textbox at the bottom of the screen has the prompt words of "Over-current protection!"

★ Flashover protection shutdown

When the tested product or the booster is discharged, the instrument will trigger the flashover protection and shut down quickly to protect the tested product and equipment. At the same time, the textbox at the bottom of the screen has the prompt words of "Flashover protection".

(5) Print

Click the "Print Report" button in Figure 9 to print the data on the display screen into a test report.

(6) View historical data

To view historical data, click the "Data View" button in Figure 4 to view the currently displayed historical data.

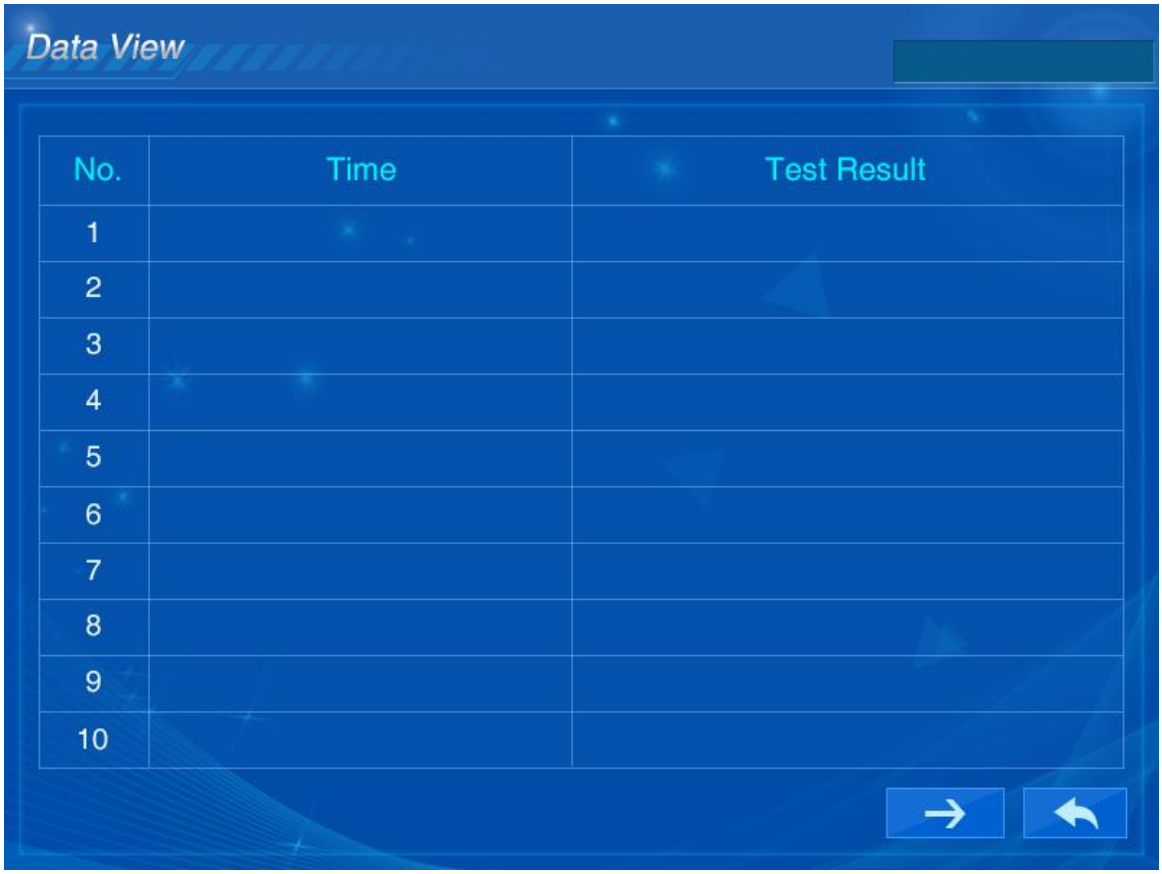


Figure 10 View Historical Data

