KvTester
www.kvtester.com

ZCVF-A 1500kVA-750kV

Variable Frequency Series Resonant

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

Dear customer,

Thank you for purchasing our series resonant test system. Before using this product for the first time, please read this user manual in detail, as it may help you proficiently use this test system.

Our goal is to continuously improve and improve our company's products, so the products you use may differ slightly from the user manual. If there are any changes, we will inform you by attaching a page. Please understand!

If you are unsure, please contact the company's after-sales service department, and we will definitely meet your requirements.

Warning!!!

Due to the possibility of voltage on input and output terminals, test pillars, etc., when inserting or unplugging test wires or power sockets, electric sparks may be generated. Be careful of electric shock, avoid electric shock hazards, and pay attention to personal safety!

Quality Assurance:

Within three months from the date of shipment, if the products produced by our company have defects, they will be replaced under the warranty. If there are defects in the product within one year (including one year), free maintenance will be implemented. If the product has defects for more than one year, paid lifelong maintenance will be implemented.

Safety requirement:

Please read the following safety precautions to avoid personal injury and prevent this product or other connected products from being damaged. This product only can be used within the specified scope to avoid possible risk.

This product only can be repaired by qualified technician.

Avoid fire or personal injury!

Use proper power line. Only the power line specialized for this product or in accordance with this product specification can be used.

Connect and disconnect correctly. Please do not connect or disconnect the testing line casually when the testing line is connected with electrical terminal.

Product earthing: The earthing stem of product enclosure must be earthed except that this product is earthed through the earthing conductor of power line. The earthing conductor must be connected with ground to avoid electric shock. Please be sure

that this product has been earthed correctly before connecting the input or output terminal of this product.

Pay attention to rated values of all terminals. Please pay attention to all rated values and marks of this product to avoid fire or electric shock. Please read the operation instruction of this product before connecting it, to know more information about rated value.

Please do not operate when there is no cover plate of instrument. Please do not operate this product if the cover plate or panel has been dismounted.

Please do not operate this product for any suspicious fault. Please ask the maintenance personnel to inspect this product and do not continue operating it for any damage doubt.

Please do not operate this product under humid environment.

Please do not operate this product under explosive environment.

Please keep the product surface clean and dry.

Content

Chapter 1 Product Overview

The device is mainly used for 110kV power cable, electric generators, as well as 330kV and below for all the main electrical equipment such as transformers, bus switch AC withstand voltage test of the design and manufacture.The reactor is designed in more than one separately, which not only can meet the test condition requirements for equipment with high voltage and low current, but also can meet requirements for low-voltage alternating-current withstand voltage test of 10kV cable. Possessing a wider application scope, it is the ideal withstand voltage equipment for prefecture-level, municipal-level and county-level high-voltage test departments as well as power installation and repair & testing engineering units.

This unit mainly consists of variable-frequency power source, exciting transformer, reactor and capacitive voltage divider.

Advantages of applying series resonant test system in power systems:

1. The required power capacity is greatly reduced. The series resonant power supply generates high voltage and large current through resonance between the resonant reactor and the tested capacitor. In the entire system, the power supply only needs to provide the active power consumption part of the system. Therefore, the required power supply for the test is only 1/Q of the test capacity.

2. The weight and volume of the equipment are greatly reduced. In the series resonant power supply, not only does it eliminate the bulky high-power voltage regulating device and ordinary high-power power frequency test transformer, but also the resonant excitation power supply only needs 1/Q of the test capacity, greatly reducing the system weight and volume, which is generally 1/10 of the ordinary test device.

3. Improve the waveform of the output voltage. Resonant power supply is a resonant filtering circuit that can improve the waveform distortion of the output voltage, obtain a good sinusoidal waveform, and effectively prevent the accidental breakdown of the test object caused by harmonic peaks.

4. Prevent large short-circuit currents from burning fault points. In the series resonance state, when the insulation weakness of the test object is broken down, the circuit immediately becomes de tuned, and the circuit current rapidly drops to 1/Q of the normal test current. When conducting voltage withstand tests using parallel resonance or test transformers, the breakdown current immediately increases by tens of times, and compared to the two, the short-circuit current and breakdown current differ by hundreds of times. So, series resonance can effectively identify insulation weaknesses without the worry of large short-circuit currents burning fault points.

5. There will be no recovery overvoltage. When the test object experiences breakdown, due to the loss of resonance conditions, the high voltage immediately disappears, the arc immediately extinguishes, and the process of establishing the recovery voltage is long, making it easy to disconnect the power supply before reaching the flashover voltage again. This voltage recovery process is an intermittent oscillation process of energy accumulation, which is long and does not cause any recovery overvoltage.

The main functions and technical characteristics of our company's frequency modulation resonance device:

1. The unit possesses the overvoltage, overcurrent, zero start, system detuning (flashover) and other protective functions. The protective value of over voltage and over current can be adjusted as per requirements of customers. The protective function of flashover also can remember voltage value of flashover when there is a flashover of test object, which can be used for test analysis.

2. The weight of single piece of whole unit is very light with no more than 40kg,

which can be convenient for field service.

3. There are three working modes for this unit, which is convenient for users to flexibly select according to field condition and improve the test speed.

Three working modes are fully automatic mode, manual mode and the mode with automatic tuning and manual boosting.

