Operation Manual

HMCOP

VLF Hipot Tester with Tan Delta and PD Measurement

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Catalogue

Part 1: Introduction to the ultra-low frequency and high voltage power supply series products

1.1 Product Features Introduction

This product adopts digital frequency conversion technology, microcontroller control, and is fully automated for boosting, reducing voltage, measuring, and protecting. Due to its fully electronic design, it is small in size and light in weight. It adopts a large screen color touch screen, which is clear and intuitive, easy to operate, and displays output waveforms. The design index meets the national standard of General technology Conditions for Ultra Low Frequency and High Voltage Generators. The main features are as follows:

1.1.1 For ultra-low frequencies with a rated voltage less than or equal to 60kV, a single connection structure (one booster) is used; Ultra low frequencies greater than 60kV adopt a series structure (two boosters are connected in series), greatly reducing the overall weight and enhancing the load-bearing capacity. Moreover, both boosters can be used separately, achieving one machine with multiple functions.

1.1.2 Current and voltage data are directly sampled from the high-voltage side, so the data is accurate.

1.1.3 Intelligent comprehensive protection function: Without setting current and voltage protection values, the instrument can calculate overvoltage and overcurrent protection values based on the size of the sample capacitance and the test voltage value. It can also provide protection against voltage and current mutations, so it can capture discharge situations. The protection action time is less than 20ms.

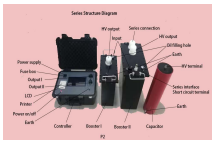
1.1.4 Using 150kV high-voltage line output, safe and reliable.

1.1.5 Due to the use of a closed-loop negative feedback control circuit, the output has no capacitance rise effect.

1.1.6 The new product has added DC, dielectric loss, and partial discharge testing functions, which can synchronously measure the dielectric loss, capacitance, insulation resistance, and partial discharge of the test object during the withstand voltage test process.

1.2 Product specifications of ultra-low frequency and high voltage power supply series:

Table 1

Rated voltage	Load	Shape	Product structure, weight, and application range
30kV （Peak）	Automatic frequency 0.1Hz-0.01Hz Capacity: ≤ 5 μ F		Controller: 4 kg Booster: 25 kg Used for voltage withstand test of cables and motors up to 10KV
40kV （Peak）	Automatic frequency 0.1Hz-0.01Hz Capacity: ≤ 5μ F		Controller: 4 kg Booster: 25 kg Used for voltage withstand test of cables and motors up to 10KV
50kV （Peak）	Automatic frequency 0.1Hz-0.01Hz Capacity: ≤ 5 μ F		Controller: 4 kg Booster: 45 kg Used for voltage withstand test of cables and motors up to 15KV
60kV （Peak）	Automatic frequency 0.1Hz-0.01Hz Capacity: ≤ 5 μ F		Controller: 4 kg Booster: 45 kg Used for voltage withstand test of cables and motors up to 25KV
80kV （Peak）	Automatic frequency 0.1Hz-0.01Hz Capacity: ≤ 5 μ F		Controller: 4 kg Booster1: 40KV Boooster2:40KV Used for voltage withstand test of cables and motors up to 35KV

30KV 40KV 50KV 60KV (Integrated unit)	Automatic frequency 0.1Hz-0.01Hz Capacity: ≤ 5 μ F		Weight: 40kg Appearance: 400* × three hundred × 500（mm） The purpose of each specification product is the same as above

1.3 Technical indicators of ultra-low frequency and high voltage power supply

1.3.1 Rated output voltage: 30kV-80kV. Different specifications are shown in Table 1

1.3.2 Output frequency: Automatic frequency conversion range: 0.1Hz-0.01Hz

1.3.3 Carrying capacity: see Table 1

1.2.4 AC voltage resolution: 0.1kV

1.3.5 Voltage accuracy: 3%

1.3.6 AC current resolution: 0.1mA

1.3.7 AC current accuracy: 3%

1.3.8 Voltage positive and negative peak error: 3%

1.3.9 Voltage waveform distortion: 3%

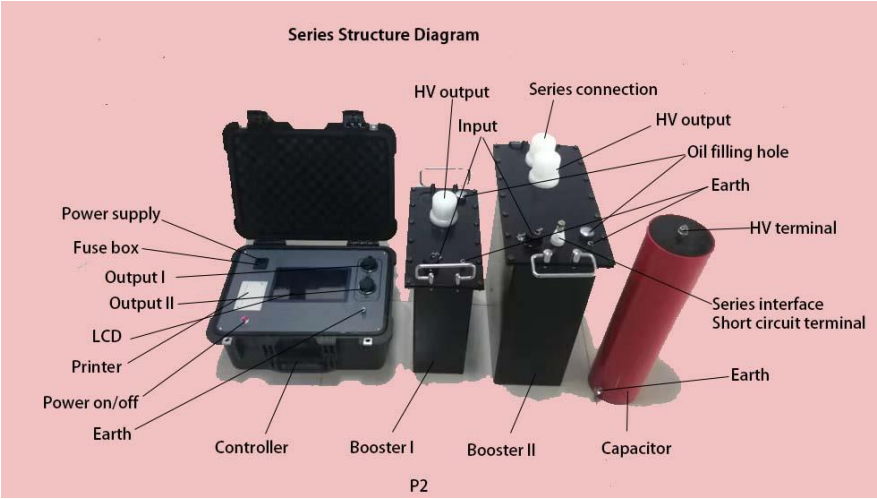
1.3.10 Service conditions: indoor and outdoor; Temperature: -10 ℃ to+40 ℃; Humidity: ≤ 85% RH

1.3.11 Input power supply: frequency 50Hz, voltage 220V ± 5% (or frequency 60Hz, voltage 110V ± 5%). If using a micro generator for power supply, a variable frequency generator should be used instead of a regular generator, as the unstable speed of the regular generator can cause abnormal boost and damage to the instrument.

1.4 Main structure of ultra-low frequency and high voltage power supply

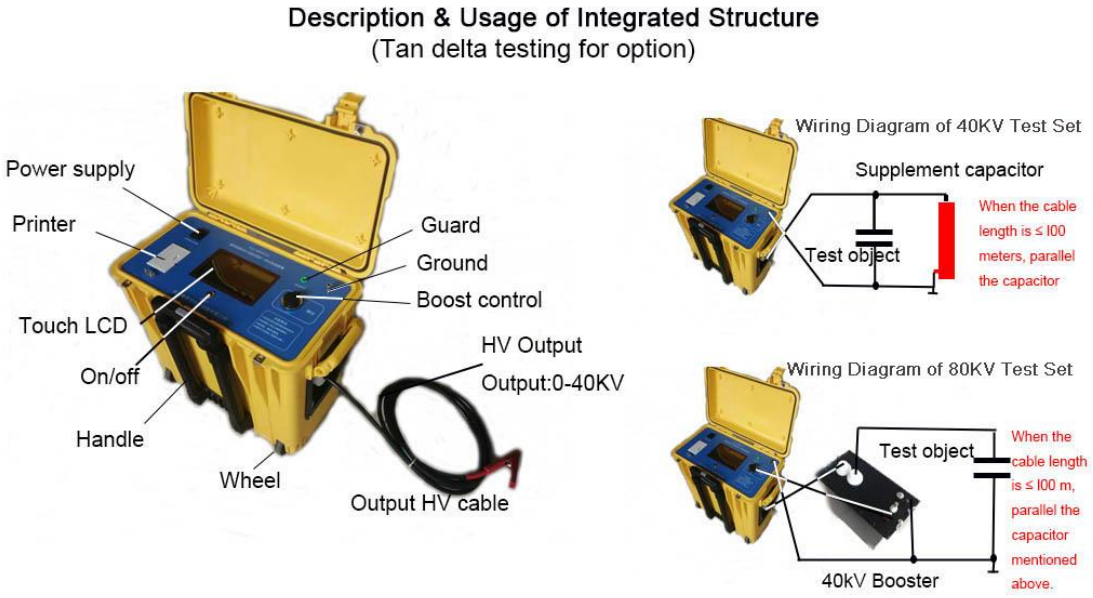
1.4.1 For ultra-low frequencies with a rated voltage below 50kV, a booster is used, which is called a single connected ultra-low frequency. The structure and various components are explained in the following figure:

1.4.2 For ultra-low frequencies with a rated voltage above 50kV, two boosters are connected in series, known as series type ultra-low frequencies. The structure and various components are explained in the following figure:



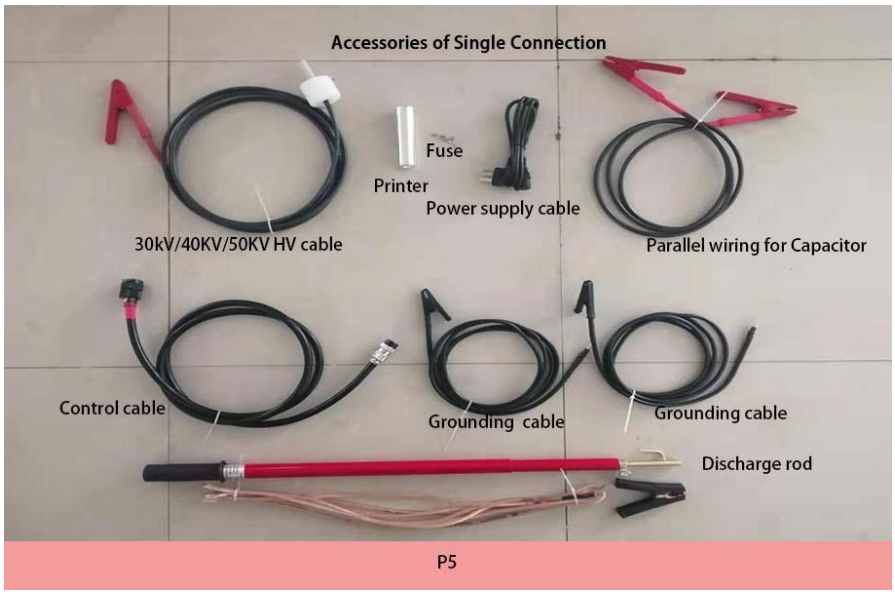
1.4.3 Integrated ultra-low frequency structure description and usage

The all-in-one machine has four specifications: 30KV, 40KV, 50KV, and 60kV. If you want to output a higher voltage, you can connect a booster in series, which can rise to 80kV. The explanation is as follows:



1.5 List of accessories for ultra-low frequency and high voltage power supply

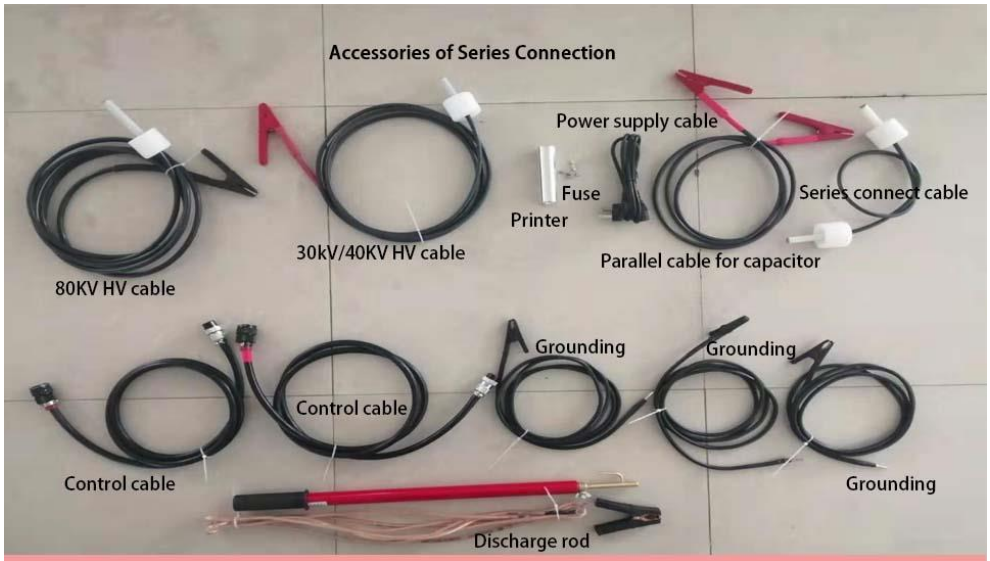
1.5.1 The single connected ultra-low frequency accessory is shown in the following figure:



Sr.no	Description	Quantity	
1	Control unit	1	unit
2	Booster	1	unit

3	HV Connection Cable	1	unit
4	LV conncetion cable	1	unit
5	Power supply cable	1	unit
6	Discharging rod	1	unit
7	Earth cable	2	unit
8	Capacitor, 0.04μF	1	unit
9	Print paper	2	unit
10	Fuse	2	unit
11	Maunal	1	unit
12	Calibration report	1	unit

The 1.5.2 series type ultra-low frequency accessory is shown in the following figure:



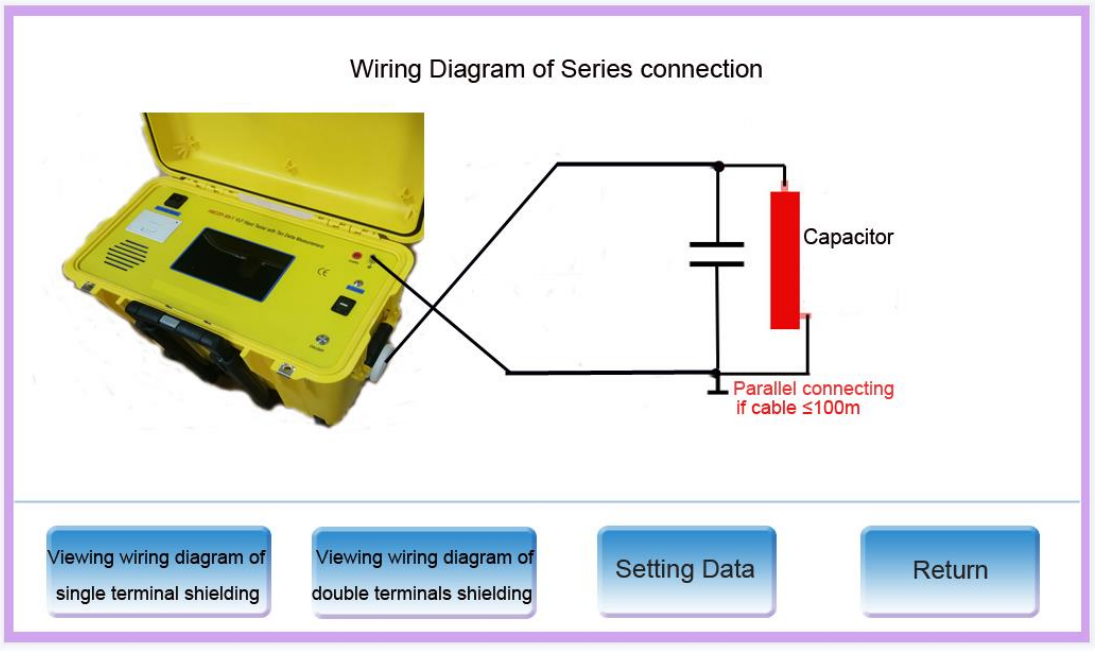
Sr.no	Description	Quantity	
1	Control unit	1	unit
2	Booster	2	unit
3	HV Connection Cable	1	unit
4	LV conncetion cable	1	unit
5	Series connection	1	unit

	cable		
6	Power supply cable	1	unit
7	Discharging rod	1	unit
8	Earth cable	2	unit
9	Capacitor, 0.04μF	1	unit
10	Print paper	2	unit
11	Fuse	2	unit
12	Maunal	1	unit
13	Calibration report	1	unit

