

Foreword

- I. Thank you for selecting the product of our company! You can obtain comprehensive technical support and services from our company.
- II. This product manual is applicable to the **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.

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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 (International Electrotechnical Commission) at present. The new generation of VLFS series microcomputer type 0.1 Hz ultra-low frequency high-voltage generators are core products independently developed by FARSEE, they overcome many shortcomings of mechanical 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.

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. 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 VFLS series 0.1 Hz ultra-low frequency high-voltage generator researched and developed by FARSEE adopts the latest power electronic components and the latest 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 0.1 Hz ultra-low frequency high-voltage technology of FARSEE Company is in the lead in the country, and it is the most cost-effective!

Attached table: 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. 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. The instrument has the electronic calendar function, and the time can still be maintained after powering down.

☆ 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 ≤ 20 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 industrial touch screen, manual storage, and manual printing.

☆ The instrument has the data communication function. It can be connected to a computer through a USB port for uploading test data to the computer.

The instrument has the help documentation function, through which the directions for use, wiring and notes of the instrument can be known without viewing the instruction book.

The instrument has the system setting function, through which the current time can be modified.

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.

IV. Technical Parameters of VLFS Series Products

1. Technical parameters

★ Main parameters of series products are shown in Table 1

| Model | Peak Voltage | Measuring Range | Weight | Purpose |
|--------|--------------|--|----------------------------------|---|
| 30/1.1 | 30kV | $\leq 1.1\mu\text{F @ } 0.1\text{Hz}$ | Controller: 4kg Booster: 25kg | Cables, generators with voltage of 10kV and below |
| | | $\leq 2.2\mu\text{F @ } 0.05\text{Hz}$ | | |
| | | $\leq 5.5\mu\text{F @ } 0.02\text{Hz}$ | | |
| 60/1.1 | 60kV | $\leq 1.5\mu\text{F @ } 0.1\text{Hz}$ | Controller: 5kg Booster: 35kg | Cables, generators with voltage of 20kV and below |
| | | $\leq 3.0\mu\text{F @ } 0.05\text{Hz}$ | | |
| | | $\leq 7.5\mu\text{F @ } 0.02\text{Hz}$ | | |
| 80/1.1 | 80kV | $\leq 1.1\mu\text{F @ } 0.1\text{Hz}$ | Controller: 5kg Booster: 45kg | Cables, generators with voltage of 35kV and below |
| | | $\leq 2.2\mu\text{F @ } 0.05\text{Hz}$ | | |
| | | $\leq 5.5\mu\text{F @ } 0.02\text{Hz}$ | | |

Table 1 Main Technical Parameters of VLFS Series Ultra-low Frequency High-voltage Generator

★ Power supply: 220V \pm 10%, 50 \pm 5%Hz

Note: When a portable generator is used for supplying power, it is required that output voltage and frequency of the generator shall be stable (generally it is required that power shall be greater than 3 kW, the frequency shall be 50 Hz, and voltage shall be 220V \pm 5%), otherwise some assistance measures shall be used to stabilize output of the generator.

★ Output voltage precision:

Degree of instability for peak value of output high voltage: $\leq 5\%$

Degree of instability for frequency of output voltage: $\leq 3\%$

Distortion rate of output voltage waveform: $< 5\%$

★ The instrument has the function of not burning the booster and the mainframe in case of power failure and sudden shutdown during the operation.

★ Service environment: Temperature: $-10^{\circ}\text{C} \sim +40^{\circ}\text{C}$, humidity: $\leq 85\% \text{RH}$

★ Description of testing range:

1. The capacitance of the tested product shall not exceed the maximum rated capacitance of the instrument, and the value is as shown in Table 1;

2. If the capacitance of the tested product is too low, the waveform would be affected.

If it is lower than $0.05\mu\text{F}$, the instrument would not output normally, so that the auxiliary device (optional) provided by the company can be adopted.

3. For capacitance estimation of common electrical equipment, see Table 2 and Table 3.

Table 2 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 3 Capacitance ($\mu\text{F}/\text{km}$) of XLPE Insulated Single-core Power Cable

| Sectional area (mm^2) | 16 | 25 | 35 | 50 | 70 | 95 | 120 | 150 | 185 | 240 | 270 |
|---|------|------|------|------|------|------|------|------|------|------|------|
| Capacitance ($\mu\text{F}/\text{km}$) | | | | | | | | | | | |
| Voltage (kV) | | | | | | | | | | | |
| 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 |

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. Schematic diagram of controller panel

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

"Ground" - Grounding terminal: Connect to the earth when in use.

"Output" – Output multi-pin socket: Connect to the input multi-pin socket of the booster when it is 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.

"8-inch industrial control touch screen" –Menu operation, data setting and output waveform.

2. Schematic diagram of booster structure

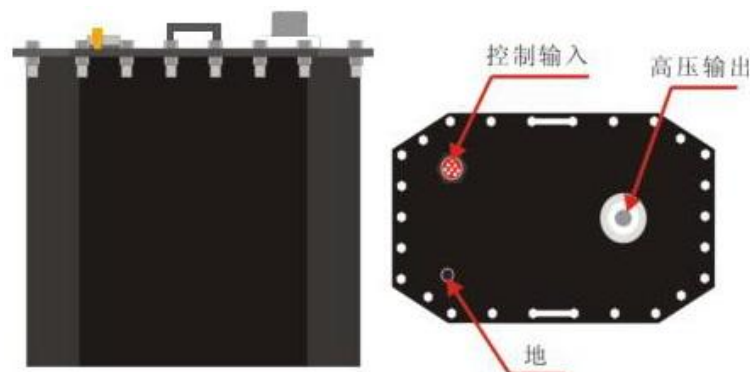


Figure 2 Schematic Diagram of Booster Structure

3. Schematic diagram of display screen



Figure 3 Schematic Diagram of Display Screen

VI. Operating Instructions

1. Wiring method



Figure 4 Schematic Diagram of Wiring

Wiring instructions: Use two private wires and the grounding wire enclosed with the product to connect as shown in Figure 4. 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 and reset, the instrument automatically enters the interface as shown in Figure 5. 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 1.