4. It can save data with data number of figure, which is convenient for users to identify and search.

5. The frequency sweeping can be set casually within specified scope and the frequency sweeping direction can be selected upward or downward during the automatic frequency sweeping process of the unit. Meanwhile, the large LCD screen can show scanning curve, which is convenient for users to intuitively understand whether they can find the resonance point or not.

6. It adopts DSP platform technology, which is convenient to add or delete functions and upgrade according to customers' requirements, and enables the man-machine interface to become more humanized.

Chapter 2 Test system functions and components

1. Interpretation of the product number:

ZCVF-A - Refers to the manufacturer's series code;

1500kVA refers to the maximum rated capacity that this test system can output;

750kV refers to the voltage level that the equipment can output;

2. Technical specifications of this series resonant test system:

2.1 Waveform distortion rate of output voltage should be less than 1.0%.

2.2 The permissible continuous working time is to work for 60 minutes at one time under rated condition.

2.3 Quality factor of unit itself: Q>50

2.4 Quality factor under full load in test of fire power generator: Q>10 (relating to load)

2.5 Quality factor under full load in cable test: Q>30 (relating to load)

2.6 Quality factor under full load in test of main transformer: Q>30 (relating to load)

2.7 GIS, the quality factor under full load in switch test and other tests: Q>50 (relating to load)

2.8 Input power supply: three phase of 380V

2.9 Frequency adjustment range: 30Hz～300Hz

2.10 Accuracy of system measurement: 1.5%

2.11 The unit possesses protective functions, such as over voltage, over current and zero start.

3. Standards complied with by this test system

IEC 60076-6:2007 "Power Transformers Part 6: Reactors"

IEC 60034 -18-1: Test Specification for Motor Insulation Systems

IEC60050 "Electrotechnical Terminology"

IEC60060-1/2 "High Voltage Test Techniques"

4. Configuration and Technical Parameters of Main Components

4.1 Variable frequency power source (one set)

Rated power:75kVA；

Input voltage: three phase of 380V±10% and 45～65Hz

Output voltage: 0～400V adjustable

Output voltage frequency: 30～300Hz

0.1Hz adjustable stepping

Instability degree of frequency ≤0.02%

Output current: 0～187.5A

4.2 Excitation transformer (one set)

Rated capacity：75kVA

Input voltage：400V

Output voltage：35kV

4.3 High voltage reactors (three sets in total)

Rated working voltage：250kV

Rated working current：2A

Rated inductance value：400H

Continuous working time：60min

Temperature rise should be less than 60℃.

Working frequency: 30~300Hz

4.4 Capacitor voltage divider (one set)

Self capacitance: 500pF

Working frequency: 30～300Hz

Uncertainty: 1.5%

Rated voltage:750kV/500pF

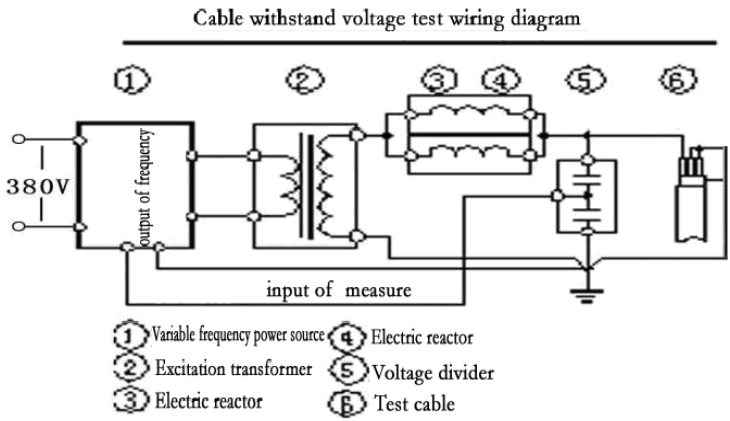
4.5 One set of testing lines and accessories

1 set of internal connecting line and test cables

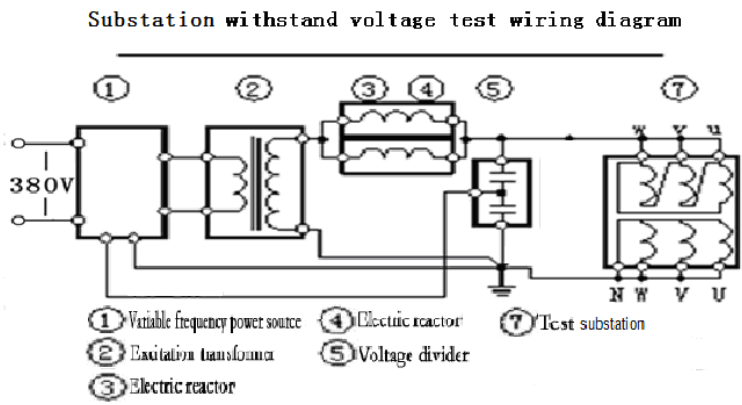
1 set of accessories for reactor and voltage divider