Clock Setting

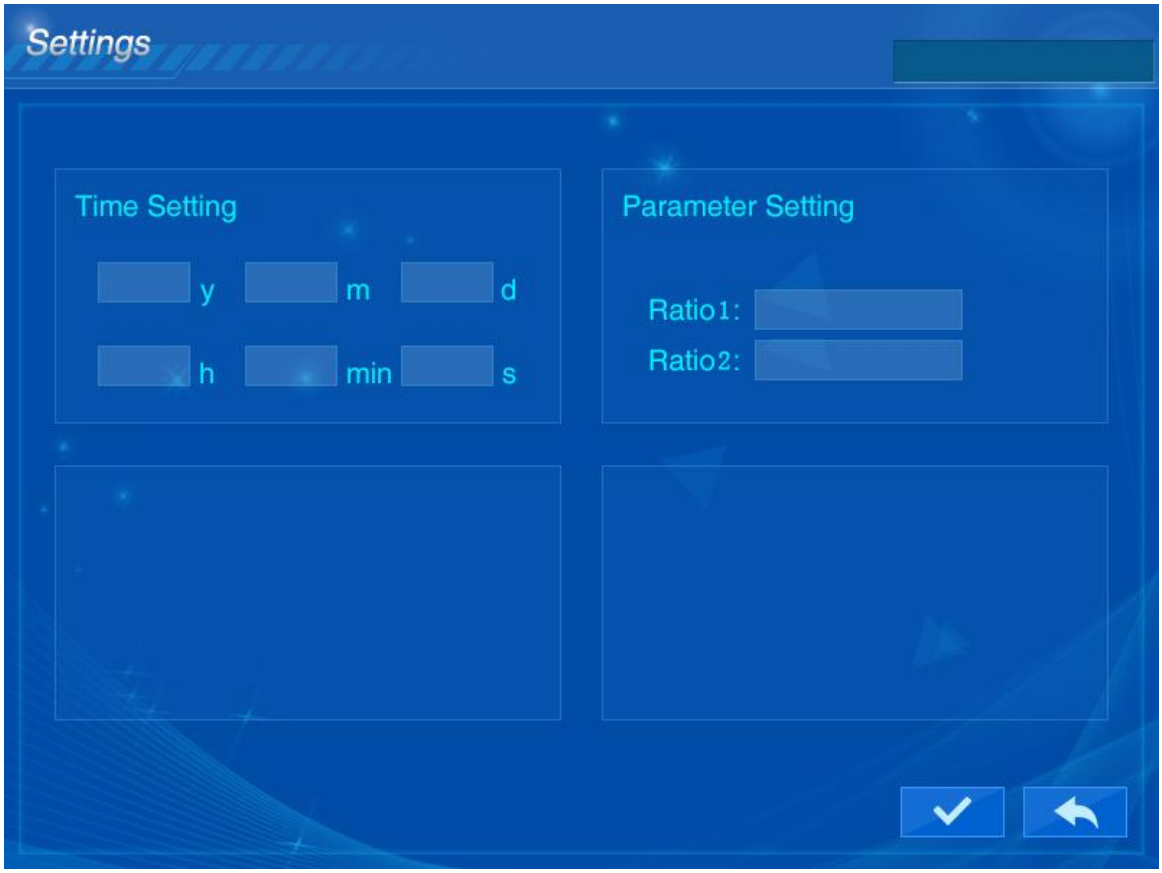


Figure 11 Clock Setting Interface

Click the touch button of Time Setting in Figure 11, a clock RTC display interface and a calculator dialog box will appear. You can set the year, month, day, hour, minute, and second.

The instrument also has the function of help documentation. Click the "Help Documentation" icon in Figure 4, the instrument enters the help documentation interface, and there is an introduction to the entire ultra-low frequency wiring as shown in the figure below:

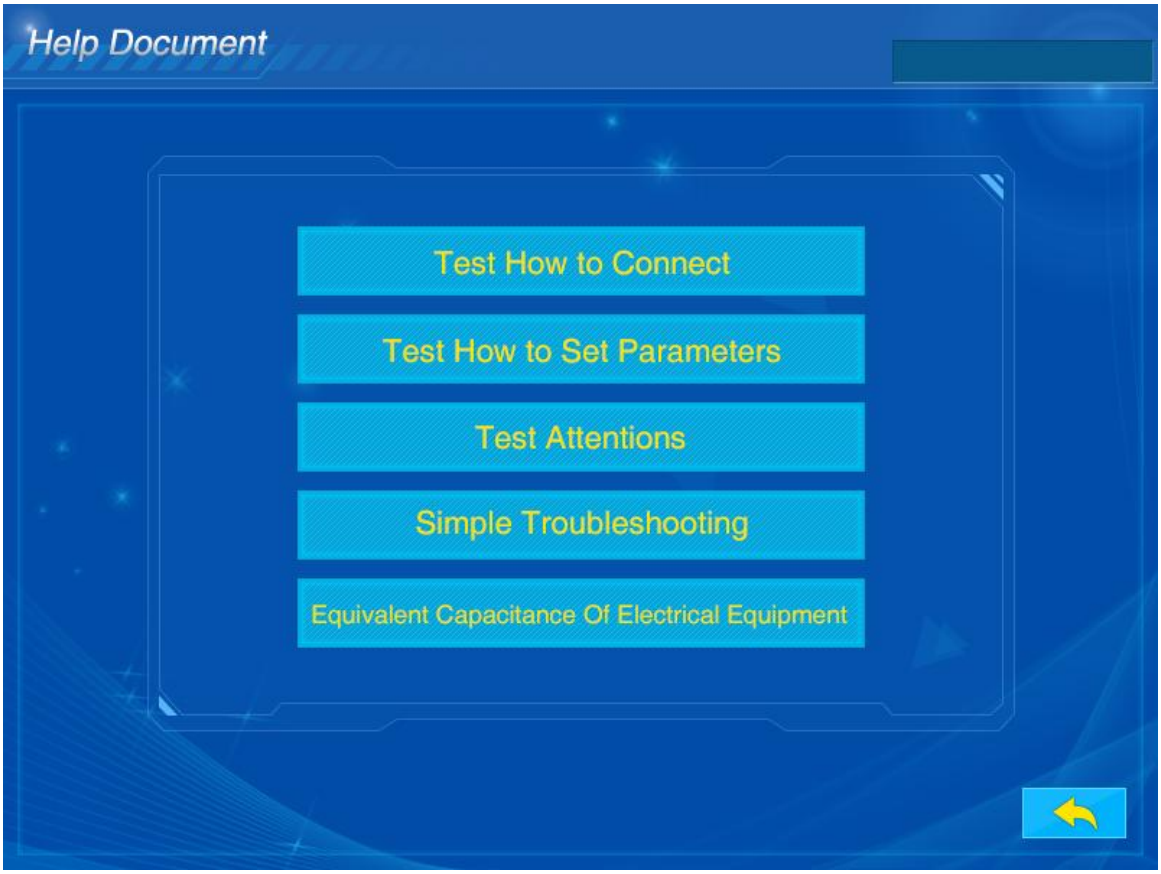

Help Document
Test How to Connect
Test How to Set Parameters
Test Attentions
Simple Troubleshooting
Equivalent Capacitance Of Electrical Equipment