(2) Limit parameter setting

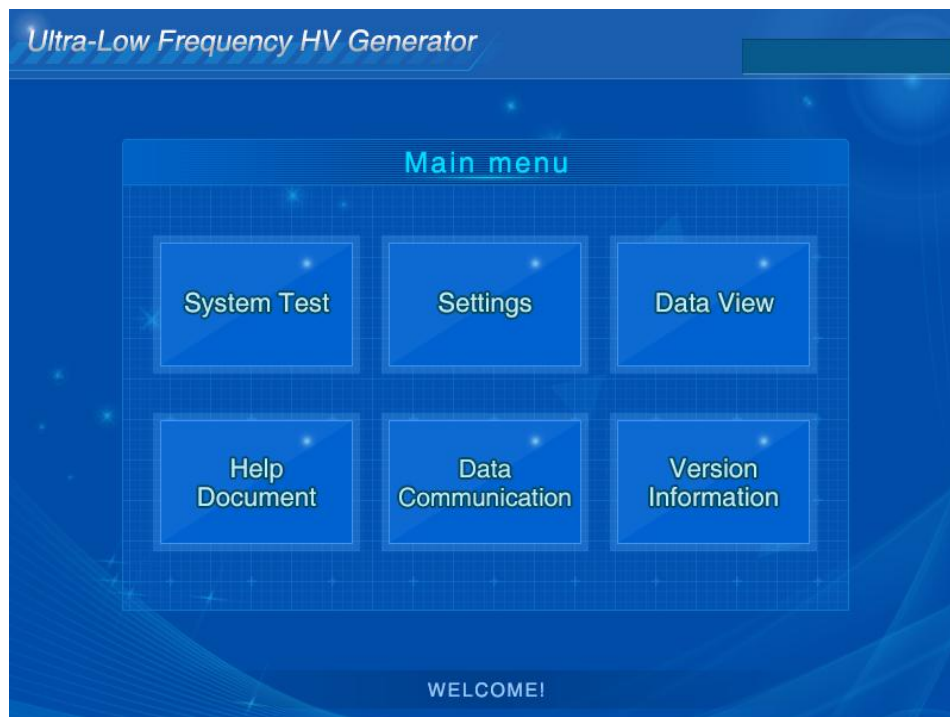


Figure 5 Main Operation Interface

Click the “System testing” menu on the main interface as shown in Figure 5 to enter the parameter setting interface as shown in Figure 6.

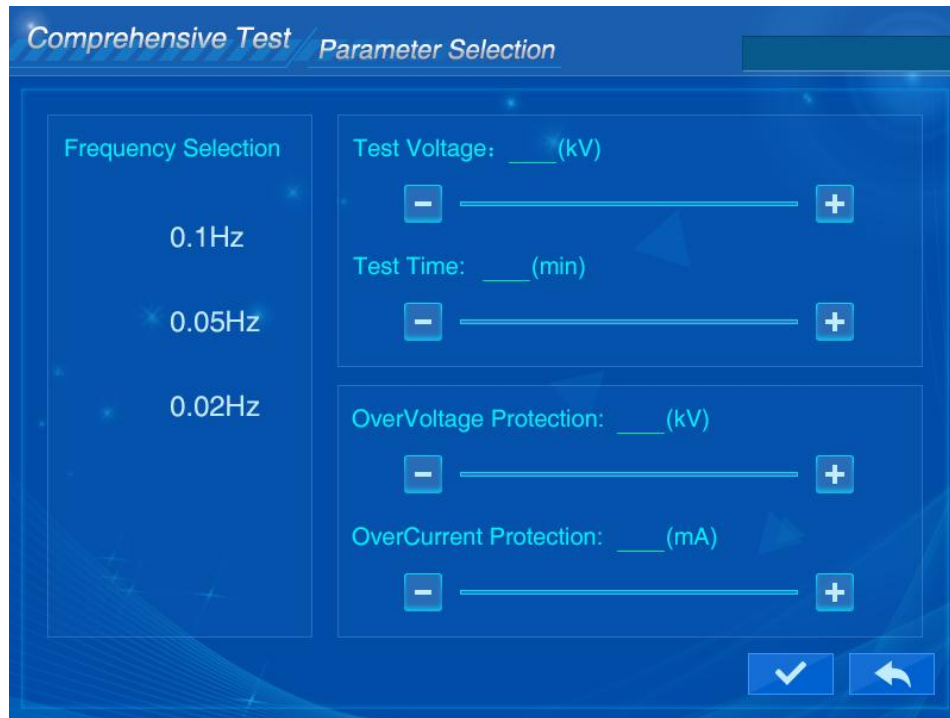


Figure 6 Parameter Selection Interface

Click the frequency checkbox below frequency selection to select the output frequency.