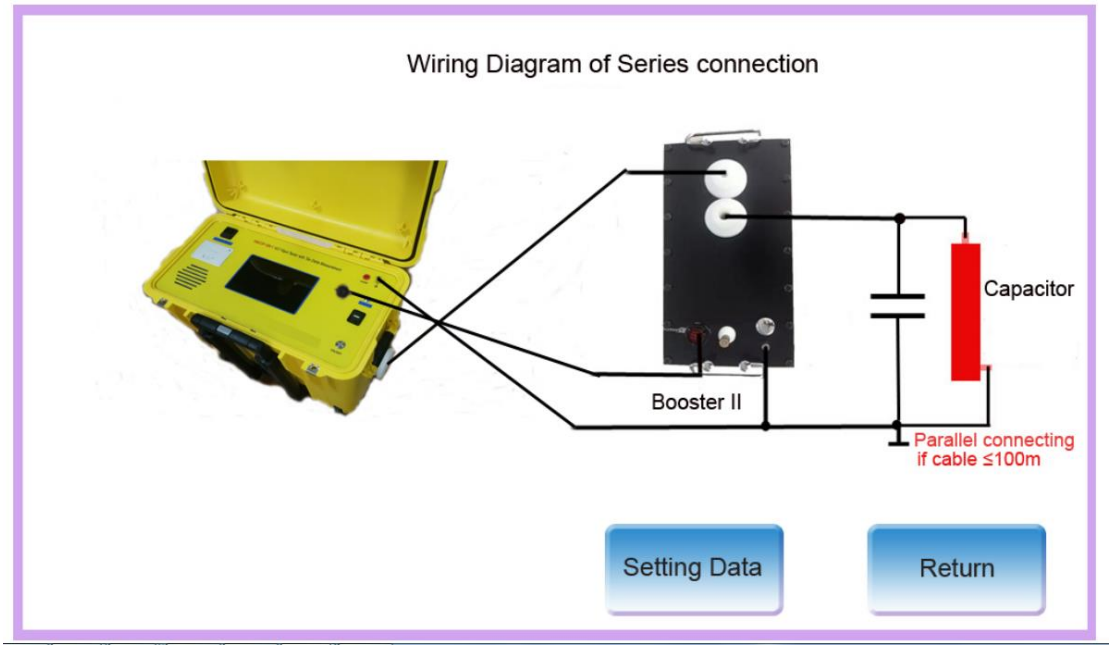
Part 2: Operating Instructions for Ultra Low Frequency Voltage Withstand Test

2.1 Wiring method for ultra-low frequency withstand voltage test

2.1.1 The wiring method for single connected ultra-low frequency withstand voltage test below 60kV is as follows



2.1.2 The wiring method for the ultra-low frequency withstand voltage test when two stage boosters are connected in series is as follows



2.2 Introduction to the Ultra Low Frequency Voltage Withstand Test Procedure (Q/ED116501-2004 Rubber Plastic Power Cable Handover and Preventive Test Procedure)

Ultra low frequency is mainly used in the AC voltage withstand test of cables within 35kV. The test voltage and test time for different specifications of cables are determined according to relevant regulations, and the content of these regulations is basically the same at home and abroad. Below is a summary of the main content of the "Q/ED116501-2004 Rubber Plastic Power Cable Crossing and Preventive Test Regulations", which is for user reference:

2.2.1 Test time 60 minutes

2.2.2 The ultra-low frequency withstand voltage test voltage of various cables is shown in the table below:

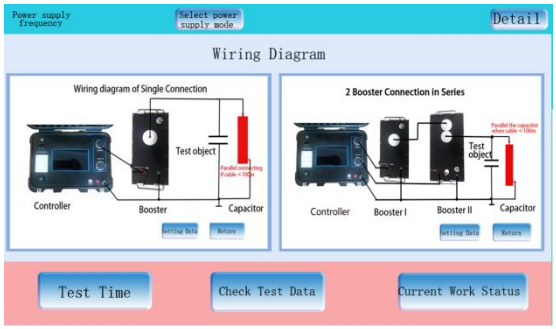
Rated Voltage U0 / U	Handover Test Voltage		Preventive Test Voltage	
	Times	Voltage(kV)	Times	Voltage(kV)
1.8/3	3U0	5	3U0	5
3.6/3	3U0	11	3U0	11
6/6	3U0	18	3U0	18

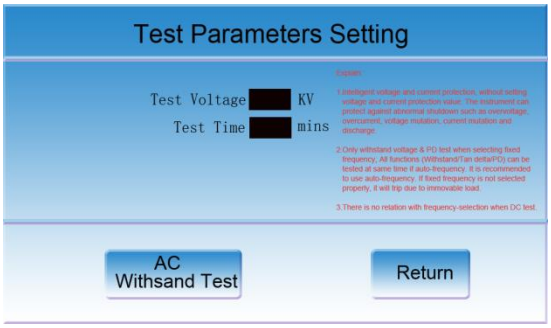
6/10	3U0	18	3U0	18
8.7/10	3U0	26	3U0	26
12/20	3U0	36	3U0	36
21/35	3U0	63	3U0	63
26/35	3U0	78	3U0	78

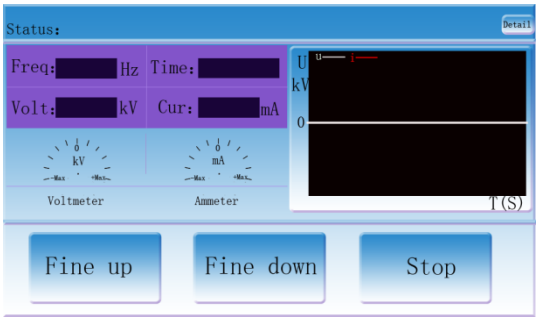
2.3 Operation instructions for ultra-low frequency withstand voltage test

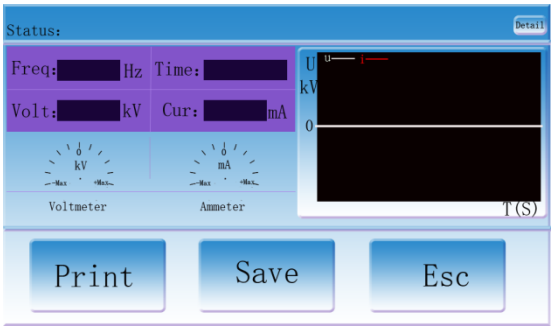
After connecting the on-site testing system as described above, connect the power supply to enter the test. The homepage of the touch screen of the control box is for selecting the wiring diagram. Select the wiring diagram that is consistent with the actual situation to enter the parameter setting interface. Test time, test voltage, modified according to test requirements. Click on the data to be modified, and a numeric keypad will pop up to input the required data. In order to ensure safety, the system has limited the input data: the test voltage range is 0 to the rated value; The test lasts from 1 to 99 minutes, and data entry beyond the range is invalid. After the experiment, this parameter will automatically be saved as the default value for the next experiment. Clicking on the withstand voltage test will enter the test, and the instrument will use two to three cycles to raise the voltage to the set voltage. In the first two cycles, pre test the test sample to determine if there is a low resistance fault, measure the capacitance of the test sample, and then determine the appropriate frequency for voltage withstand testing based on the size of the capacitance of the test sample. The system provides intelligent protection for the testing process: overvoltage, overcurrent, voltage and current sudden changes, discharge, and other protective actions. When the test time is full, the instrument will automatically stop, or you can directly click the stop button to stop. The shutdown process will automatically discharge the test object. After shutdown, the current data can be printed or saved, and 90 sets can be saved in a cycle. Selected data records can be printed in historical data queries. The top line of the screen is a prompt for the working status of the instrument, which includes some fault information of the instrument. Click on the “check test data” button to view all information, including the working status and faults of the scraping

instrument and test sample. Because there are touch key prompts and help information, users can also follow the prompts for operation. Before disassembling the wire, the power cord should be unplugged first, and the test object should be discharged with a discharge rod, followed by a short circuit discharge before disassembling the wire. If the tested cable is less than 100 meters and the instrument cannot output a smooth sine wave voltage, compensation capacitors can be connected in parallel at the test object end. Waveform distortion can affect measurement accuracy. The four main operation interfaces are as follows:









Part 3: Operating Instructions for Ultra Low Frequency Dielectric Loss Test

Special note: Only ultra-low frequency testing devices with dielectric loss function can be purchased to measure dielectric loss

3.1 Why should ultra-low frequency be used for dielectric loss testing of cables

Due to the large capacitance of the insulation layer of the cable, it is required that the dielectric loss instrument have a large testing capacity and a high testing voltage. For example, for 35kV cables, the dielectric loss test voltage should be 1.5 times U0 (i.e. 39KV). The conventional power frequency dielectric loss tester has a small load capacity and a low test voltage (less than 12KV), which cannot meet this testing requirement. Ultra low frequency has strong carrying capacity due to its low operating frequency, making it suitable for conducting dielectric loss tests on cables.