Chapter 3 Application of the Test system

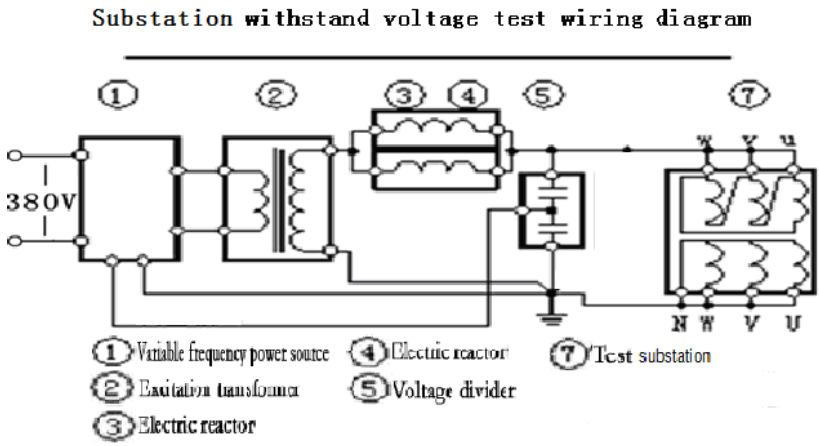
1. AC withstand voltage test of cables



2. AC withstand voltage test of the main transformer



3. AC withstand voltage test for GIS, switches, and circuit breakers



Chapter 4 Guidance of variable frequency power supply

1. Operation Panel Description

Figure 1 Operation Panel

Power switch: responsible for the power supply of the variable frequency power supply.

High voltage indication: Variable frequency power supply startup indication.

Reset: Fault reset after load detuning, frequency conversion source overheating, and other protective actions.

Emergency stop: Emergency interruption button in case of emergency.

Voltage divider signal: used to connect to the low-voltage arm of the voltage divider, with a maximum voltage of 100V.

Grounding: for system safety

USB interface: used to access a USB flash drive for querying data or connect

a mouse instead of touch operation

LCD display: used for displaying various system parameters, waveforms, menus, etc.

Input: Power supply connected, three-phase 380V ± 10% 45-65Hz, and connect A, B, and C to three-phase power supply.

Output: The variable frequency power supply outputs to the excitation transformer input.

2. Power on the test system

After powering on the variable frequency power operation box, close the "power switch" and the LCD screen will light up for display.

Attention: If the fans at the openings on both sides of the instrument are running, it indicates that the internal power components of the instrument are working properly. Otherwise, it indicates that the instrument has overheated internally or did not reset during the last test. At this point, the power should be cut off, the instrument should be placed in a ventilated area and left to stand for about 1 hour. After the internal temperature is appropriately lowered, the power should be turned on.

When the fan frequently does not start, it is recommended to contact the manufacturer immediately.

Please do not disassemble the instrument yourself when there is an irreparable fault with the equipment.

3. Touch screen display

The control screen of the variable frequency power supply is a full touch screen, and you only need to lightly click on the position you want to operate on the screen to proceed with the operation.

3.1 After turning on, the display interface is shown in Figure 2.

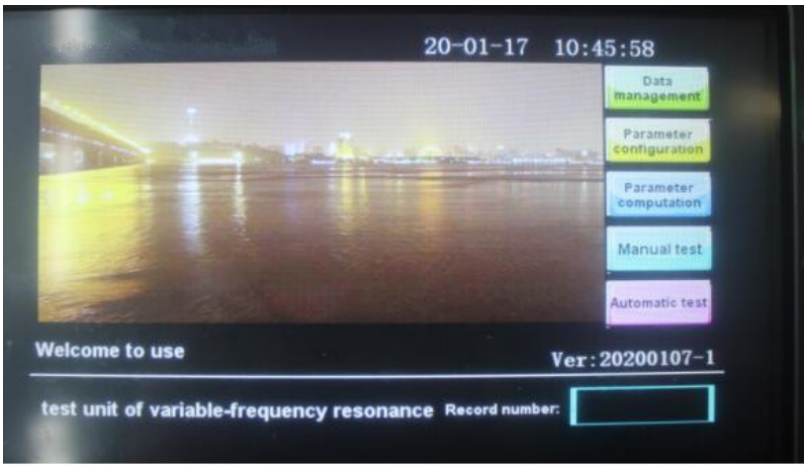


Figure 2

- **Automatic test** is the automatic test mode;
- **Manual test** is the full-manual te st mode and semi-automatic test mode;
- **Parameter configuration** is the configuration for various test parameters;
- **File management** is to check and output test record;
- **Parameter computation** is the conversion between inductance, capacitance and frequency; the third constant can be worked out with two known constants.

3.2 Test parameter configuration: The various parameters of the current test must be correctly set before each test! After clicking on "Parameter Configuration", the display interface is shown in Figure 3.

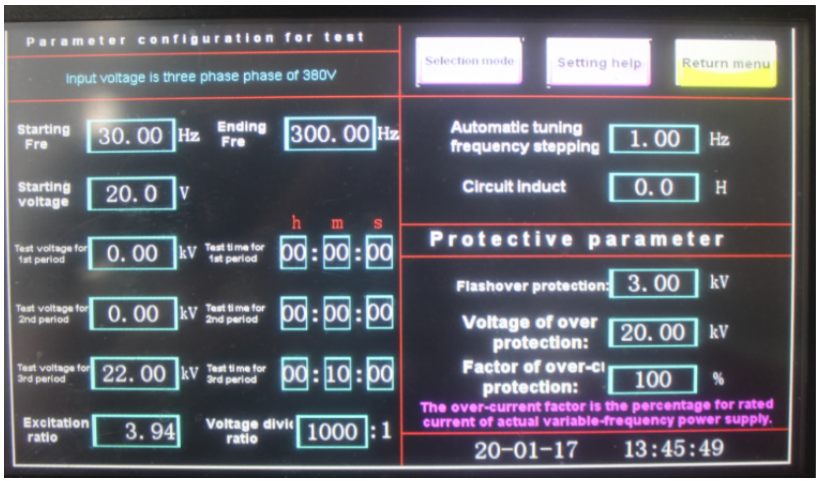


Figure 3

Starting frequency: Select the starting frequency for automatic tuning, with a maximum lower limit frequency of 30Hz and a minimum upper limit frequency of 200Hz.