- ★ There are three options of: 0.1, 0.05 and 0.02 for frequency, which is measured in Hz.
- ★ Modification range of test time: 0-60 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.
- ★ The setting range of over-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.
- ★ The setting range of over-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.

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

(3) Testing interface

Click the “OK” button, and the instrument enters the booster standby interface as shown in Figure 7.

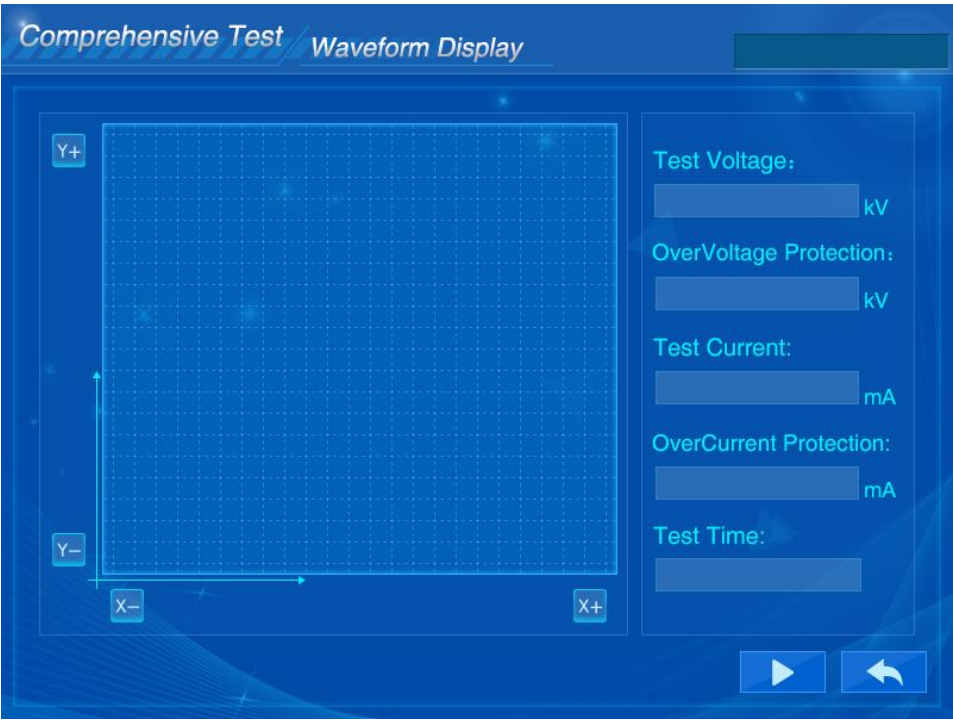


Figure 7

Click the “Start” button: Enter the automatic testing interface (as shown in Figure 8).

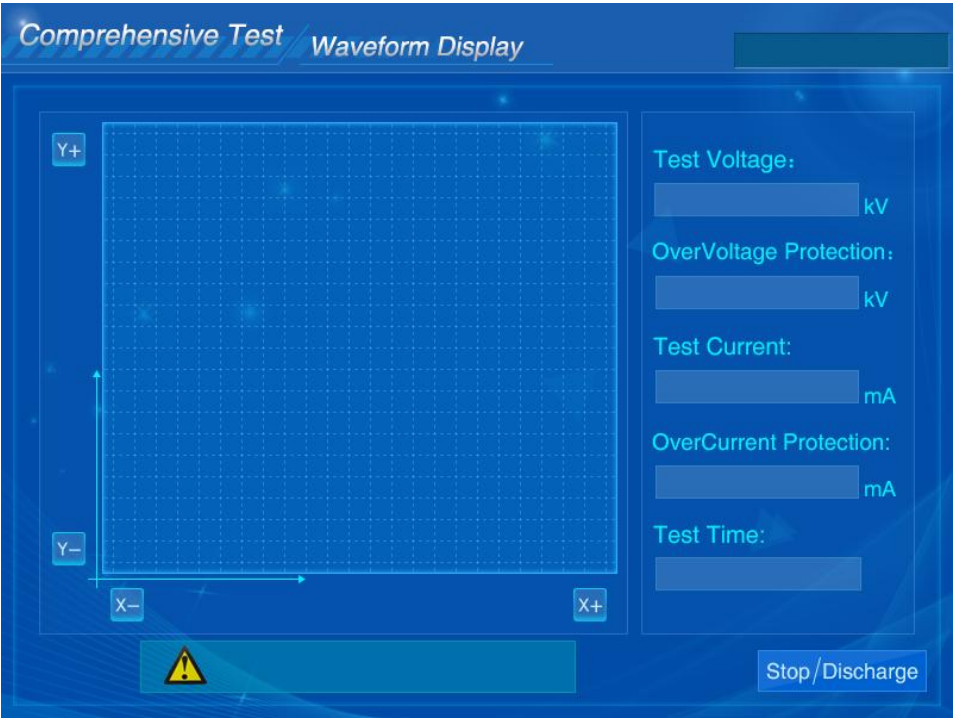


Figure 8

(4) Auto boost

After clicking the “Start” button as shown in Figure 7, the instrument will carry out the voltage stepping up test according to the following process under control of the computer:

Self-inspection → Boosting → Constant-amplitude output → Shutdown

After passing the self-inspection, the instrument enters the boosting status automatically, as shown in Figure 8, and the instrument will take a plurality cycles to boost voltage to the set value. During the boosting process, if you want to pause, you can click the “Stop/discharge” button as shown in Figure 8, and the instrument will shut down. After voltage is boosted to the set value, the instrument starts timing automatically. Click the “Stop/discharge” button, the instrument will stop outputting high voltage, and it will discharge automatically for the tested product.

(5) Fine tuning of voltage

Voltage carries out fine increasing or fine decreasing automatically. When the voltage value exceeds the set one, the instrument will carry out fine decreasing automatically under control of the CPU so as to reach the set voltage value. When the voltage value is lower than the set one, the instrument will carry out fine increasing automatically under control of the CPU.

(6) Shutdown

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/ discharge" button to shut down.

These two shutdown modes are normal shutdowns. The prompt interface as shown in Figure 9 will appear after shutdown.

Generally, when current has no abnormality and the tested product has no discharge phenomenon or over-current protection, it can be considered that it passes the test.

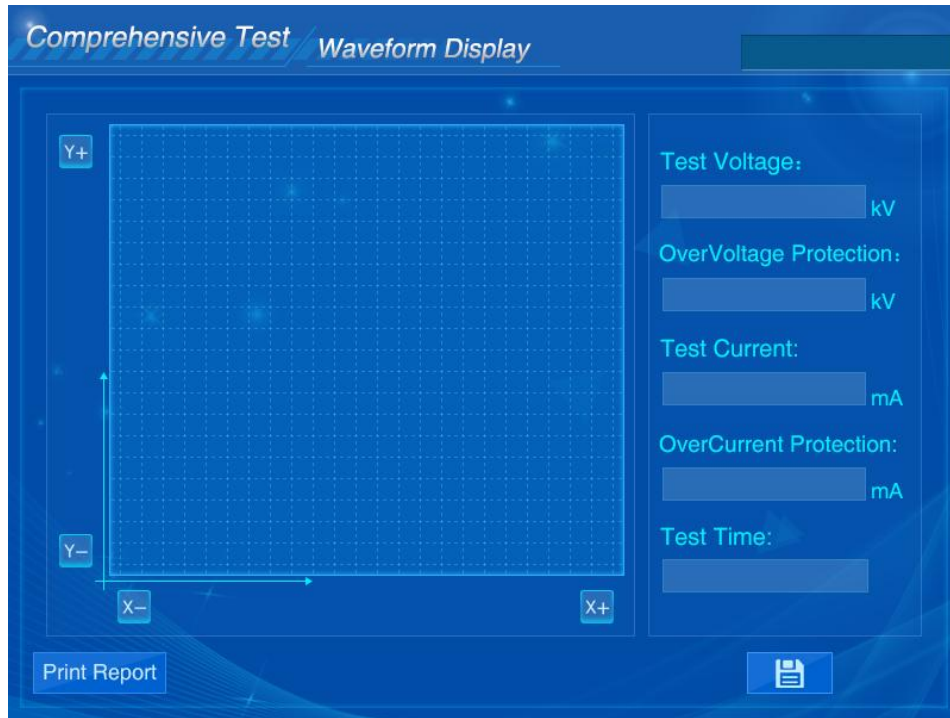


Figure 9 Interface of Passing the Test

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

After click the “Stop/discharge” button, the instrument will stop outputting automatically to discharge automatically. When the loaded voltage value is as low as 0.6KV, the mainframe returns to the page as shown in Figure 9, and click the “Save” button to save the test data. Click the “Print report” button to print the tested data. Click the “Return” button to skip to the interface as shown in Figure 10.