3.2 Introduction to Dielectric Loss Ultra Low Frequency Series Products

All specifications and products of different voltage levels can be equipped with dielectric loss testing function. Dielectric loss ultra-low frequency is a multifunctional cable tester that can measure the dielectric loss, capacitance, insulation resistance of cables, and also perform AC and DC withstand voltage tests. Due to the installation of the sampling device for electrical parameters related to dielectric loss in the ultra-low frequency booster and control box, the device is small in size, light in weight, simple in connection, and easy to use. It is a good helper for on-site cable testing and determining cable insulation performance.

3.3 Dielectric loss ultra-low frequency technical indicators

3.3.1 Dielectric loss test voltage range: 1kV-40kV (low test voltage affects test accuracy)

3.3.2 Dielectric loss test frequency: 0.1Hz

3.3.3 Dielectric loss measurement range: 0.01 × 10-3- 655.35 × 10-3 for sizes greater than 655.35 × The value of 10-3 will be greater than 655.35 × 10-3 Reminder

3.3.4 Dielectric loss measurement accuracy: 1%

3.3.5 Dielectric loss resolution: 1x10-5

3.3.6 Capacitance measurement range: 0.001 μ F–10 μ F

3.3.7 Electrical capacity resolution: 0.001 μ F

3.3.8 Capacitance measurement accuracy 3%

3.3.9 Insulation resistance measurement range: 1MΩ -65535MΩ. For values greater than 65535MΩ, a prompt of>65535MΩ will be given (these data are located in the qualified area of the cable).

3.3.10 Insulation resistance resolution: 1M Ω

3.3.11 Insulation resistance measurement accuracy 3%

3.3.12 Voltage accuracy: 3%

3.3.13 AC current range: 0-59mA

3.3.14 AC current resolution: 0.1mA

3.3.15 AC current accuracy: 3%

3.3.16 DC current range: 0-20mA

3.3.17 DC current resolution: 1 μ A

3.3.18 DC current accuracy: 3%

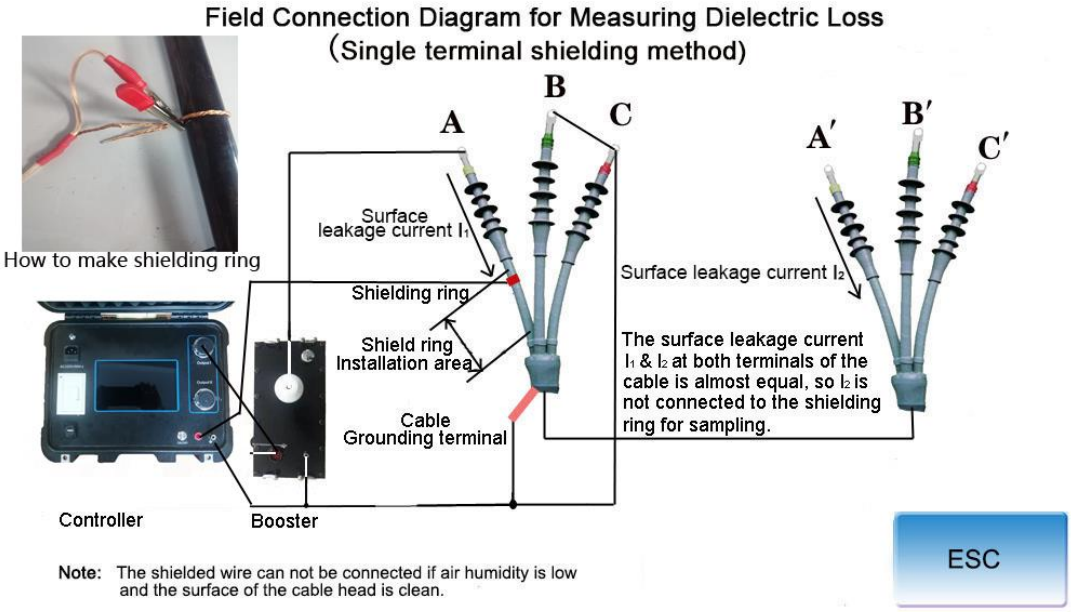
3.3.19 RS232 (or USB) communication interface

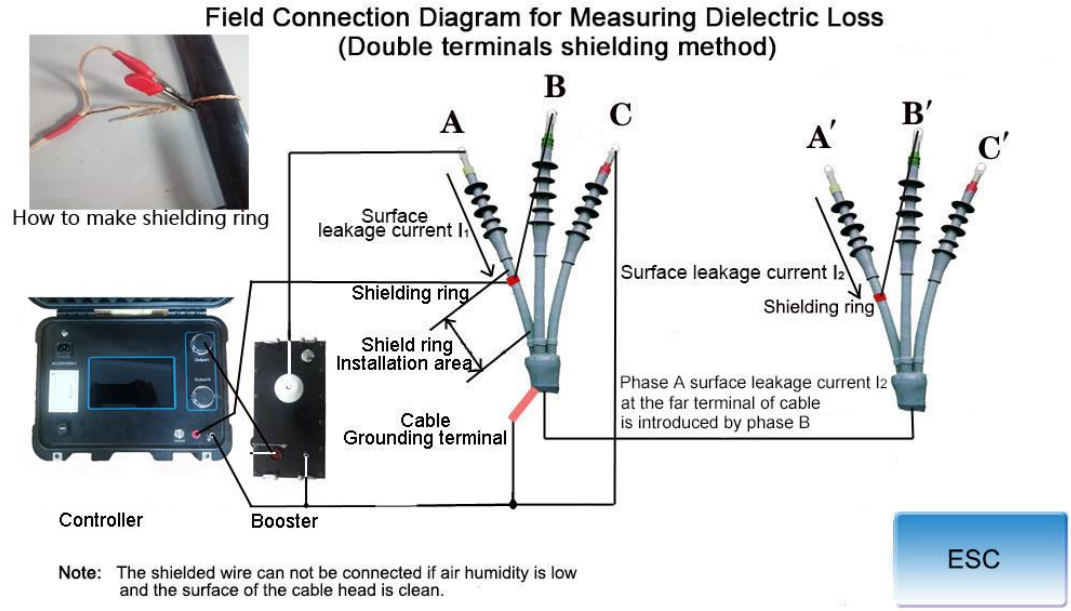
3.4 Dielectric Loss Test Wiring Method

3.4.2 Field Wiring Diagram

The on-site wiring method is the same as the withstand voltage test. If you want to eliminate the impact of surface leakage current at the end of the cable on dielectric loss, you can introduce leakage current to the instrument and deduct this impact from the total dielectric loss. The wiring method of introducing leakage current from one end of the cable is called single end shielding method; The wiring method of introducing leakage current from both ends of the cable is called the double end shielding method. The working principle of eliminating the influence of surface leakage current on dielectric loss is shown in section 3.6 below. How to eliminate the influence of cable surface leakage current on dielectric loss. The two on-site wiring diagrams are as follows:

3.4.2.1 Single ended shielding method wiring diagram





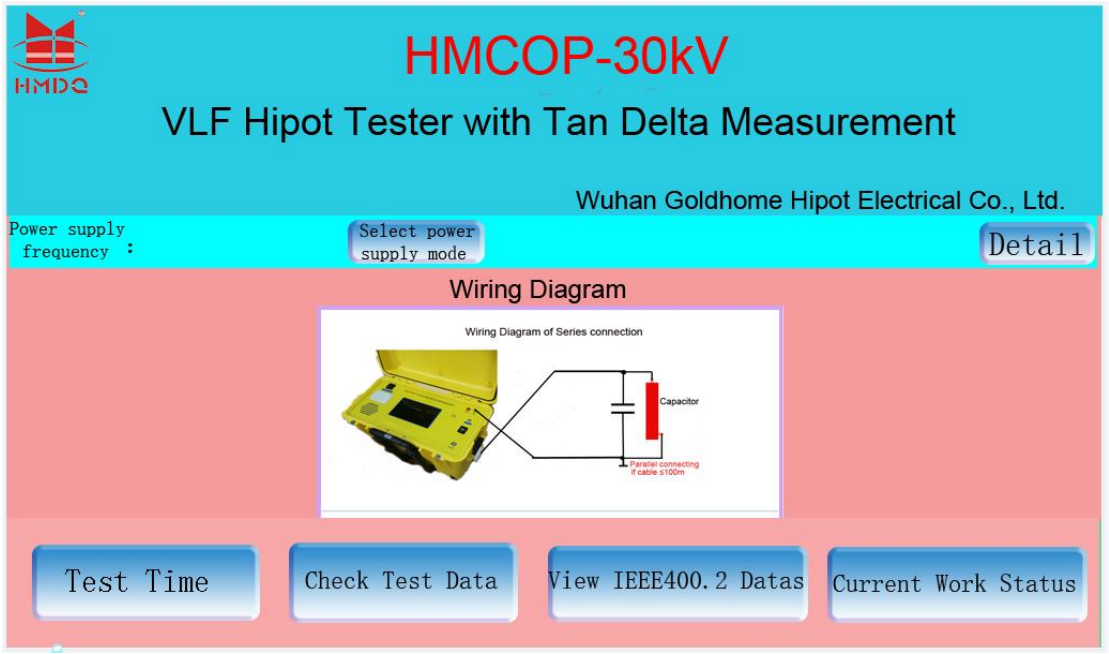
3.4.2.2 Wiring diagram of dual terminal shielding method

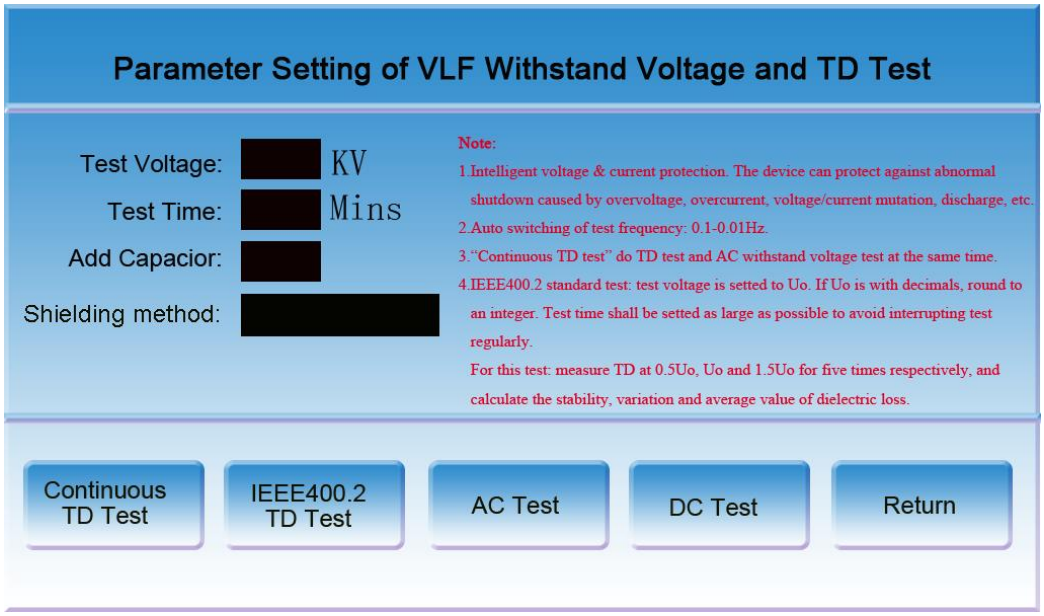
3.5 Operation method for ultra-low frequency dielectric loss test

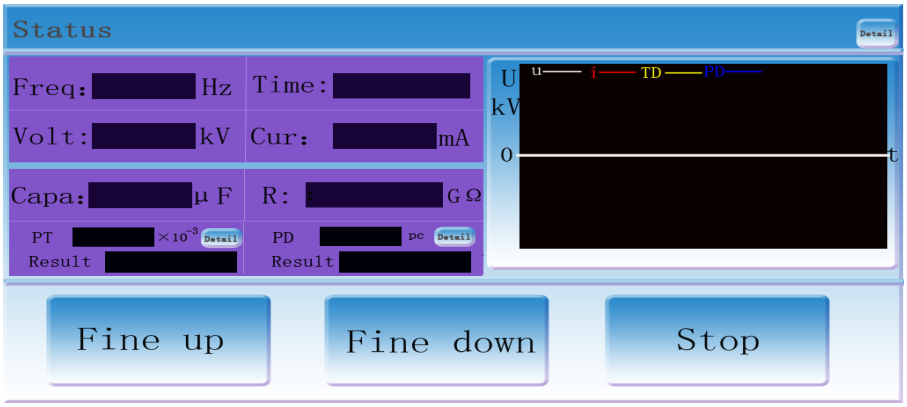
After connecting the on-site testing system as described above, connect the power supply to enter the test. The homepage of the touch screen of the control box is for selecting the wiring diagram, entering the parameter setting interface, testing time, testing voltage, and

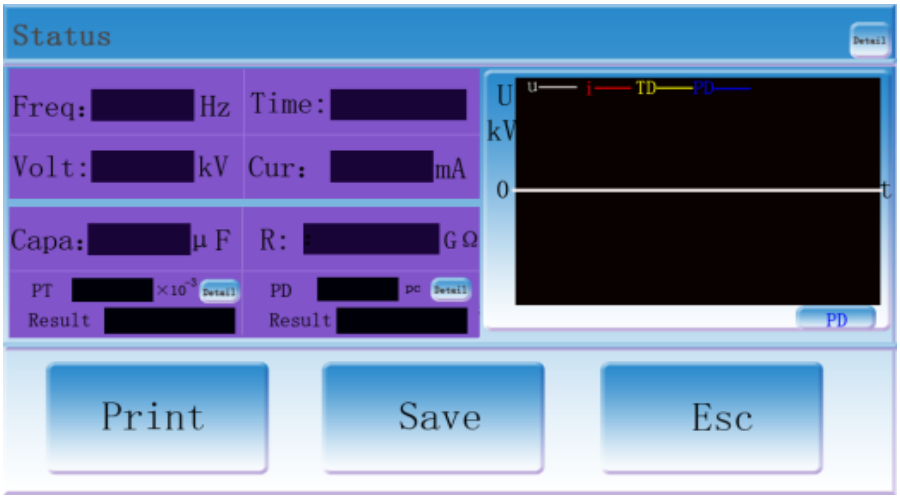
modifying according to the testing requirements. Click on the data to be modified, and a numeric keypad will pop up to input the required data. In order to ensure safety, the system has limited the input data: the test voltage range is 1kV to the rated value; The test time is 1-99 minutes. Continuous dielectric loss test is a continuous measurement of dielectric loss at a set voltage, which can also be used as an AC withstand voltage test. The national standard dielectric loss test is to perform eight data tests on three-phase cables under three point voltages (0.5U0, U0, 1.5U0) according to regulations, and calculate the average value, variation, and stability of dielectric loss, automatically distinguishing the insulation quality of cables according to regulations. Please refer to 3.7 below for an introduction to the automatic ultra-low frequency dielectric loss test program according to regulations. After the experiment, this parameter will be automatically saved as the default value for the next experiment. Continuous dielectric loss testing program: The instrument first enters a self check, which is a pre test of the test object and calibration of the instrument itself. The length of the self check time is related to the length of the cable. The longer the cable, the longer the self check time, which can be as long as one to five minutes. It requires patience to wait. After the self inspection is completed, it automatically enters the continuous dielectric loss test, which can simultaneously measure the dielectric loss, capacitance, and insulation resistance values, and update the data once per cycle. Our company has designed a more stable and accurate measurement technology. After a few measurement cycles, the data will become very stable and can be read. The system provides intelligent protection for the testing process: overvoltage, overcurrent, voltage and current sudden changes, discharge, and other protective actions. The shutdown process will automatically discharge the test object. After shutdown, the current data can be printed or saved, and the selected data records can also be printed in the historical data query on the homepage. The top line of the screen is a prompt for the working status of the instrument, which includes some fault information of the instrument. Because there are touch key prompts and help information, users can follow the prompts to operate. Before disassembling the wire, the power cord should be unplugged first, and the test object should be discharged with a discharge rod,