Termination frequency: Select the ending frequency for automatic tuning, with a maximum lower limit frequency of 100Hz and a minimum upper limit frequency of 300Hz.

- Set the 'Start Frequency' to be no higher than the 'End Frequency'.
- It is recommended to use 30Hz~300Hz for scanning during the first experiment.
- When the approximate frequency range is already known, it is possible to select an appropriate frequency range for scanning to reduce the test time.

Starting voltage: Set the initial value of the input voltage during tuning.

- The initial values of test object with lower Q values should be set as 30～

40V, such as generator, motor and aerial bus.

- The initial values of test object with higher Q values should be set as 20V, such as power cable, transformer and GIS, etc.

Test voltage and test time: It is used for setting the maximum value of withstand test voltage and withstand voltage time for different periods.

- “Test voltage for different periods”: If the withstand voltage test is not divided into different periods, you should only set the test voltage and test time for the first period; test voltages and test times for other periods are set as 0.

- If the test is divided into different periods, you can finish setting by respectively clicking the corresponding test voltage and test time.

Exciting transformer ratio is to select the ratio of tap voltage and original edging voltage of exciting transformer in test. For example: When the tap of exciting transformer is 35kV in test, the excitation ration is 35/0.4=87.5.

Voltage divider ratio is the partial voltage ratio. Input 7500 when the partial voltage ratio is 7500. Notice: The secondary voltage for capacitive voltage divider shall be no more than 100V if the capacitive voltage divider is not the matched one. It will display voltage for surpassing 100V.

Automatic tuning frequency stepping is the frequency stepping for automatic scanning frequency in automatic test. The frequency stepping must be set in automatic test; or there will be not scanning frequency in automatic test. The frequency stepping can be set under 2Hz; the found resonance point is not the best one and the test voltage may not rise if the frequency stepping is set too high.

Circuit inductance and circuit capacitance can be set when the inductance and capacitance in loop are known; they can not be set when the inductance

and capacitance in loop are unknown. The record data in file management can display the value of the other item when any item is set; both items will not be displayed if they are not set.

Flashover protection is the protective voltage for breakdown. The breakdown protection will be more sensitive as the flashover protection value gets smaller; there would be some false operations sometimes. Under normal circumstances, the value can be set as 3kV when the maximum voltage of equipment is less than 150kV; the value can be set as 5kV when the maximum voltage of equipment is less than 150~300kV; the value can be set as 8kV when the maximum voltage of equipment is less than 300~500kV; the value can be set as 12kV when the maximum voltage of equipment is less than 500~800kV. The value is a theoretical value and it can be set on itself according to field requirements.

Voltage of over-voltage protection is used for setting the limit value of test voltage; the test will be stopped automatically when the voltage surpasses the limit value to protect test equipments and test object. The value is set as 10% higher than test voltage in general.

- Factor of over-current protection is used for setting the maximum value for output current of variable-frequency power supply. It is set as 100% in general.
- It also can be set as 150% for a short period; it is mainly used for protecting power devices of variable-frequency power supply from being burnt out.

Setting help refers to some prompt help in setting.

Return menu means returning back to main menu, shown in Figure 2.

Selection mode: You can select automatic test or maunal test by clicking “Selection mode” after setting test parameters; there is no need to select

automatic test or manual test returning to main menu, shown in Figure 4.

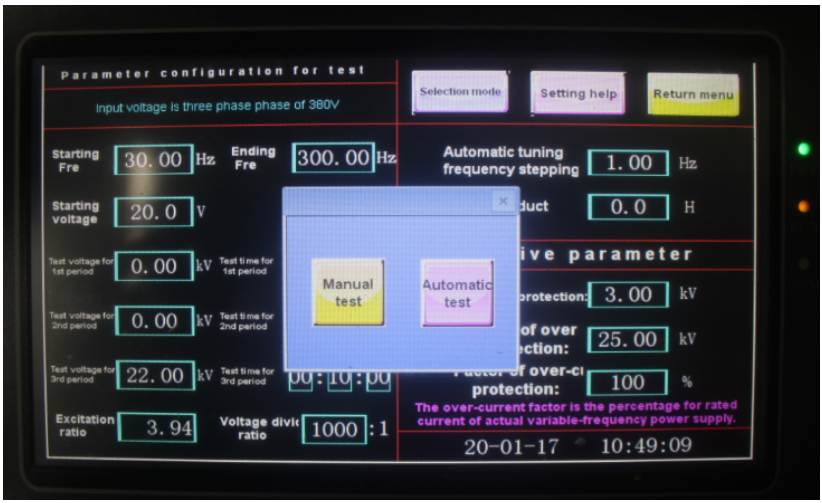


Figure 4

Chapter 5 Universal operation description

Universal operation step:

Connect test loop correctly according to wiring diagram and related requirements. Set on-site warning marks for test. Set various test parameters correctly.