Figure 12

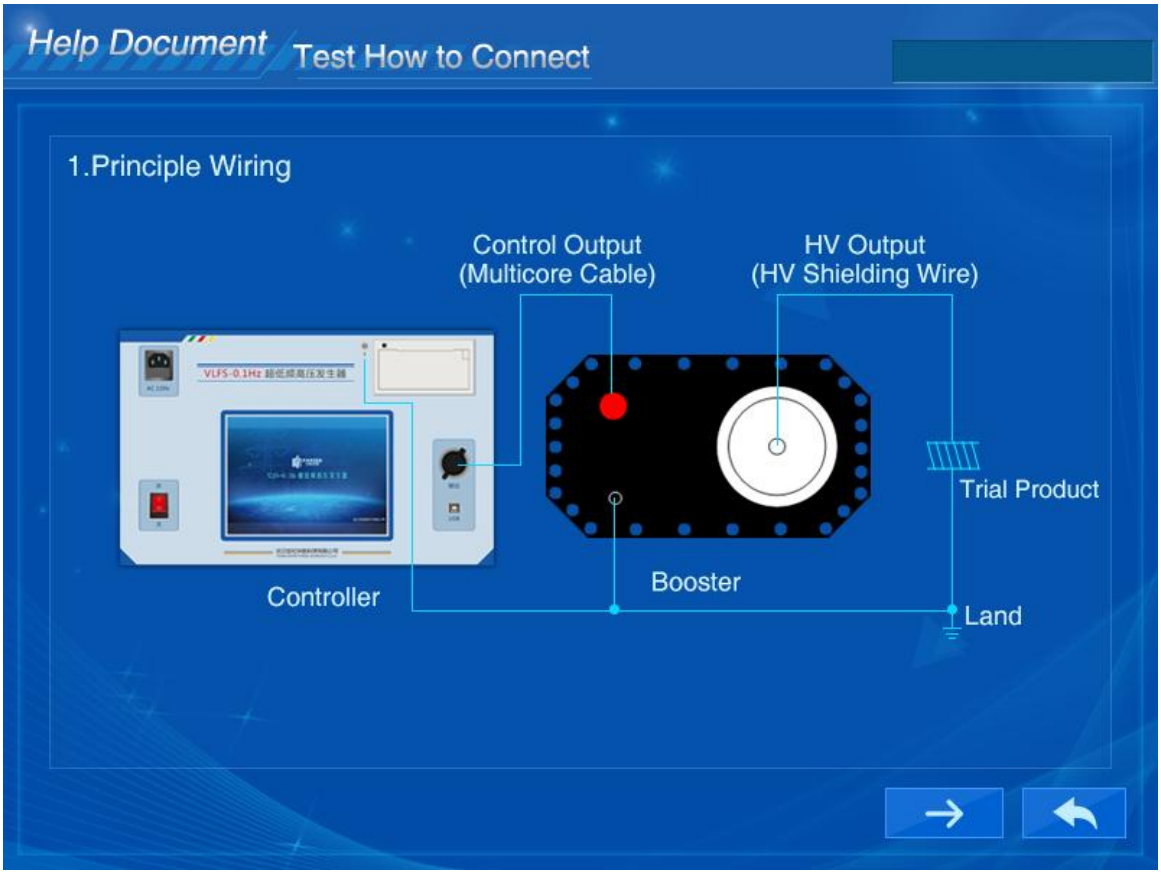

Help Document
Test How to Connect
1.Principle Wiring
Control Output
(Multicore Cable)
HV Output
(HV Shielding Wire)
Trial Product
Booster
Controller
Land

Figure 13

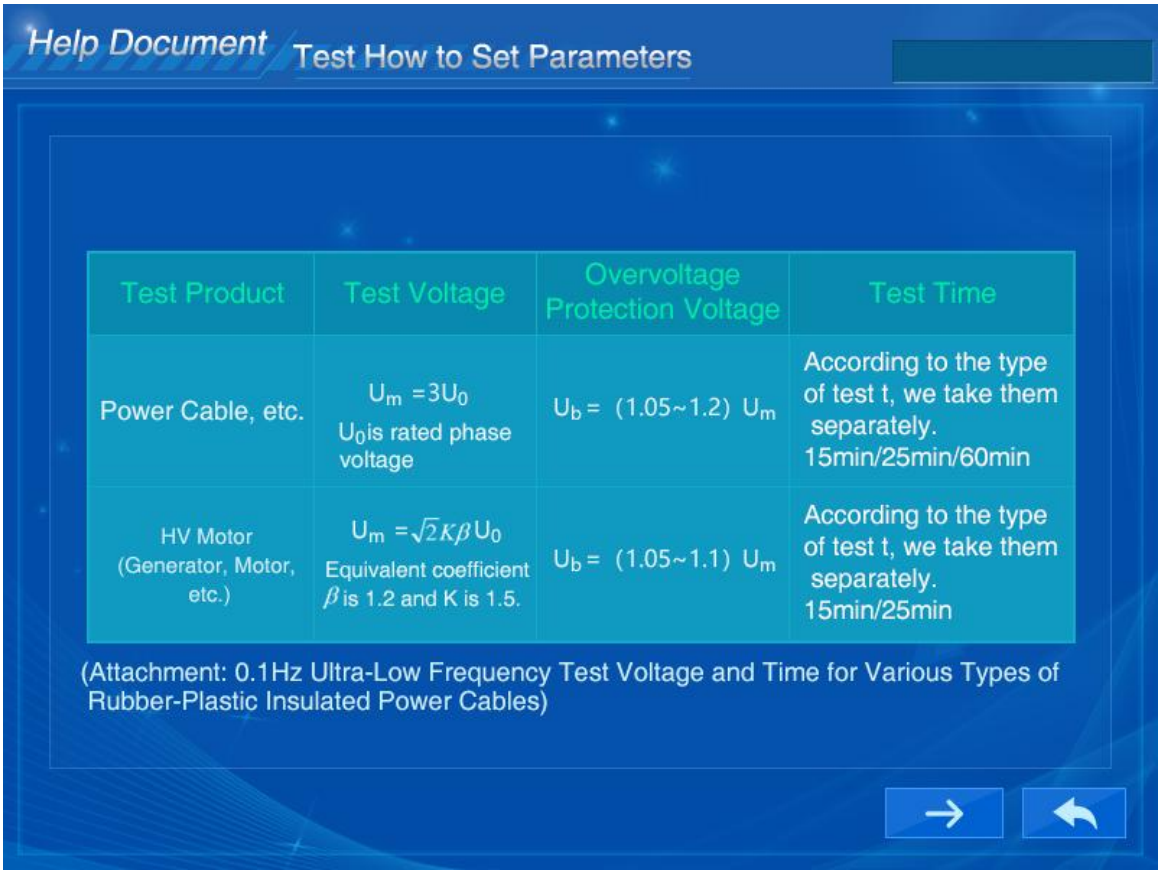

Help Document
Test How to Set Parameters
Test Product
Test Voltage
Overvoltage Protection Voltage
Test Time
Power Cable, etc.
$U_m = 3U_0$
$U_0$is rated phase voltage
$U_b = (1.05 \sim 1.2)\ U_m$
According to the type of test t, we take them separately. 15min/25min/60min
HV Motor (Generator, Motor, etc.)
$U_m = \sqrt{2} K \beta U_0$
Equivalent coefficient β is 1.2 and K is 1.5.
$U_b = (1.05 \sim 1.1)\ U_m$
According to the type of test t, we take them separately. 15min/25min
(Attachment: 0.1Hz Ultra-Low Frequency Test Voltage and Time for Various Types of Rubber-Plastic Insulated Power Cables)

Figure 14

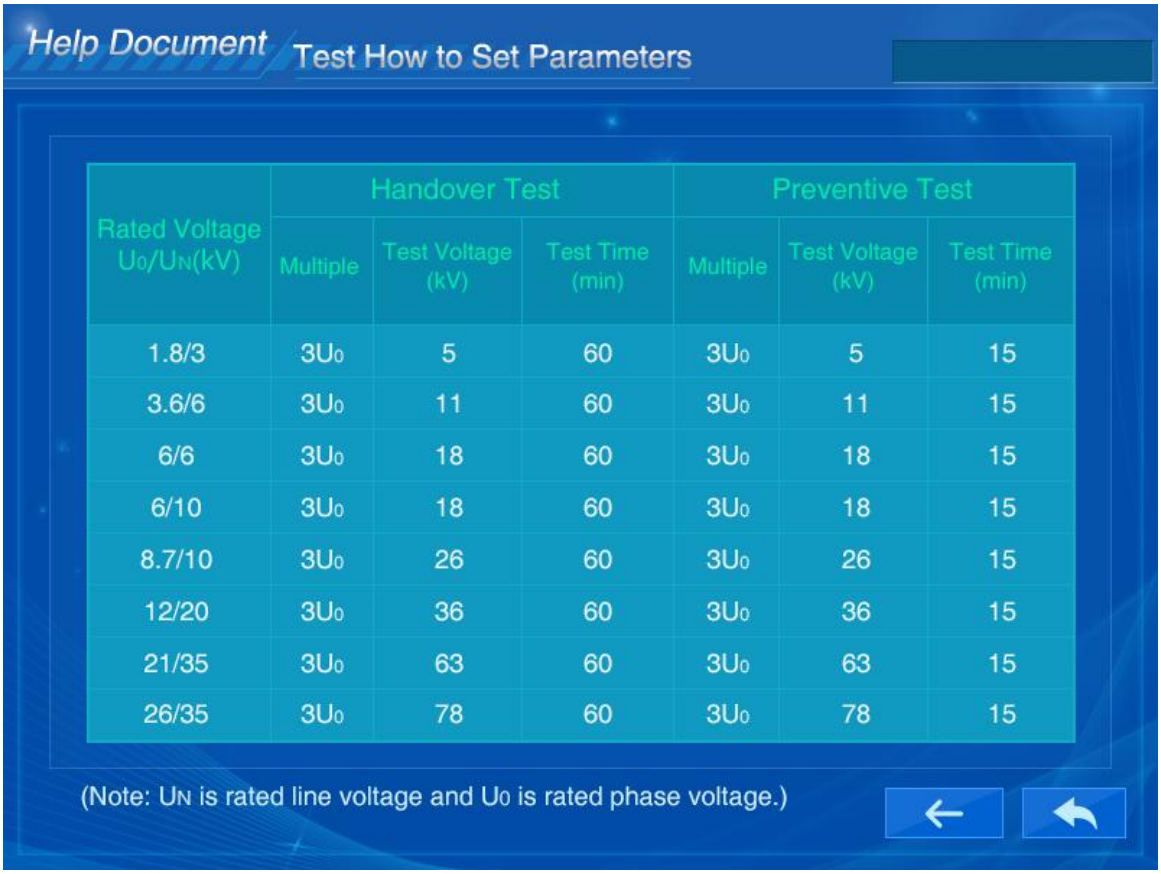

Help Document
Test How to Set Parameters
Rated Voltage U0/UN(kV)
Handover Test
Multiple
Test Voltage (kV)
Test Time (min)
Preventive Test
Multiple
Test Voltage (kV)
Test Time (min)
1.8/3 3U0 5 60 3U0 5 15
3.6/6 3U0 11 60 3U0 11 15
6/6 3U0 18 60 3U0 18 15
6/10 3U0 18 60 3U0 18 15
8.7/10 3U0 26 60 3U0 26 15
12/20 3U0 36 60 3U0 36 15
21/35 3U0 63 60 3U0 63 15
26/35 3U0 78 60 3U0 78 15
(Note: UN is rated line voltage and U0 is rated phase voltage.)

Figure 15

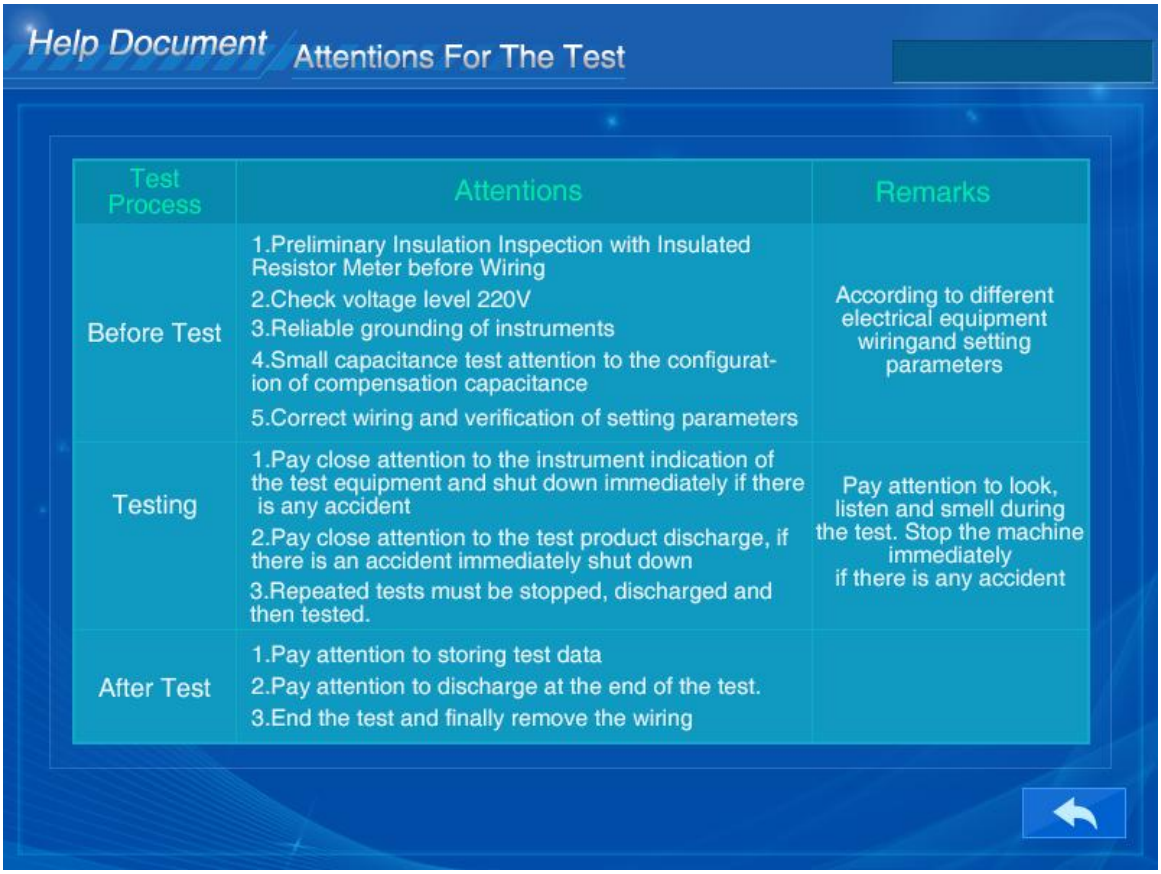


Figure 16

VII. Withstand Voltage Test Methods of Power Cables

1. Disconnect all electrical equipment connected to the cable under test.

2. Use a megameter to test the insulation parameters for each phase of the cable. Only after passing the test can the ultra-low frequency withstand voltage test be carried out.

3. Voltage value of the setting test: U_{max}=3Uo, where Uo is the rated phase voltage value of the cable.

Example 1: Parameters of a cable: The rated line voltage is 10 kV, the rated phase voltage Uo=6kV, so the setting value of test voltage is:

Umax=3Uo=18kV

The setting value of the 0.1 Hz ultra-low frequency test voltage value for various models of rubber-plastic insulated power cables is as shown in Figure 15.

4. Test time: The test time of the acceptance test is 60 minutes, and that of the preventive test is 15 minutes.

5. Over-current protection setting current value:

Estimation method of capacitive current (or leakage current) for the ultra-low frequency withstand voltage tested product:

Io=2πfCU=2×3.14×0.1CU(mA)……(Formula 1)

Wherein: C is the cable-to-earth capacitance, in uF; U is the effective value of test voltage, in kV.

Example 2: The length for a model of 10 kV (UN=10kV, Uo=8.7kV) cable is 4 km, the single-phase-to-ground capacitance is 0.21uF/km, and the 0.1 Hz ultra-low frequency test voltage is 26 kV (peak), the leakage current is approximately:

Io=2πfCU=2×3.14×0.1CU=0.628×0.21×4×26/ $\sqrt{2}$

=9.69（mA）

Over-current protection setting current value:

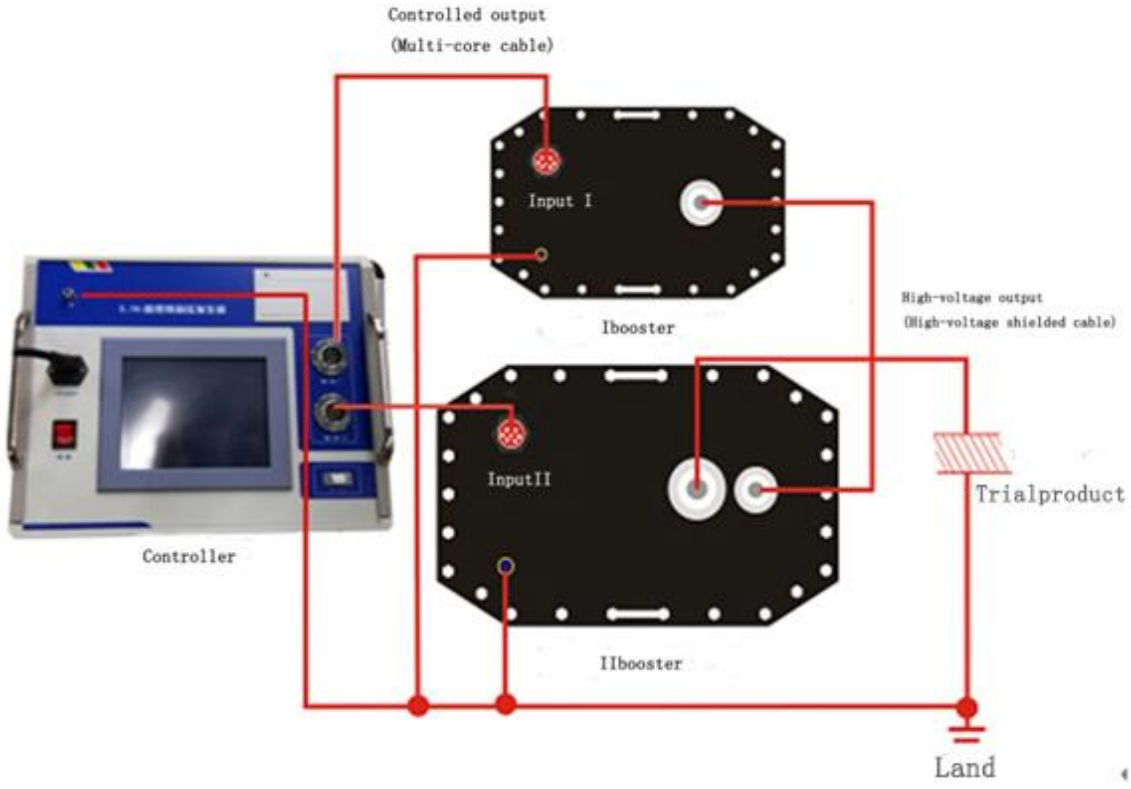
I=kIo……(Formula 2)

Wherein: k is the reliability coefficient of over-current protection, obviously k>1

If k is taken as 1.5, the over-current protection setting current value can be taken as: 14.5 mA

6. Test wiring: Connect the test equipment and the test cable by means of the enclosed special connections according to the method shown in Figure 13. After carefully checking that the wiring is correct, switch on the power supply, set the test frequency, time, voltage, and the over-current protection value and the over-voltage protection value on the high voltage side, and then start the boost test.

During the boosting process, closely monitor the high-voltage circuit and monitor whether there is any abnormal noise in the cable of the tested product. When it reaches the test voltage, the instrument will automatically record the test time and display the test voltage value.



Wiring Diagram of two Boosters in Serial Connection Test

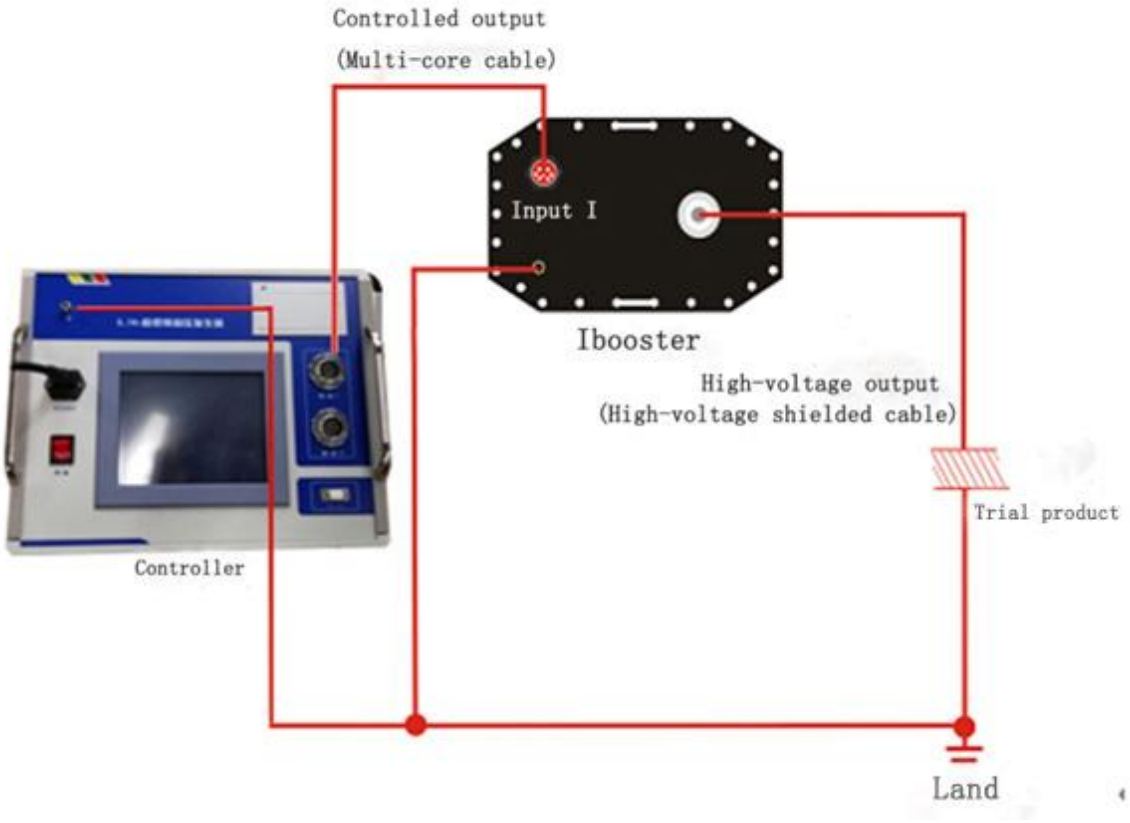


Figure 17 Wiring Diagram of Separate Connection

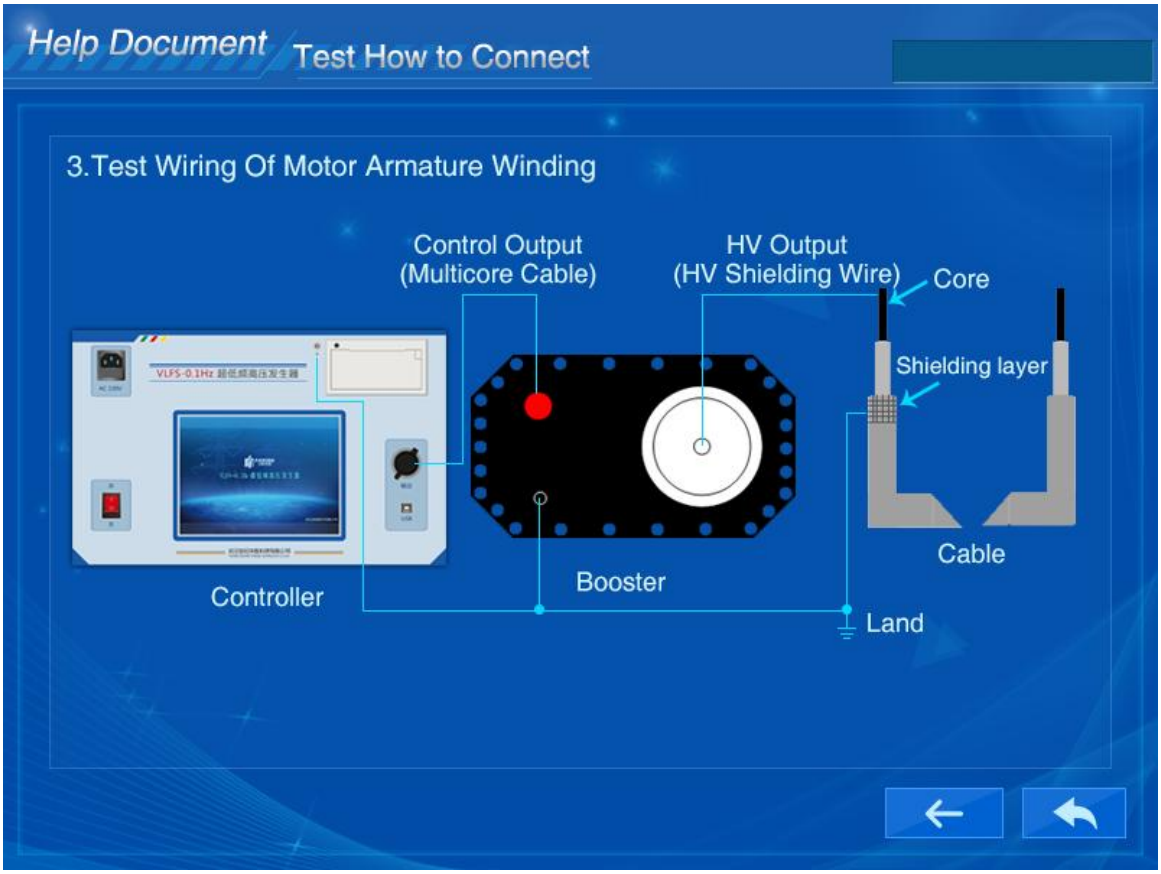


Figure 18 Wiring Diagram of Power Cables

7. After the test time is up, the instrument will shut down automatically. If no destructive discharge occurs during the test, it is considered to have passed the withstand voltage test.

8. In the process of boosting and voltage withstanding, if the output waveform is abnormally distorted, the current is abnormally increased, the voltage is unstable, the test cable has peculiar smell, smoke, abnormal noise or flashover, etc., the boosting shall be stopped immediately. Find out the cause after shutdown. If these phenomena are caused by the weak insulation of the cable in the tested product, it would be considered that it does not pass the withstand voltage test. If it is confirmed that the cable of the tested product is contaminated due to air humidity or surface contamination, etc., the cable shall be cleaned and dried before the test.

9. During the test, if there is over-current protection of the instrument due to any insulation defect of the non-tested product cable, the withstand voltage test shall be performed again after the cause is found out.

VIII. Withstand Voltage Test Methods of Synchronous Motor

The operation method for the ultra-low frequency withstand voltage test of the synchronous motor is similar to that of the cable. The following is a supplementary explanation of the different places.

1. This test can be carried out during handover, overhaul, local replacement of windings and routine tests. The withstand voltage test of the motor with 0.1 Hz ultra-low frequency is more effective than the power frequency withstand voltage test for the defects of the generator end insulation. The reason is that under the power frequency voltage, because the capacitive current flowing from the wire rod causes a larger voltage drop when flowing through the semiconductor anti-corona layer outside the insulation, the voltage on the insulation of the wire rod at the end is reduced; in the case of ultra-low frequency, the capacitive current is greatly reduced, and the voltage drop on the semiconductor anti-corona layer is also greatly reduced, so the voltage on the end insulation is relatively high, which is convenient for finding defects.

2. Wiring method: The test shall be carried out in phases, the tested phase shall be pressurized, and the non-tested phase shall be short-circuited and grounded. The test wiring is as shown in Figure 14 below.

Figure 19 Wiring Diagram of Synchronous Motor

3. According to the regulations, the test voltage peak value can be determined according to the following formula 3:

Umax= $\sqrt{2}$ βKUo…….. (Formula 3)

Wherein Umax: peak value of 0.1 Hz test voltage (kV);

β : The equivalent coefficient of 0.1 Hz and 50 Hz voltage. According to the requirements in regulations in our country, β is taken as 1.2;

K: Setting coefficient, usually it is 1.3 to 1.5, generally it is taken as 1.5

Uo: Rated voltage (kV) of stator winding for synchronous motor

For example: For a synchronous motor with rated voltage of 10.5 kV, the calculation method for the peak value of the ultra-low frequency test voltage is:

Umax= $\sqrt{2}$ ×1.2×1.5×10.5≈26（kV）

4. Test time setting: The same as the test time of power frequency withstand voltage, generally 1 min.

5. The setting value of over-current protection action current: The setting method is the same as that of the cable.

6. In the process of voltage withstanding, if there is no abnormal sound, smell, smoke, data display

instability, etc., it can be considered that the insulation has withstood the test. In order to better understand the insulation situation, the surface condition of the insulation shall be monitored as comprehensively as possible, especially for air-cooled units. Experience has pointed out that appearance monitoring can find abnormal phenomena of synchronous motor insulation that cannot be reflected by the meter, such as surface corona and discharge.

Note: Compared with the synchronous motor, the structure of the asynchronous motor only has no rotor winding, and its test wiring is similar to that of the synchronous motor.

IX. Notes

1. During the test, please strictly abide by the safety regulations of the high-voltage test. The test shall be operated by professionals;
2. If the instrument has any fault, do not disassemble and repair it by yourself, and contact our company immediately;
3. After shutting down, use the discharge rod to fully discharge the tested product, and make sure that it is completely discharged to remove the wire!

X. Enclosed Accessories

S/N	Name	Quantity	Unit
1	Controller	1	Set
2	Booster	2	Set
3	High-voltage connection cable	2	Piece
4	Special high-voltage connection cable	2	Piece
5	Power line	1	Piece
6	Discharge rod	1	Piece
7	Ground lead	1	Piece
8	Compensating capacitor	1	Set
9	Fuse	4	Set
10	Printing paper	2	Roll
11	Specification	1	Copy
12	Packing list	1	Copy
13	Test report	1	Copy

XI. Transportation and Storage

(1) Transportation

This product must be packed during transportation. The packing box can be a carton or a wooden box, and the packing box shall be lined with a foam shockproof layer. The packaged product shall be able to be transported by road, rail, and air. It shall not be placed in an open carriage during transportation. The warehouse shall be protected from rain, dust and mechanical damage.

(2) Storage

When the instrument is not in use at ordinary times, it shall be stored in a ventilated room with an ambient humidity of -20℃ ～+60℃ and relative humidity of not more than 85%, and the room shall have no corrosive gas. During storage, it shall not be close to the ground and the wall.

(3) Moisture-proof

In humid climate areas or humid seasons, if the instrument is not used for a long time, it is required to be powered on and started once a month (about two hours) to allow moisture to escape and protect the components.

(4) Sun protection

When the instrument is used outdoors, avoid or reduce direct sunlight exposure as much as possible. When the instrument is used outdoors, avoid or reduce direct sunlight exposure as much as possible.

XII. Quality Assurance

(1) This instrument is manufactured in strict accordance with national standards and corporate standards, and each instrument has undergone strict factory inspection.

(2) This instrument enjoys a warranty of one year. During this period, if quality is lower than the characteristic requirements due to manufacturing reasons, the company will provide repair for free.

(3) During the lifetime of the instrument, the company will provide related services such as instrument maintenance, user training, and software upgrades for life.

(4) If you find a problem during use, please contact our company in time, and we will take the most convenient way to provide services according to the situation.