followed by a short circuit discharge before disassembling the wire. If the length of the tested cable is less than 100 meters and the instrument cannot output a smooth sine wave voltage, compensation capacitors can be connected in parallel at the test object end. On the parameter setting interface, select "Add Compensation Capacitor", so that the test results will deduct the influence of the compensation capacitor. The compensation capacitor must be the one that comes with this product, as the parameters of this capacitor are preset in the instrument. The four main operation interfaces are as follows (the form of product interfaces varies during different periods).









3.6 How to eliminate the impact of cable surface leakage current on dielectric loss

When the air humidity is high or there is dirt on the surface of the cable end, leakage current will form on the surface of the cable end, which will increase the dielectric loss

value and affect the judgment of the dielectric loss of the cable body. So when conducting dielectric loss tests, it is necessary to eliminate this influence. The method is to wrap a shielding ring around the lower half of the cable head with bare copper wire, and connect it to the shielding terminal of the control box with a wire. Because there is surface leakage current at both ends of the cable, theoretically both sides need to be measured. The method is to use an unmeasured phase line to connect the remote shielding ring, and then connect the shielding ring signals at both ends in parallel to the shielding terminals of the instrument. This method is called double ended shielding method. This method of connecting shielded wires is obviously inconvenient on site. To simplify this problem, we consider the leakage current at both ends to be approximately the same, only measuring the leakage current at the near end, and deducting twice the leakage current during the dielectric loss test. This method is called single ended shielding method. The wiring method is shown in the on-site wiring diagram of dielectric loss above. So in the parameter setting page, the corresponding shielding connection method should be selected. If the air humidity is low and the surface of the cable end is clean, shielded wires may not be connected.

3.7 Introduction to the program for automatically conducting ultra-low frequency dielectric loss tests according to regulations

We referred to the following three test procedures:

China Electric Power Enterprise Federation Standard T/CEC-243-2019

Enterprise Standard of China Southern Power Grid Co., Ltd. Q/CSG1205027-2020

EU Standard IEEE400.2

The dielectric loss test methods for cables in these three regulations are basically the same, and the main content is summarized as follows:

1. Dielectric loss test points 0.5U0, U0, 1.5UO

2. Table of Treatment Opinions for Judging Cable Insulation Performance Based on Dielectric Loss Test Values

Cable insulation	Average dielectric		Dielectric loss variation		Dielectric loss stability

aging state Evaluation conclusion	loss U_0 （10^{-3}）		Difference of $1.5U_0$ & $0.5U_0$ （10^{-3}）		Standard Deviation of U_0 dielectric loss value （10^{-3}）
Normal state	＜4	and	＜5	and	＜0.1
Attention state	4 - 50	or	5 - 80	or	0.1 - 0.5
Abnormal state	＞50	or	＞80	or	＞0.5

Explanation to the above table:

Using the average value of dielectric loss, the change in dielectric loss, and the absolute value of dielectric loss stability as evaluation indicators, or based on the comparison with historical data, the status of cable insulation can be divided into the following three types:

a) Normal state: No maintenance action required.

b) Attention status: Further testing is recommended. Regularly retest the cable route, with a recommended time interval of 1 year,

If there is no significant change in the retest results, it can continue to be put into operation;

If the retest result has significantly increased or the result value has entered the required range

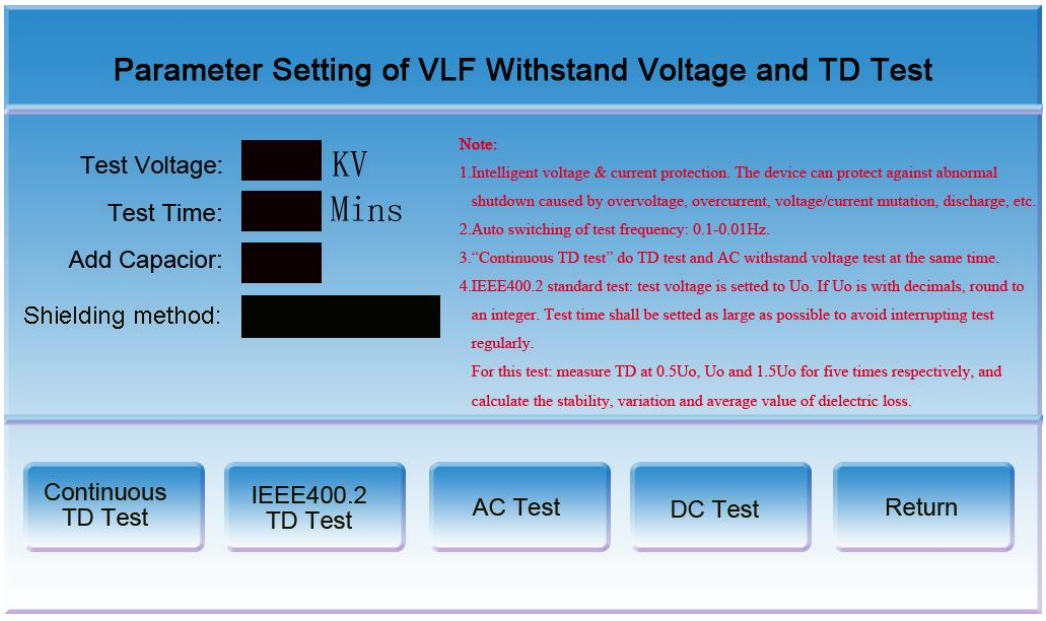
The scope of maintenance actions to be taken should be immediately checked for the location of cable line defects and replaced in a timely manner.

c) Abnormal status: Maintenance action is required. The location of cable line defects should be immediately inspected and repaired or replaced in a timely manner.