1. Automatic test:

Click "**Automatic test**" after entering into interface of Figure 2 or 4. Click "**Start test**" after entering into interface of Figure 5. Then the tuning, voltage rising, timekeeping and voltage decreasing can be carried out automatically.

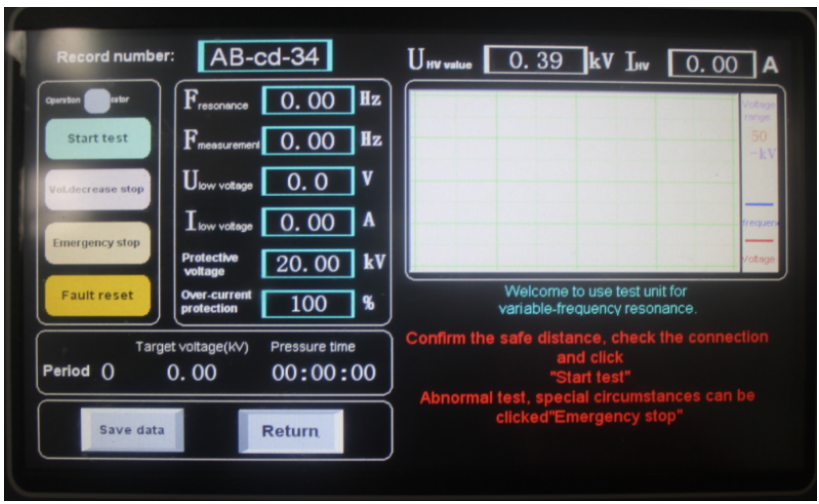


Figure 5

The interfaces will be shown in following: **Tuning**

Figure 6

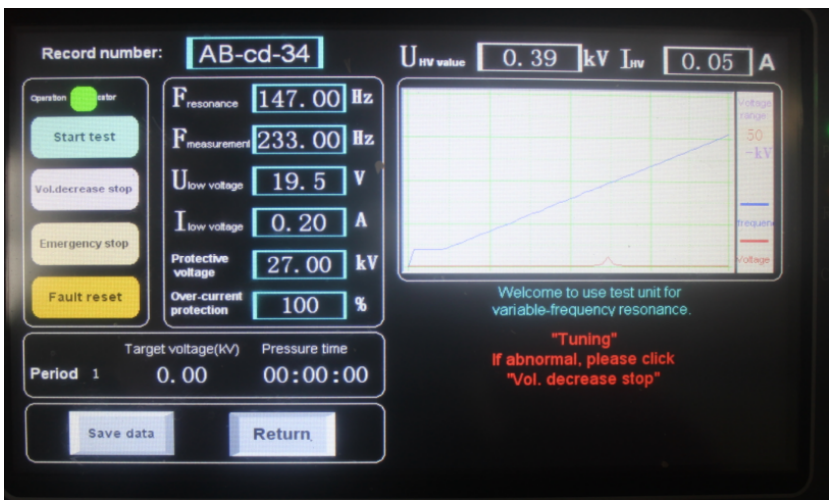


Figure 7

Timekeeping:

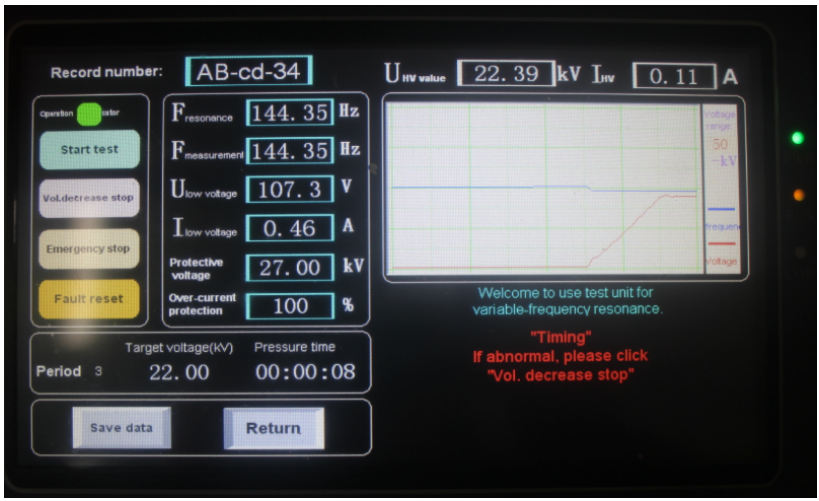


Figure 8

Voltage descending:

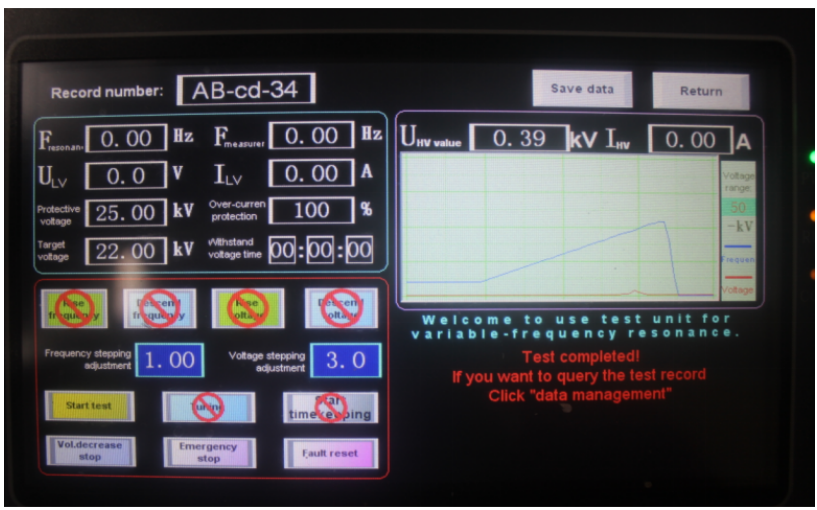


Figure 9

If there is some protective action during the test, there will be related interfaces shown in Figure 10 and Figure 11.

Over-voltage protection:

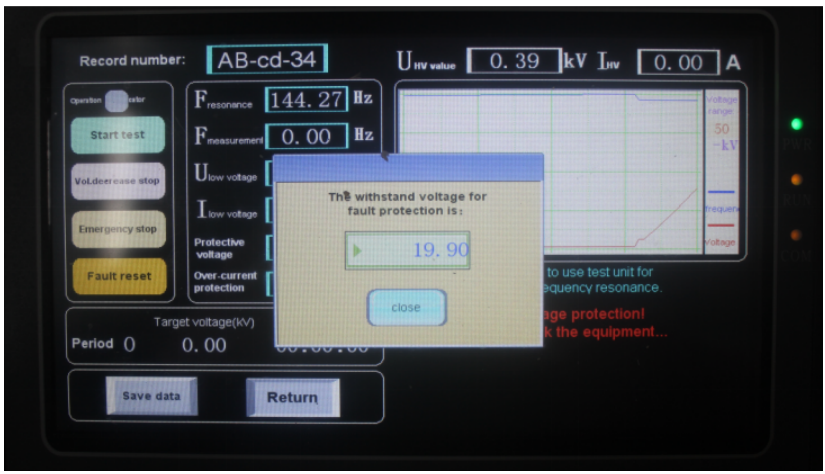


Figure 10

Flashover protection:

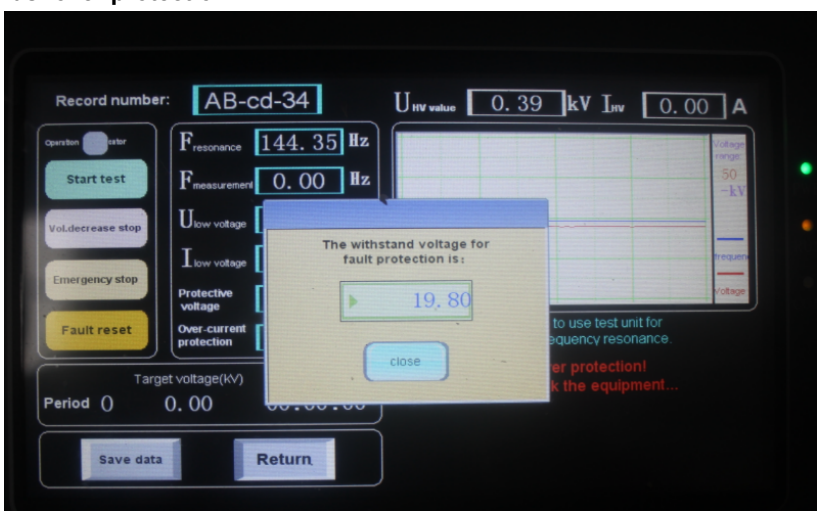


Figure 11

2. Manual test/ semi-automatic test:

Click "**Manual test**" after entering into the interface of Figure 2 or 4; Click "**Start test**" after entering into the interface of Figure 12. The manual/ semi-automatic frequency modulation and manual voltage rising can be carried out.