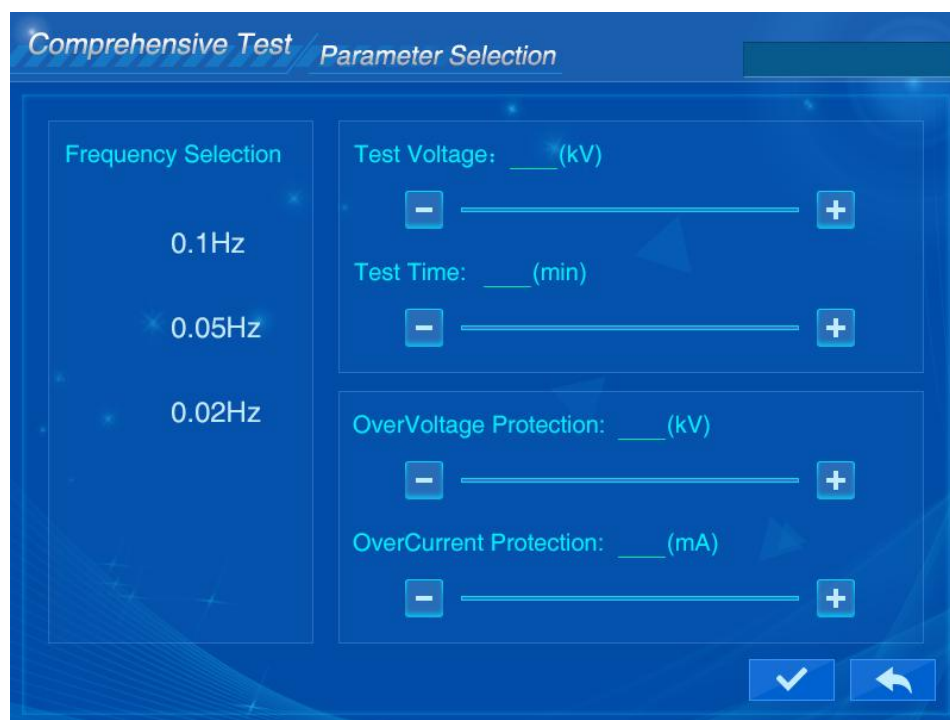


Figure 10

(7) View historical data

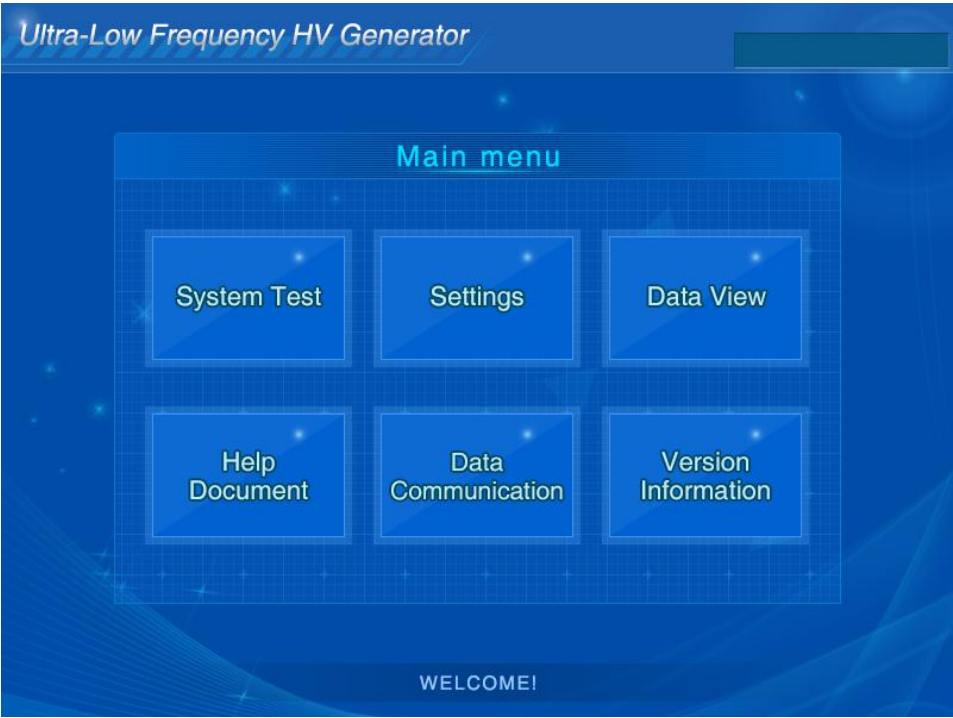


Figure 11

Click the "Data View" button in the main menu to enter the Figure 12 interface to view the stored data.

Data View

| No. | Time | Test Result | | |
|-----|------|-------------|-------------|-------------|
| 41 | | Voltage: kV | Current: mA | Length: min |
| 42 | | Voltage: kV | Current: mA | Length: min |
| 43 | | Voltage: kV | Current: mA | Length: min |
| 44 | | Voltage: kV | Current: mA | Length: min |
| 45 | | Voltage: kV | Current: mA | Length: min |
| 46 | | Voltage: kV | Current: mA | Length: min |
| 47 | | Voltage: kV | Current: mA | Length: min |
| 48 | | Voltage: kV | Current: mA | Length: min |
| 49 | | Voltage: kV | Current: mA | Length: min |
| 50 | | Voltage: kV | Current: mA | Length: min |

Figure 12

| Data View | | | | | | |
|-----------|------|-------------|----|----------|----|--------------|
| No. | Time | Test Result | | | | |
| 11 | | Voltage : | kV | Current: | mA | Length : min |
| 12 | | Voltage : | kV | Current: | mA | Length : min |
| 13 | | Voltage : | kV | Current: | mA | Length : min |
| 14 | | Voltage : | kV | Current: | mA | Length : min |
| 15 | | Voltage : | kV | Current: | mA | Length : min |
| 16 | | Voltage : | kV | Current: | mA | Length : min |
| 17 | | Voltage : | kV | Current: | mA | Length : min |
| 18 | | Voltage : | kV | Current: | mA | Length : min |
| 19 | | Voltage : | kV | Current: | mA | Length : min |
| 20 | | Voltage : | kV | Current: | mA | Length : min |

Figure 13

It can save 50 groups of data. In the data, the testing time (year, month, date, hour, minute and second), the test voltage value, the test current value, and the test duration are recorded.

(8) Help documentation

Click the “Help documentation” button on the main page, the system enters the page as shown in Figure 14 to view help information.



Figure 14

Click each navigation button on the page to respectively enter different help interfaces, as shown in the figures.



| 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)



| Rated Voltage U_0/U_N (kV) | Handover Test | | | Preventive Test | | |
|---------------------------------|---------------|-------------------|-----------------|-----------------|-------------------|-----------------|
| | Multiple | Test Voltage (kV) | Test Time (min) | Multiple | Test Voltage (kV) | Test Time (min) |
| 1.8/3 | $3U_0$ | 5 | 60 | $3U_0$ | 5 | 15 |
| 3.6/6 | $3U_0$ | 11 | 60 | $3U_0$ | 11 | 15 |
| 6/6 | $3U_0$ | 18 | 60 | $3U_0$ | 18 | 15 |
| 6/10 | $3U_0$ | 18 | 60 | $3U_0$ | 18 | 15 |
| 8.7/10 | $3U_0$ | 26 | 60 | $3U_0$ | 26 | 15 |
| 12/20 | $3U_0$ | 36 | 60 | $3U_0$ | 36 | 15 |
| 21/35 | $3U_0$ | 63 | 60 | $3U_0$ | 63 | 15 |
| 26/35 | $3U_0$ | 78 | 60 | $3U_0$ | 78 | 15 |

(Note: U_N is rated line voltage and U_0 is rated phase voltage.)

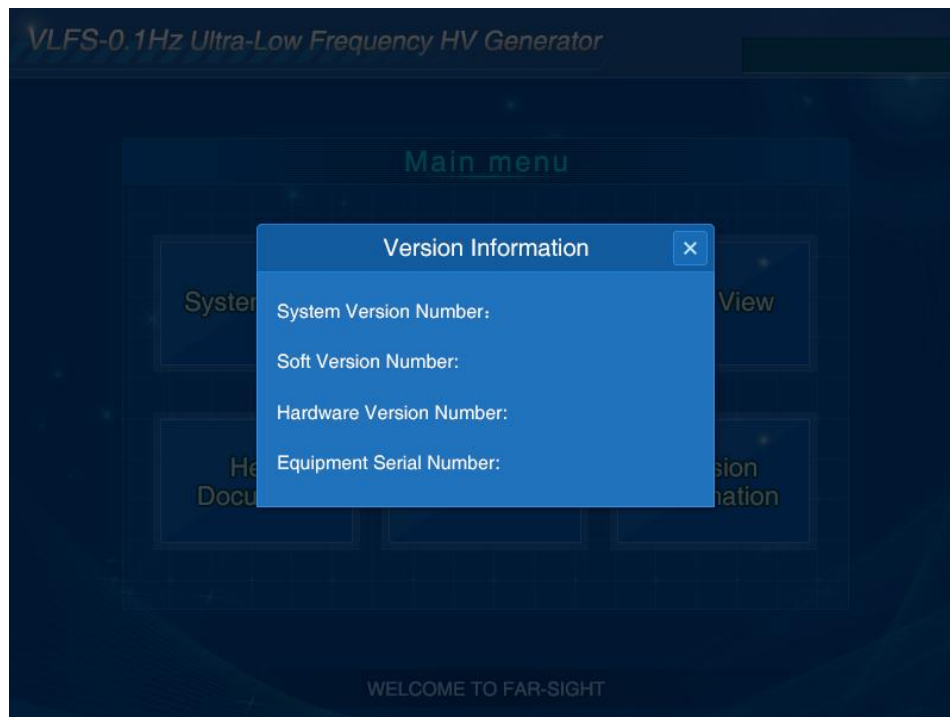


| Help Document / Attentions For The Test | | |
|---|--|--|
| Test Process | Attentions | Remarks |
| Before Test | 1.Preliminary Insulation Inspection with Insulated Resistor Meter before Wiring 2.Check voltage level 220V 3.Reliable grounding of instruments 4.Small capacitance test attention to the configuration of compensation capacitance 5.Correct wiring and verification of setting parameters | According to different electrical equipment wiring and setting parameters |
| Testing | 1.Pay close attention to the instrument indication of the test equipment and shut down immediately if there is any accident 2.Pay close attention to the test product discharge, if there is an accident immediately shut down 3.Repeated tests must be stopped, discharged and then tested. | Pay attention to look, listen and smell during the test. Stop the machine immediately if there is any accident |
| After Test | 1.Pay attention to storing test data 2.Pay attention to discharge at the end of the test. 3.End the test and finally remove the wiring | |

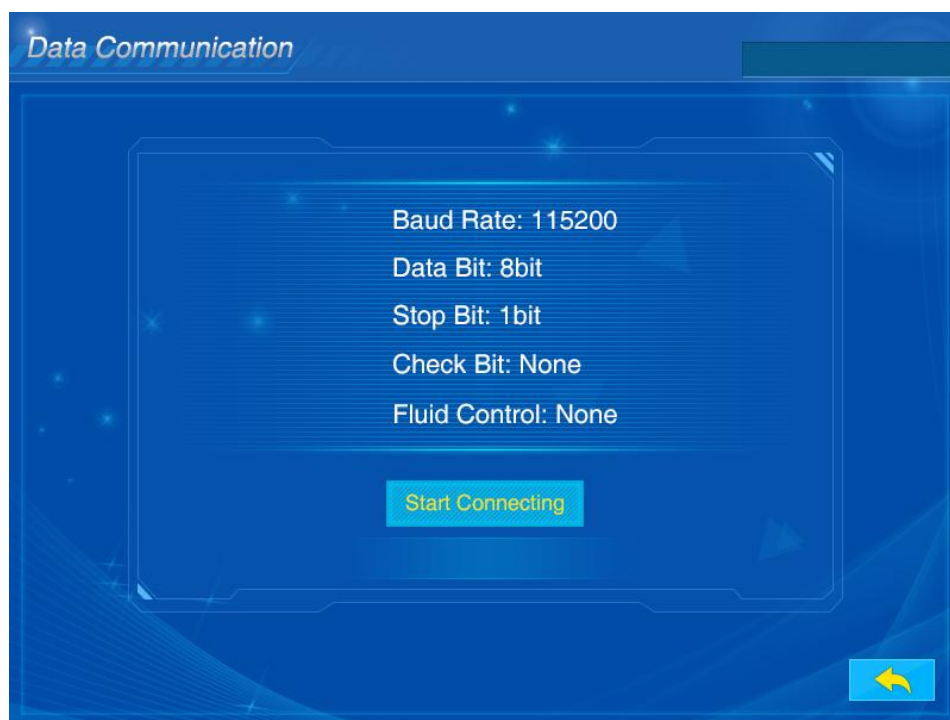
| Help Document / Simple Troubleshooting | | |
|--|--|---|
| Phenomenon | Possible Reasons | Troubleshooting |
| The instrument is electrically charged but not boosted | 1.Wiring error | Check wiring |
| | 2.Test Product Too small or too short | Parallel Compensation Capacitor |
| Boost not up to set value shutdown | Overvoltage protection or current protection value set too small | Reset settings |
| Output waveform distortion or instability | The working power supply voltage or frequency is not stable | Need a stabilized power supply |
| Black screen | Power loss or instrument power supply fuse | Check power supply or replace power insurance |

(9) Version information

Click “Version information” on the main page, the system skips to the page as shown in the figure, and the system version information is displayed.



(10) Click the “Data communication” button, the system click to the page as shown in the figure. Communication can be carried out through the USB socket on the panel and the computer to upload data in “Data view” to the computer.



(11) System setting

Click the “System setting” button in the main menu, the system skips to the page as shown in the figure to modify the current time.

The screenshot shows a software window titled "Settings". It contains two main sections: "Time Setting" and "Parameter Setting".

Time Setting: This section includes input fields for time duration. The first row has fields for "y" (years), "m" (months), and "d" (days). The second row has fields for "h" (hours), "min" (minutes), and "s" (seconds).

Parameter Setting: This section includes two input fields labeled "Ratio1:" and "Ratio2:".

At the bottom right of the window, there are two buttons: a checkmark button (to confirm settings) and a back arrow button (to return to the previous screen).

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: $U_{\max}=3U_0$, where U_0 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 $U_0=6\text{kV}$, so the setting value of test voltage is:

$$U_{\max}=3 U_0=18\text{kV}$$

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 Table 4.

Table 4 0.1 Hz ultra-low frequency test voltage and time for various models of rubber-plastic insulated power cables

| Rated Voltage $U_o/U_N(\text{kV})$ | Acceptance Test | | | Preventive Test | | |
|---------------------------------------|-----------------|----------------------|-----------------------|-----------------|----------------------|-----------------------|
| | Multiple | Test Voltage (kV) | Test Time (Minute) | Multiple | Test Voltage (kV) | Test Time (Minute) |
| 1.8/3 | $3U_o$ | 5 | 60 | $3U_o$ | 5 | 15 |
| 3.6/6 | $3U_o$ | 11 | 60 | $3U_o$ | 11 | 15 |
| 6/6 | $3U_o$ | 18 | 60 | $3U_o$ | 18 | 15 |
| 6/10 | $3U_o$ | 18 | 60 | $3U_o$ | 18 | 15 |
| 8.7/10 | $3U_o$ | 26 | 60 | $3U_o$ | 26 | 15 |
| 12/20 | $3U_o$ | 36 | 60 | $3U_o$ | 36 | 15 |
| 21/35 | $3U_o$ | 63 | 60 | $3U_o$ | 63 | 15 |
| 26/35 | $3U_o$ | 78 | 60 | $3U_o$ | 78 | 15 |

Note: U_N is the rated line voltage of the cable, and U_o is the rated phase voltage

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:

$$I_o = 2\pi fCU = 2 \times 3.14 \times 0.1CU (\text{mA}) \dots \dots \dots (\text{Formula 1})$$

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

Example 2: The length for a model of 10 kV ($U_N=10\text{kV}$, $U_o=8.7\text{kV}$) cable is 4 km, the single-phase-to-ground capacitance is $0.21\mu\text{F}/\text{km}$, and the 0.1 Hz ultra-low frequency test voltage is 26 kV (peak), the leakage current is approximately:

$$I_o = 2\pi fCU = 2 \times 3.14 \times 0.1CU = 0.628 \times 0.21 \times 4 \times 26 / \sqrt{2} \\ = 9.69 (\text{mA})$$

Over-current protection setting current value:

$$I = kI_o \dots \dots \dots (\text{Formula 2})$$

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 with the special connecting wire attached with the machine according to the method shown in Figure 15. 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.

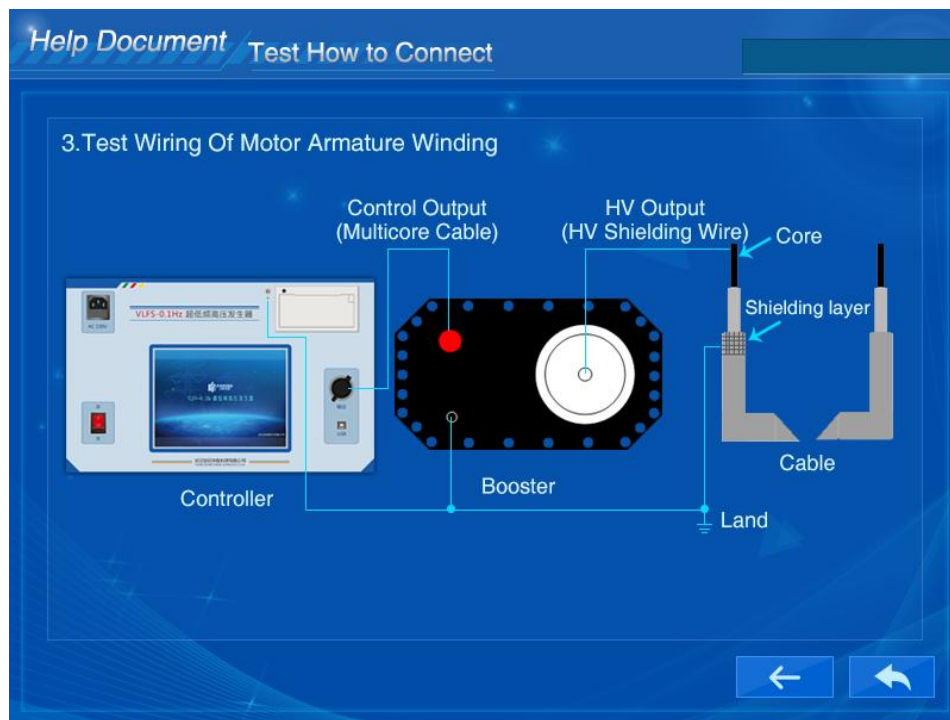


Figure 15 Wiring Diagram for Single-phase Cable Test

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 16 below.

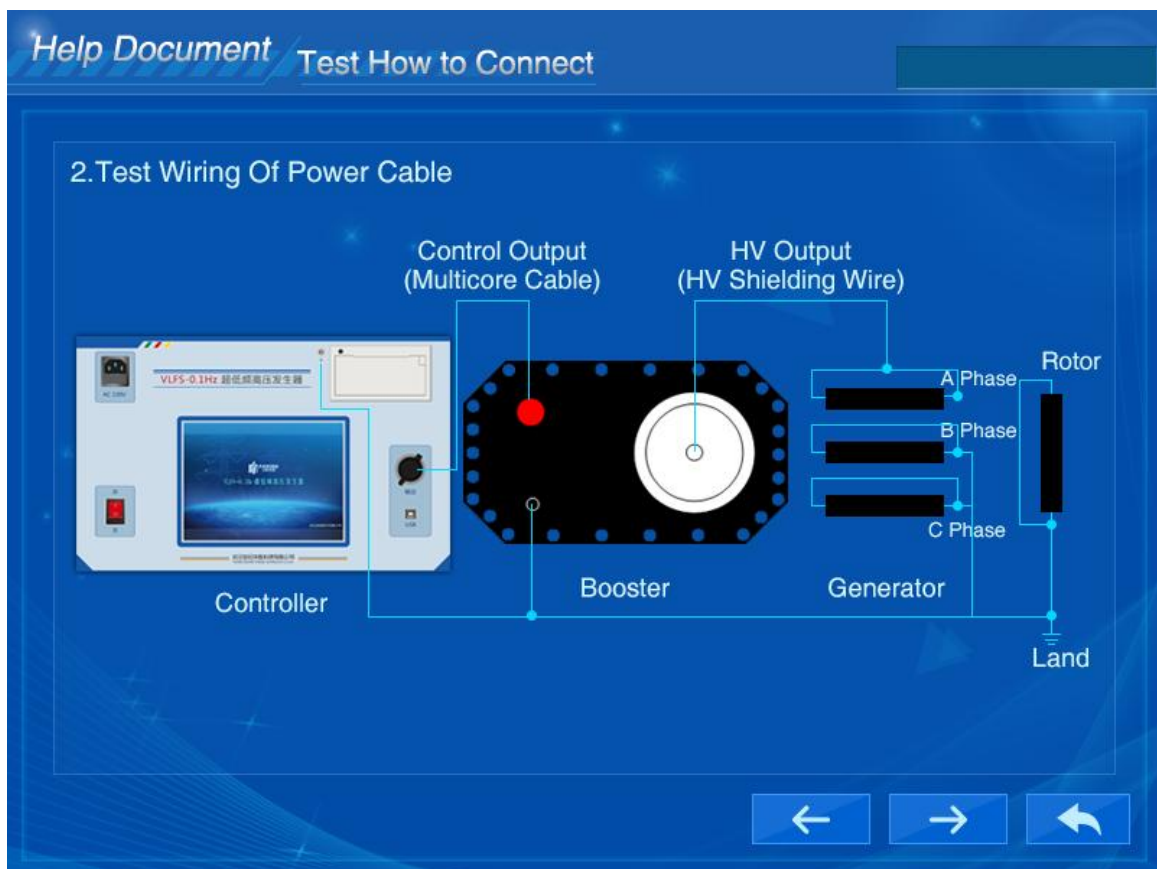


Figure 16 Wiring Diagram of Synchronous Motor

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

$$U_{\max} = \sqrt{2} \beta K U_0 \dots \dots \dots \text{(Formula 3)}$$

Wherein U_{\max} : 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

U_0 : 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:

$$U_{\max} = \sqrt{2} \times 1.2 \times 1.5 \times 10.5 \approx 26 \text{ (kV)}$$

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 | Power line | 1 | Piece |
| 2 | Ground lead | 1 | Piece |
| 3 | Controller | 1 | Set |
| 4 | Booster | 1 | Set |
| 5 | High voltage output line | 1 | Piece |
| 6 | Connecting line | 1 | Piece |
| 7 | Fuse | 2 | Set |
| 8 | Discharge rod | 1 | Piece |
| 9 | Compensating capacitor | 1 | 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 $-20^{\circ}\text{C} \sim +60^{\circ}\text{C}$ 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.