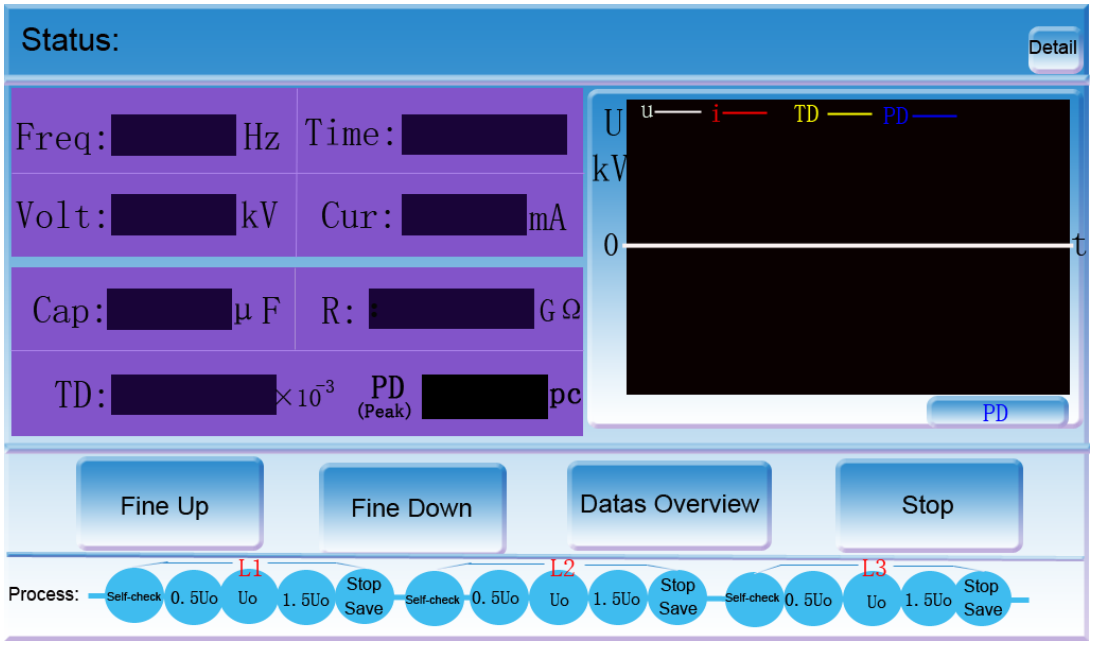
According to the above regulations, we have developed a specialized testing program, abbreviated as the national standard dielectric loss test. The automatic test program is as follows: the interface process is the same as the withstand voltage test. In the parameter setting interface, the voltage is set according to the U0 value, and the compensation capacitor and shielding connection method are selected according to the actual wiring diagram. The time is set to a maximum of 99 minutes, so that there is no scheduled

shutdown during the automatic test process. Click the national standard dielectric loss test button, and the instrument will enter automatic dielectric loss test until the three-phase test is completed. Just follow the prompts to switch phases and connect wires halfway through. For safety reasons, before switching phases and connecting wires, the power should be turned off and discharged with a discharge rod before connecting wires. Shutting down will not change the status of the instrument. After turning it on, clicking to continue the last test will continue the test, and the three-phase test data will be automatically saved after completion. On the homepage, you can browse the historical records and view the judgment conclusions for cables in the viewing of national standard records. If you click on cancel the last test, the test will be terminated and the instrument will be reset to normal without saving data. See the interface diagram below.

Parameter setting interface



After switching phases, continue testing the testing interface



Data processing results, cable evaluation interface

Data Processing & Insulation Evaluation of Cable's Tan Delta

Phase	Mean at 0.5Uo 10^{-3}	Mean at Uo 10^{-3}	Mean at 1.5Uo 10^{-3}	Variation (Dev.1.5Uo & 0.5Uo) 10^{-3}	Stability (Uo Standard Dev.) 10^{-3}	Insulation aging Result
L1						
L2						
L3						
Evaluation Description		Normal: <4 Attention: 4~50 Abnormal: >50		Normal: <5 Attention: 5~80 Abnormal: >80	Normal: <0.1 Attention: 0.1~0.5 Abnormal: >0.5	STD IEEE400.2 (Reference)

1、Each item is treated as 8 times of data, and the incomplete part is treated as "0". Therefore, it is necessary to ensure the integrity of three-phase data, otherwise the evaluation conclusion will be affected. This table has the function of real-time calculation. What you see in this table is the current calculation result.

2、TD Mean: $\overline{TD}=(\overline{TD1}+\ldots+\overline{TDn})/N$

3、TD Variatio: $d\overline{TD}=\overline{TD}(1.5U0)-\overline{TD}(0.5U0)$

4、TD Stability (Standard dev) $S=\sqrt{[(TD1-\overline{TD})^2+\ldots+(TDn-\overline{TD})^2]/N}$

Return

Data Overview Interface

Record No.: Data processing result Upload datas of the page Return

Test Voltage	Times	L1			L2			L3		
		TD(10^{-3})	C(μF)	R(GΩ)	TD(10^{-3})	C(μF)	R(GΩ)	TD(10^{-3})	C(μF)	R(GΩ)
0.5U0	1									
	2									
	3									
	4									
	5									
	6									
	7									
	8									
U0	1									
	2									
	3									
	4									
	5									
	6									
	7									
	8									
1.5U0	1									
	2									
	3									
	4									
	5									
	6									
	7									
	8									

Part 4: Operation Instructions for Partial Discharge Test

4.1 Product characteristics and application scope

This product integrates a partial discharge testing module and an ultra-low frequency power supply, without the need for any external components. As long as the partial discharge function is purchased, it can automatically display the partial discharge quantity, partial discharge quantity, and voltage curve overlay map synchronously during AC withstand voltage, DC withstand voltage, and dielectric loss tests. The operation is very simple. Cable discharge faults can be divided into two categories. The first type is that discharge can cause instrument tripping protection, and the second type is that it cannot cause tripping protection. The second type of discharge is called partial discharge. Partial discharge test is a test conducted for this type of fault. This instrument is mainly used for the test of partial discharge of large capacitive test objects (such as cables). Superposition the voltage waveform diagram and discharge capacity diagram to visually reflect the discharge process of the test sample with voltage variation.

4.2 Main technical indicators of ultra-low frequency partial discharge

4.2.1 General technology indicators of ultra-low frequency high-voltage power supply: the same as 1.3

4.2.2 Partial discharge detection resolution: 0.1pc

4.2.3 Range of partial discharge measurement: 0.1pc-2000.0pc

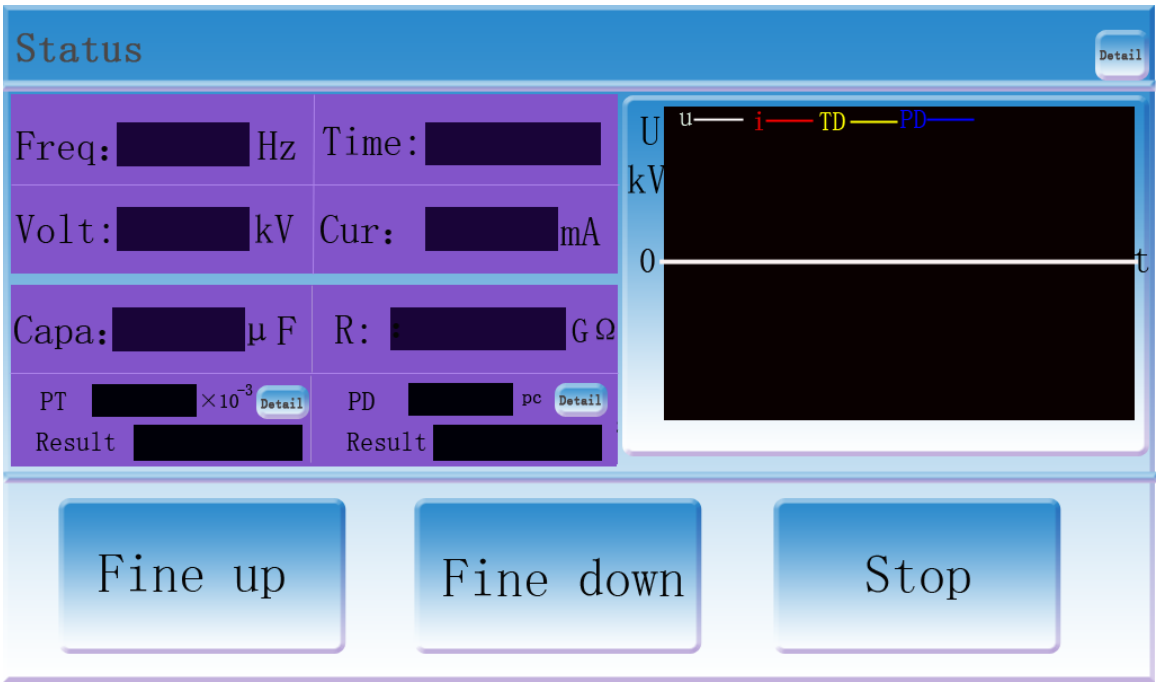
4.2.4 Partial discharge side measurement accuracy 3%

4.2.5 Sampling bits: 12 bits

4.2.6 Sampling speed: 12M/S

4.3 Evaluation method of sample quality using local emission volume:

The discharge capacity of the test sample is related to the quality of the test sample, the applied voltage, and the discharge position, so judging the quality of the cable based on the discharge capacity should be comprehensively considered. This instrument provides an intelligent discrimination system, as shown in the following figure:



The displayed value of partial discharge is an instantaneous value that varies with voltage changes. The unit is PC (leather library).