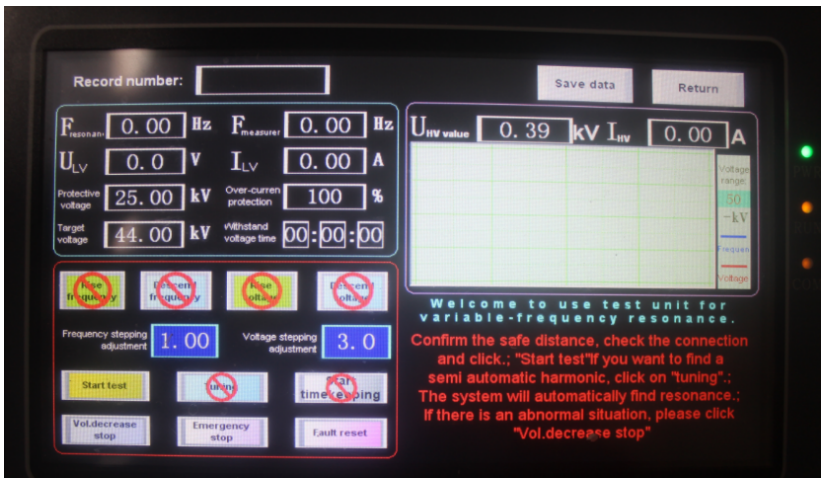


Figure 12

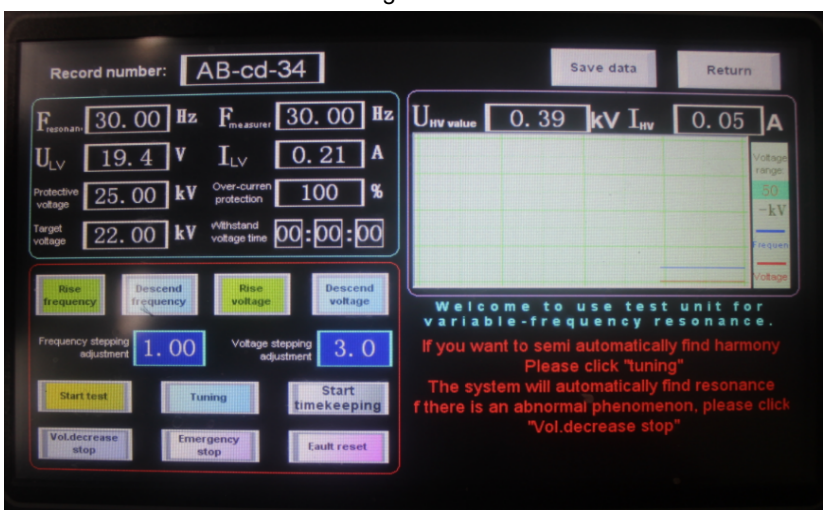


Figure 13

Semi-automatic test: the automatic tuning will be carried out by clicking “Tuning”; Rise voltage manually by clicking “Rise voltage” and “Descend voltage” after finishing tuning. Notice: the “Frequency stepping adjustment” and “Voltage stepping adjustment” should be set in advance before clicking “Tuning”, or the tuning will not be carried out automatically.

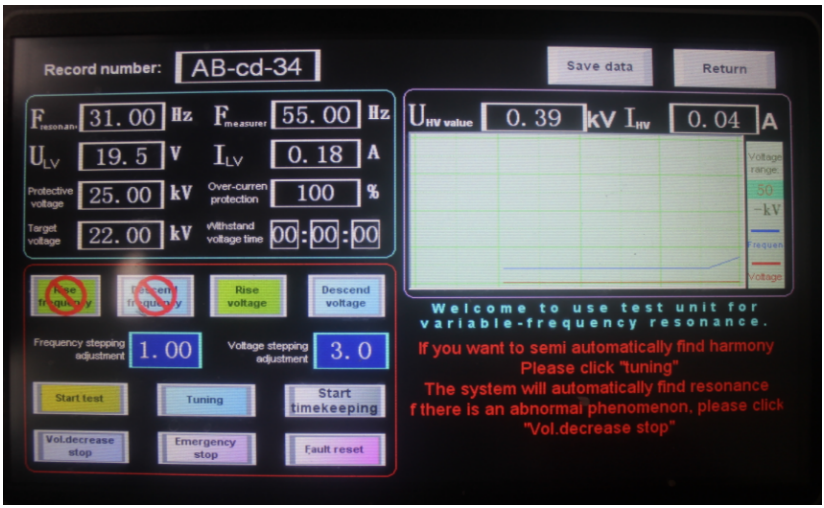


Figure 14

Manual test: the manual tuning will be carried out by clicking “Rise frequency” and “Descend frequency”; Rise voltage manually by clicking “Rise voltage” and “Descend voltage” after finishing tuning. Notice: the “Frequency stepping adjustment” and “Voltage stepping adjustment” should be set in advance before clicking “Rise frequency”, “Descend frequency”, “Rise voltage” and “Descend voltage”; or the “Rise frequency”, “Descend frequency”, “Rise voltage” or “Descend voltage” shall not be clicked.

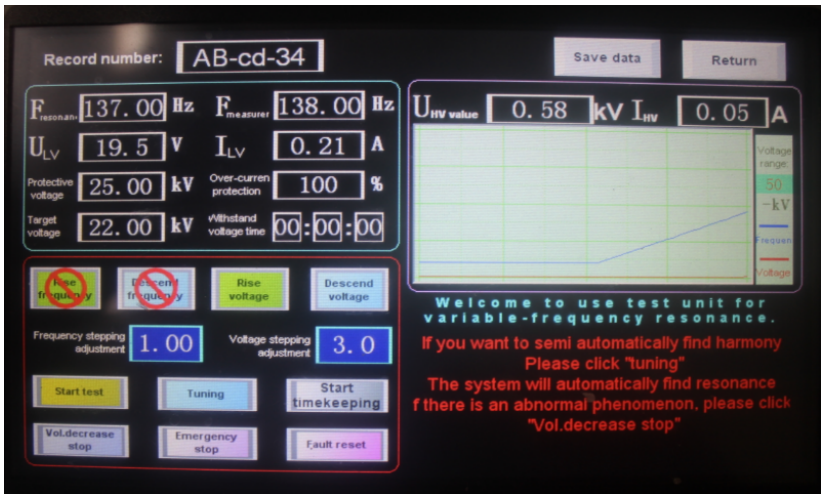


Figure 15

3. Data inquiry and output test result

Enter material interface by clicking “File management” after entering into the interface of Figure 2; then records for all previous tests can be consulted, shown in Figure 16.

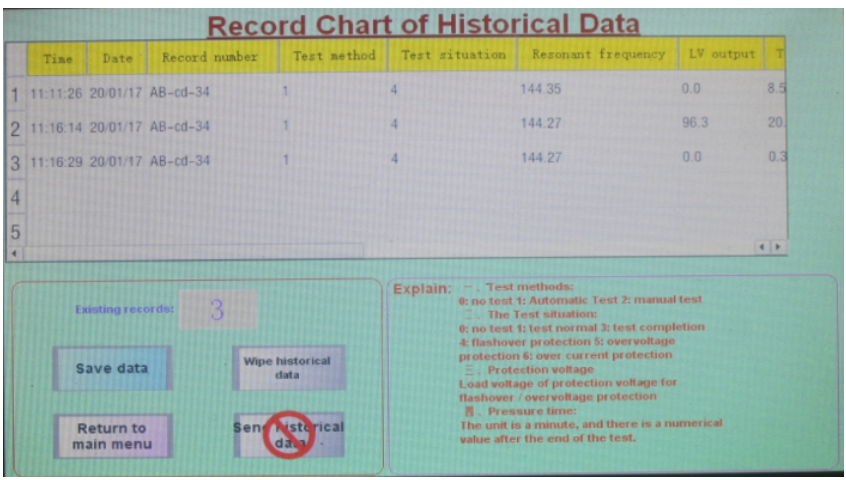


Figure 16

The test value can be saved only by clicking “Save data” in automatic test or manual test. The real-time data shall not be saved for not clicking “Save data”. After inserting U flash disk into USB interface, the historical data can be saved in U flash disk by pulling out of U flash disk after 1 min after clicking “Send historical data”. The historical data can be generated into “Excel” file on computer through the self-programmed software of our company.

Chapter 6 Common troubleshooting

1. Universal notes

2. 1.1 This test equipment should be operated by professional high-voltage testers. Please read the operation instruction carefully and carry out repeated operation trainings before using it.

1.2 The number of operators shall be no less than 2. Operators should strictly abide by safety operation regualtions relating to high-voltage test of our company before using the equipment.

1.3 In addition to getting familiar with the instruction book for this product, the test must be strictly operated according to related national standards and regulations.

1.4 Various connection wires shall not be connected improperly, or it will damage test devices.

1.5 As the output voltage in using this unit is high voltage or super-high voltage, it should be earthed reliably and pay more attention to operation security.

2. Reason and removal for common faults

2.1 The fan cannot start:

1) Failure to press "fault reset" after emergency stop, fault protection, and detuning protection;

2) High internal temperature, thermal protection of power components;

Troubleshooting: Turn off the power supply of the instrument, let it stand for about 30 minutes, turn on the power again, press the "Reset" button on the instrument panel, and then start the instrument.

If the fan still cannot be started, please contact the manufacturer and do not disassemble the instrument!

2.2 Automatic tuning cannot be completed, resonance point cannot be found

Phenomena:

The tuning curve is completely a straight line, and after tuning is completed, the instrument prompts that there is no resonance point

Reason:

Poor grounding of the circuit, incorrect wiring of the test circuit, and an open circuit in a certain instrument of the device

Troubleshooting:

1) Check the reliability of the grounding device and whether there are any disconnection points in the grounding connection wire;

2) Check the connection and disconnection of the high and low voltage coils of the excitation transformer; (Resistance value of low voltage winding; resistance value of high voltage winding, each output end to high voltage tail)

3) Check the on/off of each reactor; (Resistance value of each winding)

4) Check the continuity of the signal line of the voltage divider; (High and low voltage electrical capacity)

5) Check the connection and disconnection of the high and low voltage capacitor arms of the voltage divider; (1 hole to core, 2 holes to shell respectively conductive; 1 hole to 2 holes disconnected)

6) There is no resonance point when the device is boosting itself, and it is also necessary to check the on/off of the compensation capacitor;

If all components are normal and there are still no resonance points, please

contact the manufacturer. The instrument cannot be disassembled!

2.3 Unable to boost to test voltage

Phenomena:

1) The tuning curve is a straight line with lower peak;

2) The primary voltage is higher, while the high voltage is lower in the test;

3) The primary voltage has reached rated voltage and the voltage descends automatically for loop even when the high voltage has not reached test voltage.

Reason:

1) The reactor does not match with the capacitance of test object. The resonance point is not found exactly;

2) The loss of test object is higher, while the Q value is too low;

3) The output voltage of high voltage for exciting transformer is lower;

4) The high-voltage connection line is too long or the high-voltage corona prevention line is not adopted.

Troubleshooting:

1) Put the compensation capacitor back to test loop and increase the loop capacitance;

2) Try to connect as many reactors as possible in series and increase the loop capacitance;

3) Increase the output voltage of exciting transformer;

4) Carry out a drying treatment to test object to improve the insulation strength of test object and reduce the power loss of loop;

5) The high-voltage corona prevention line should be adopted for higher voltage output for equipment in general; or change the common high-voltage output line to shorter connection line, which should be no more than 5 meters in general.

Please contact the manufacturer if the problem is still not dealt with after all treatments. The instrument shall not be disassembled.

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