There are three types of evaluation conclusions:

Qualified (<0.1), Concerned (0.1-10), Unqualified (>10). This conclusion is for reference only.

Part 5: DC withstand voltage test

5.1 Main technical indicators

5.1.1 Rated output voltage: 30kV-80kV

5.1.2 Voltage accuracy: 3%

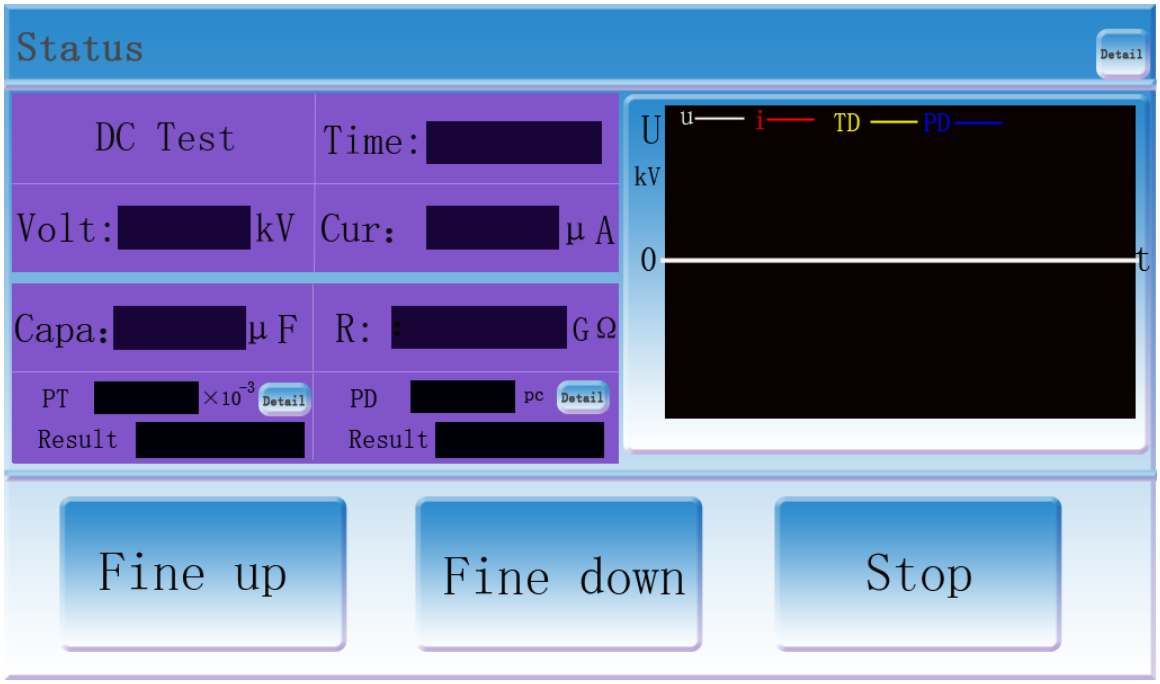
5.1.3 DC leakage current range: 0-20mA

5.1.4 Resolution of DC leakage current: 1 μ A

5.1.5 DC leakage current accuracy: 3%

5.2 Operation methods

The operation method is the same as that of the ultra-low frequency AC test, and the wiring method is the same. Enter the parameter setting interface below, set the test voltage and test time first, and click "DC test" to start boosting. The timer automatically shuts down when it is full. Click the stop button to immediately stop the machine. After shutdown, the instrument cannot automatically discharge and should be manually discharged.



Part 6: Product Maintenance, Safety Precautions, Packaging, and Transportation Requirements

6.1 Daily maintenance and safety precautions of products

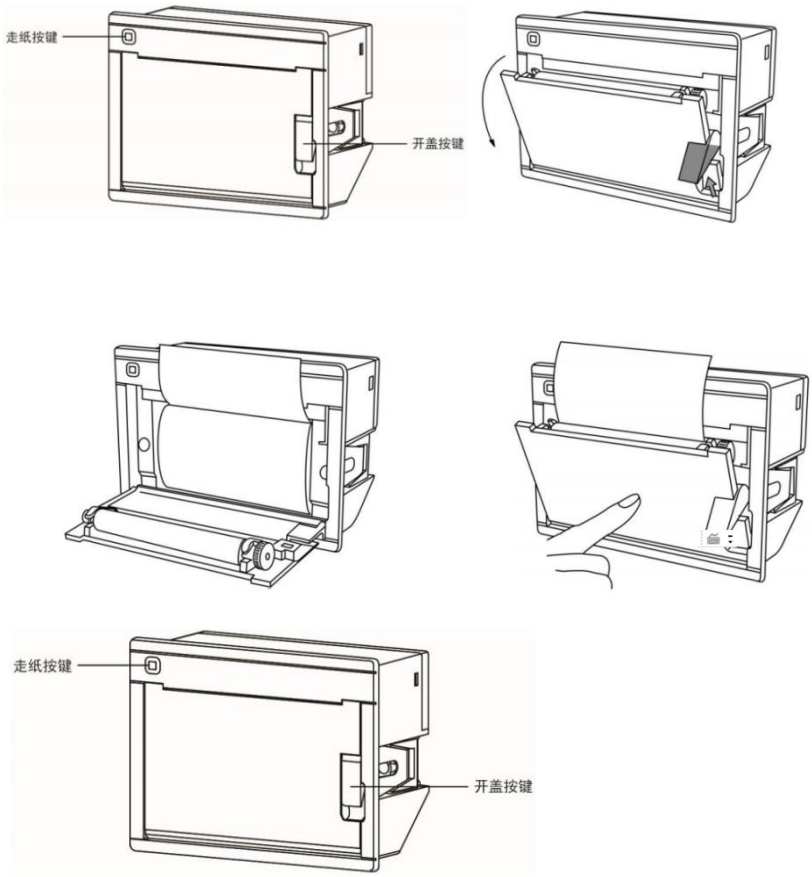
Various faults may occur during ultra-low frequency testing, and some peripheral faults

can be repaired by users themselves. For example, the plug of the connecting wire is easily detached from the wire, and can be identified by turning on or off the resistance range of the multimeter. If there is no display, check if the fuse is burnt out and if there is a problem with the power input circuit. Internal issues should be repaired by contacting the production unit.

The ultra-low frequency testing device belongs to the equipment that generates high voltage, and the surface should be kept clean, waterproof, and dustproof. The wiring sequence is to connect the test line first, and then connect the power line. After the test is completed, the test object should be fully discharged before disconnecting the wires. The disassembly sequence is to first unplug the power cord and then dismantle the test circuit.

6.2 Printer Paper Replacement Method

Press the button to open the front cover of the printer, take out the remaining paper cores, put in a new paper roll, pull out a portion of the paper head, place it in the center position, and close the front cover, as shown in the following figure:



6.3 Product packaging and transportation requirements

The booster and accessories are packaged in aluminum alloy boxes. If long-distance transportation is required, the control box and aluminum alloy box should be packaged in wooden boxes. Prevent lateral lying, inversion, and waterproofing during transportation. The packaging boxes used are shown in the following figure: