Dear Client,

Thank you for purchasing our UHV-8003 Partial Discharge Detector. Please read the manual in detail prior to first use, which will help you use the equipment skillfully.

Our aim is to improve and perfect the company's products continually, so there may be slight differences between your purchase equipment and its instruction manual. You can find the changes in the appendix. Sorry for the inconvenience. If you have further questions, welcome to contact with our service department.

The input/output terminals and the test column may bring voltage, when you plug/draw the test wire or power outlet, they will cause electric spark. PLEASE CAUTION RISK OF ELECTRICAL SHOCK!

◆ SERIOUS COMMITMENT

All products of our company carry one-year limited warranty from the date of shipment. If any such product proves defective during this warranty period, we will maintain it for free. Meanwhile we implement lifetime service. Except otherwise agreed by contract.

◆ SAFETY REQUIREMENTS

Please read the following safety precautions carefully to avoid body injury and prevent the product or other relevant subassembly to damage. To avoid possible danger, this product can only be used within the prescribed scope.

Only qualified technician can carry out maintenance or repair work.

--To avoid fire and personal injury:

Use Proper Power Cord

Only use the power wire supplied by the product or meet the specification of this produce.

Connect and Disconnect Correctly

When the test wire is connected to the live terminal, please do not connect, or disconnect the test wire.

Grounding

The product is grounded through the power wire; besides, the ground pole of the shell must be grounded. To prevent electric shock,

the grounding conductor must be connected to the ground.

Make sure the product has been grounded correctly before connecting with the input/output port.

Pay Attention to the Ratings of All Terminals

To prevent the fire hazard or electric shock, please be care of all ratings and labels/marks of this product. Before connecting, please read the instruction manual to acquire information about the ratings.

Do Not Operate without Covers

Do not operate this product when covers or panels removed.

Use Proper Fuse

Only use the fuse with type and rating specified for the product.

Avoid Touching Bare Circuit and Charged Metal

Do not touch the bare connection points and parts of energized equipment.

Do Not Operate with Suspicious Failures

If you encounter operating failure, do not continue. Please contact with our maintenance staff.

Do Not Operate in Wet/Damp Conditions.

Do Not Operate in Explosive Atmospheres.

Ensure Product Surfaces Clean and Dry

—Security Terms

Warning: indicates that death or severe personal injury may result if proper precautions are not taken

Caution: indicates that property damage may result if proper precautions are not taken.

CONTENTS

1. Overview

1.1 About this manual

This manual will guide you the way how to use this product in a safe manner. Before using this product for the first time, please read the user manual carefully to help you proficiently use the product. The manual provides a detailed introduction to the operating essentials of safety regulations and the usage process of various measurement modes.

1.2 Responsibility Statement

Our company guarantees that each product has no quality issues with the main unit and accessories when leaving the factory, and that the main unit functions without any defects. The warranty period of this product is one year, calculated from the date of shipment. Provide free repair services for products within the warranty period, and guarantee that the repair period does not exceed 90 days. If the product is damaged by misuse, disassembly, negligence, accident, or abnormal operation during use, our company will not provide any free repair services.

When receiving repair services, please contact our company's service center nearby. The service center will choose whether to provide door-to-door pickup services based on your area. If door-to-door pickup is not possible, the service center will negotiate with you whether to send the product to the service center by mail. After completing the repair, the service center will contact you to negotiate a suitable way to return the product. If our company determines that the malfunction is caused by misuse, disassembly, accident, or abnormal operation, or if the product has exceeded the warranty period, our company will estimate the repair cost and only begin the repair after obtaining user authorization. For

users who pay for repairs, they will receive invoices for repair and return shipping costs at the same time as receiving the repaired product.

This statement includes all repair services provided by our company, and we do not provide any other express or implied repair services. At the same time, our company shall not be liable for any special, indirect, or accidental damage or data loss, regardless of whether it will cause economic or civil losses to users. The right to use this manual is limited to our company's users only. Without written permission from the company, it is strictly prohibited to copy, transmit, distribute, and store any content in this document in any form.

2.Product introduction

2.1 Precautions

This product is used for the detection and evaluation of the insulation state of high-voltage switchgear, ring main unit, transformer, GIS, overhead lines, cable terminals, cable branch boxes and other equipment. The following precautions are taken when using this device:

☀ Please use it indoors with a temperature of -20°C~50°C and a relative humidity of no more than 80%;

☀ Please keep away from flammable and explosive dangerous goods;

☀ To prevent interference or leakage accidents, please turn off the power switch while charging;

☀ If any liquid and corrosive substances come into contact with the instrument, it should be stopped immediately and shut down, and handled by professionals;

☀ When inserting the external sensor connector, please insert the connector radially after the sign direction of the connector is consistent with the sign direction of the socket, and when you hear the "click" sound, it means that the connection is successful, do not rotate the joint, so as not to damage the connector. When pulling out the sensor connector,

you only need to hold the connector of the metal housing and pull it out, and do not pull the connecting cable.

☀ Before using an external sensor for detection operations, be sure to connect the sensor to the host before testing, and prohibit plugging and unplugging the test line during the operation!

☀ All hosts and accessories shall not be disassembled, and shall be disassembled by the company's after-sales service personnel if necessary.

2.2 Brief Description

This product can be widely used in the partial discharge detection of power systems, including high-voltage switchgear, ring main unit, voltage/current transformer, transformer (including dry-type transformer), GIS, overhead lines, cables and other equipment insulation state detection, through the following indicators to measure the degree of discharge of electrical equipment:

Partial Discharge Intensity Detection: The intensity of partial discharge is characterized according to the maximum value (dB) in the discharge pulse sequence by measuring the discharge signal within 1 power frequency cycle.

Partial discharge frequency detection: By measuring the discharge signal within 1 power frequency cycle, the discharge pulse is extracted and the frequency of partial discharge is characterized according to the number of discharge pulses.

2.3 Product Features

☀ Configure different sensors to realize the partial discharge detection of almost all high-voltage electrical equipment;

☀ Provide a variety of discharge patterns such as time-domain waveform, PRPD, PRPS, etc., to realize the analysis of different discharge types;

☀ Humanized man-machine interface facilitates data management of different devices;

☀ Built-in ultrasonic sensor and transient ground voltage (hereinafter referred to as

TEV) sensor, which can be connected to special sensors such as transformers, GIS, overhead lines, cables, etc.;

☀ The non-invasive detection method does not require power failure during the test process, and there is no need to configure an additional high-voltage source, which is more convenient to use than the traditional pulsed partial discharge detector;

☀ The test bandwidth range is 30kHz ~ 2.0GHz, which is suitable for the detection principle of various frequency bands;

2.4 Product application

☀ Power generation and distribution enterprises

☀ Rail system

☀ Petrochemical power supply system

☀ Aerospace testing field

☀ Automated inspection field

2.5 Parameters

TEV measurement		**AE measurement**	
Measuring range	0dB~60dB	Measuring range	0dB ~ 60dB
Resolution	1dB	Resolution	1dB
Precision	±1dB	Precision	±1dB
Maximum pulse per cycle	1400	Frequency range	20~200 kHz
Measurement frequency bands	3~100MHz		
AA 、AA1、AA 2measurement		**UHF measurement**	
Measuring range	0dB~60dB	Detection bands	300~2000MHz
Resolution	1dB	Measuring range	0dB~60dB
Precision	±1dB	Sensitivity	＜1dB
Sensor center frequency	40 kHz	Sensor bands	300~2000MHz

HFCT measurement	
Sensor transmission impedance	5mV/mA
Frequency of detection	1~30MHz
Sensitivity	≤50pC
Hardware	
Apperance	ABS
Display	4.3 inch RGB LCD screen with resolution 800*480
Sampling accuracy	12bit
Synchronization mode	Synchronization within the country
Connector	USB port (also charger input)
Earphone	8 ohms minimum
SD card	16G~64G as standard
Built-in battery	3.7V/10000mAh lithium battery
Working time	Approximately 12 hours
Charger	DC 5V/3A
Temperature	-20~50℃
Humidity	20%~85% relative humidity
Volume, weight	210*100*35(mm) 0.4KG(host)

2.6 Standards

DL/T 500-2009 Technical Conditions for The Use of Voltage Detectors

GB/T 4208-2008 Classification of Enclosure Protection Grade (Ip Code)

GB/T 2423.1-2001 Basic Environmental Test Procedures for Electrical and Electronic Products Test A: Low Temperature Test Method

GB/T 2423.2-2001 Basic Environmental Test Procedures for Electrical and Electronic Products Test B: High Temperature Test Method

GB/T 2423.4-1993 Basic Environmental Test Procedures for Electrical and Electronic Products Test: Alternating Damp Heat Test Method

GB/T 2423.5-1995 Environmental Testing of Electrical and Electronic Products Part 2: Test Methods Tests and Guidelines: Impact Test Methods

GB/T 2423.10-1995 Environmental Testing of Electrical and Electronic Products Part 2: Test Methods Test and Guidance: Vibration (Sinusoidal) Test Method

GB/T 17626.2-2006 Electromagnetic Compatibility Test and Measurement Technology Electrostatic Discharge Immunity Test (IEC 61000-4-2: 1995)

GB/T 17626.5-2008 Electromagnetic Compatibility Test and Measurement Technology Surge (Impact) Immunity Test (IEC 61000-4-5: 1995)

GB/T 17626.3-2006 Electromagnetic Compatibility Test and Measurement Technology Radio Frequency Electromagnetic Field Radiation Immunity Test (IEC 61000-4-3: 1995)

GB/T 17626.4-2008 Electromagnetic Compatibility Test and Measurement Technology Fast Transient Electrical Pulse Group Immunity Test (IEC 61000-4-4: 1995)

GB/T 17626.7-1998 Electromagnetic Compatibility Test and Measurement Technology Power Supply System and Connected Equipment Harmonics, Interharmonic Wave Measurement and Measurement Instrument Guide

GB/T 19862-2005 Insulation Resistance, Insulation Strength Technical Requirements and Test Methods for Industrial Automation Instruments

2.7 Product configuration list

This product consists of a detection host, optional sensors, and related accessories. The detailed configuration is shown in Table 1:

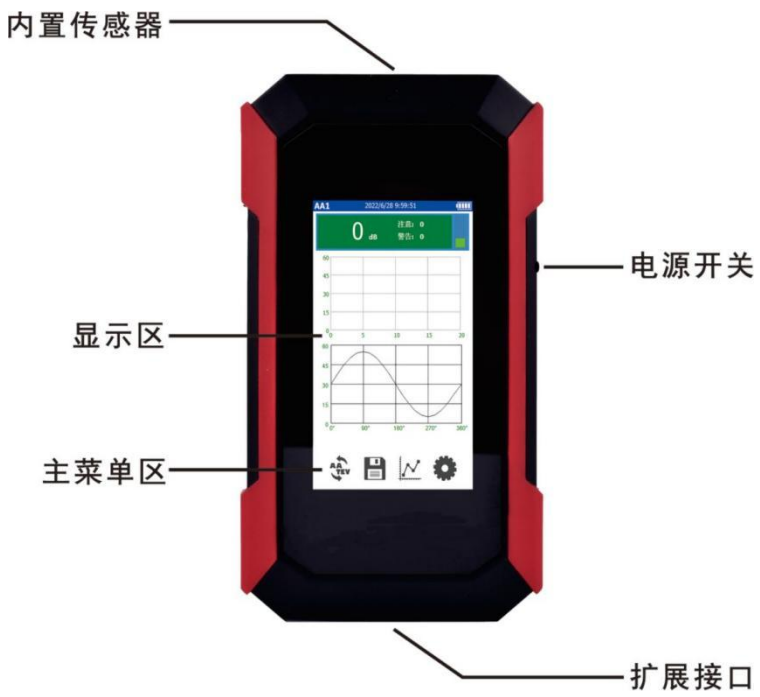
Table 1

Name		Quantity	Unit	Remarks
1	Host	1	set	Built-in TEV and AA ultrasonic sensors
2	AA1 External flexible ultrasonic sensor	1	pcs	used for partial discharge detection of switchgear
3	AE External contact ultrasonic sensor (optional)	1	pcs	used for partial discharge detection of transformers, GIS, motors, etc

4	AA2 External concentrator ultrasonic sensor (optional)	1	pcs	used for partial discharge detection of overhead lines
5	HFCT High frequency current sensor (optional)	1	pcs	used for cable partial discharge detection
6	UHF Ultra High Frequency Sensor (optional)	1	pcs	used for GIS partial discharge detection
7	Test line	1	set	
8	Host charger + charging cable	1	set	
9	Earphone	1	pcs	Listen for the sound of discharge
10	Couplant (optional)	1	pcs	
11	SD card + card reader	1	set	
12	Manual	1	pcs	
13	Ex-factory inspection report	1	pcs	
14	Certificate of conformity	1	pcs	
15	Warranty Card	1	pcs	

3. Operating instructions

3.1 Structure



Host

1. A non-contact ultrasonic sensor and a built-in TEV sensor are built into the front end of the host:

(1) In the case of no external sensor, the partial discharge detection of high and low voltage switchgear can be realized, such as the partial discharge detection of transformers, GIS, overhead lines, cables and other equipment, and the corresponding sensors need to be connected externally.

2. The expansion ports at the bottom of the host include SD card socket, USB port, charging indicator, headphone socket and sensor socket.

(1) SD card socket: The product comes with an SD card and a card reader, which are used to export the saved records inside the host to the computer, browse and print them through the supporting host computer software.

(2) USB interface: This interface is a TYPE-C interface, mainly used for charging, and the instrument comes with a set of chargers (5V/3A) and charging cable.

(3) Charging indicator: When the charging cable is not plugged in, the indicator light does not light up, after inserting the charging cable, the indicator light is red, and the

indicator light turns blue when it is fully charged.

(4) Headphone jack: used to monitor the discharge sound, the instrument comes with a headset, after the headset is inserted into the interface, when there is a discharge sound in the field test, the intermittent "Dididi" sound will be heard, and the larger the discharge signal, the more rapid the "Dididi" sound.

(5) Sensor socket: used for external sensor access test, only need to connect the corresponding special sensor through the sensor expansion port at the bottom of the host, and the host can automatically switch the measurement channel according to different sensor types.

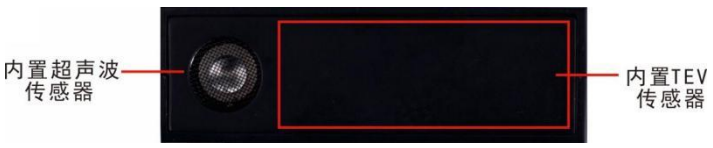
3.2 System power on/off

This product is powered on and off by touching the button on the right side of the host, pressing the power button to hear a "drop" sound, the host is turned on, and after pressing the power button continuously for 5 seconds, the host is powered off and shut down.

3.3 Testing

3.3.1 Test with built-in sensors

There are two principles for partial discharge detection of switchgear: ultrasonic principle and transient ground voltage (TEV) principle, and the built-in non-contact ultrasonic sensor and TEV sensor of this product are used to measure the partial discharge of high-voltage switchgear, and the sensor is in the front position of the host. When testing the TEV sensor, the front end of the host is close to the corresponding test point of the switch cabinet. When the ultrasonic sensor is measured, it is necessary to move along the gap of the switch cabinet, and the front end of the host should not be in direct contact with the switch cabinet, and the cabinet should not be bumped, so as not to affect the test results.



Built-in sensors in the host

TEV measurements

If you need to use the built-in TEV sensor to measure the partial discharge of the switchgear, there is almost no need to do other operations or settings after powering on, because the built-in TEV ground wave is selected by default after the product is turned on sensor mode, and "TEV" will be displayed in the upper left corner of the main test interface.

Built-in TEV sensor

The TEV probe at the front end of the host is a capacitive sensor, and the high-frequency partial discharge signal will propagate on the surface of the metal cabinet, and the frequency is generally between 3 ~ 100MHz. The metal door frame and other positions first measure the environmental value, and then measure the cabinet value by the TEV sensor at the front end of the host close to the cabinet, and judge the operation status of the switch cabinet by judging the difference between the cabinet value and the environmental value.

In the TEV measurement mode, it is necessary to refer to the number of power frequency periodic discharge pulses and the amplitude to comprehensively measure the health of the switchgear. Generally, high amplitude data with a pulse number of less than 50 is a typical discharge phenomenon.

When the environmental value is large, it is necessary to find out the interference source, the interference source of TEV is different from ultrasonic, ultrasonic interference is generally limited to a limited space, and TEV interference affects the entire space through wireless radio frequency, such as welding machines, frequency converters, walkie-talkies, wireless broadcasting stations, etc., compared with ultrasonic interference, this kind of interference signal is sometimes difficult to avoid or clear, so when the detection of environmental (interference) value is large, it is recommended to use

ultrasonic measurement.

The TEV test data can be judged by referring to Table 2, there will be slight differences in different regions, but there is little difference.

Table 2

TEV reading	Description
High background reading, which is greater than 20dB Note: The background reading refers to the reading when the sensor is not attached to the cabinet.	(a) High-level noise may conceal the discharge in the switch cabinet; (b) It may be due to external influences; the external interference source should be eliminated as much as possible before retesting
All readings of switchgear and background reference are less than 20dB.	No partial discharge. Check again once a year.
The relative value of the switch cabinet and the background reference reading is 20~29dB	The equipment has a slight partial discharge.
The relative value of the switch cabinet and the background reference reading is 29~40dB	The equipment has a medium partial discharge, which should be reported to the team or special responsibility to shorten the inspection cycle
The relative value of the switch cabinet and the background reference reading is 40~50dB	If the equipment has serious partial discharge, report to the team or special responsibility, shorten the inspection cycle, and check the source of the partial discharge when there is a motor shutdown.
The relative value of the switch cabinet and the background reference reading is 50~60dB	There is serious partial discharge of the equipment, it should be reported to the team or special responsibility, shorten the

	inspection cycle, and cut off the power as soon as possible.

AA built-in ultrasonic measurements

If you choose the built-in ultrasonic sensor to measure the partial discharge of the switchgear, you only need to click the built-in sensor type switch icon in the lower left corner of the main test interface to switch to the AA built-in ultrasonic sensor mode, and the upper left corner of the screen will display which sensor is currently connected, as shown in the figure below, this status is ultrasonic measurement mode:

Built-in sensors switch activation areas

Note that clicking on this area is only valid for the built-in sensor switching, and this function is not valid when other sensors are connected to it, the system will automatically switch and display the sensor logo according to the type of sensor connected, no need to manually select.

AA Built-in Ultrasonic Sensor Status

In the ultrasonic measurement mode, the unit of measurement data is dB, according to the processing capacity of the ultrasonic amplifier of this product, the test range of 0dB to 60dB can be achieved, the smaller the dB value, the smaller the ultrasonic signal, usually the data measured in the non-interference environment is between 0dB and 6dB.

In many cases, the environment of the test cabinet will be filled with various complex ultrasonic interference, such as flashing fluorescent lamps, ultrasonic mouse repellents, When the ultrasonic environmental value is too large (such as more than 10dB), it is necessary to eliminate all sources of interference, otherwise the excessive interference signal will cover the real signal and affect the reading, it is recommended to use TEV to measure the cabinet value when the ultrasonic interference is large and cannot

be effectively eliminated.

The ultrasonic signal is transmitted from the gap in the cabinet with air as the propagation medium, so the ultrasonic measurement of the cabinet value requires the sensor to be close to the gap position of the cabinet, and at the same time, the discharge sound in the cabinet can be heard by listening to the headphones (the ultrasonic signal is audible through digital filtering).

According to the regulations of the State Grid, refer to Table 3 to judge the insulation status of the switchgear:

Table 2

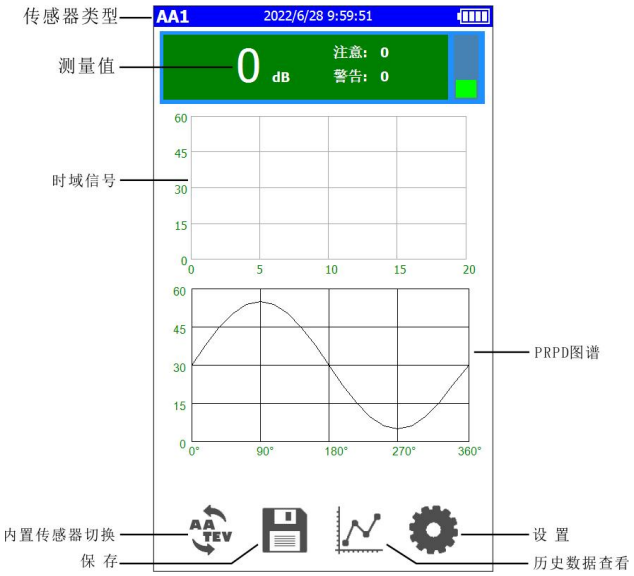
Ultrasonic reading	Description
0dB, there is no discharge sound	No partial discharge of equipment
0 ~ 6dBuV, there is a short discharge sound	There is a slight discharge in the equipment, which should be paid attention to later.
Above 6dBuV, there is discharge sound	The equipment has obvious discharge, which should be judged in conjunction with the TEV test.

Note that the demarcation point (6dBuV) varies slightly from region to region. Some areas (such as foreign countries, southern power grid) take 6dBuV as the demarcation point, and the above 6dBuV is judged to have obvious discharge phenomenon, while the national grid users generally take 8dBuV as the demarcation point. Whether it is 6dBuV or 8dBuV, its ultimate goal is to predict the insulation status of switchgear, so it is suggested to take 6dBuV as the demarcation point, which can warn the operation status of switchgear in advance.

The above is about the operation specification of the switchgear, through the reading to judge the degree of insulation of the switchgear, but also through the spectrum to analyze the operation of the switchgear, according to the spectrum can be more comprehensive understanding of the insulation status of the equipment, such as the phase of partial discharge, the number of discharge pulse groups, etc., the spectrum analysis method is suitable for all high-voltage equipment, including the switchgear, the following is a detailed introduction to the spectrum function of this product.

3. 3. 2 The main test interface of the instrument

After powering on, the instrument will enter the main test interface, as shown in the following figure:



Test interface

Function Description:

Sensor type

When using a built-in sensor (no external sensor), this area displays the currently selected built-in sensor type, and when you click the "Built-in Sensor Switch" button, you can switch the display back and forth between "AA"/"TEV". Touch this area to switch between ultrasonic and ground waves, and when using an external sensor, the sensor status icon automatically switches depending on the sensor type, which is as follows:

Schematic icon	Sensor type	Remark
TEV	Transient ground voltage sensor	Used for partial discharge test of switchgear
AA	Built-in non-contact ultrasonic sensor	Used for partial discharge test of switchgear

AA1	Externally flexible non-contact ultrasonic sensor	Used for partial discharge test of switchgear
AA2	External non-contact ultrasonic concentrator	Used for partial discharge test of overhead lines
AE	External contact ultrasonic sensor	Used for partial discharge detection of transformers, GIS, motors, etc
UHF	External Ultra high frequency sensor	Used for partial discharge test of GIS
HFCT	External high-frequency current sensor	Used for partial discharge test of cable

Time domain signal

When a discharge signal is detected, this area displays an obvious waveform. During the test, the level of noise interference and the intensity of the discharge signal can also be preliminarily evaluated according to this waveform. The general environmental noise is characterized by a signal with similar amplitude in the whole phase range, while the discharge signal is a small amount of pulse signal, and the amplitude of the signal is obviously prominent. As for the detailed discharge information, you can refer to the data below, discharge diagnosis results and PRPD and PRPS patterns.

Measurements

The measured value here represents the peak value currently tested. The numerical color will change according to the threshold value (please refer to the threshold setting in the setting interface). The data below the yellow early warning value is displayed in green, and the data between the yellow early warning value and the red early warning value is yellow. The data above the red early warning value is red.

3. 3. 3 Setting

Click "⚙"on the main test interface enter the setting interface, which is divided into system settings and threshold settings.

System settings

The system settings are as follows:

Automatic power off This product can be automatically turned off according to the time in this setting to extend the battery life, and the shutdown time can be extended or reduced by clicking "+" or "-".

Screen brightness This value can be adjusted to change the brightness of the display. Generally, this value can be increased under strong sunlight, but it can be reduced under low-light conditions. The lower the brightness, the longer the battery life.

Date Touch the "▼" button on the right side of the year, month, and day to select the corresponding year, month, and day through the drop-down menus.

Time Touch the "▼" button on the right side of the hour, minute, and second, and you can select the corresponding hour, minute, and second from the drop-down menu.

Touch tones Tap the right slider to turn it on or off, and you can hear a tone every time you touch the display after turning it on, and no sound when you turn it off.

Language/English Touch the slider on the right to turn it on or off, after opening it, the system display language will be changed to English and turn off to Chinese.

After the above parameters are adjusted, you can click Confirm to return to the main test interface.

The following steps are performed to set the threshold:

The alarm threshold has been set in the factory, and the user can also set the alarm threshold by himself, and the corresponding alarm threshold can be set according to

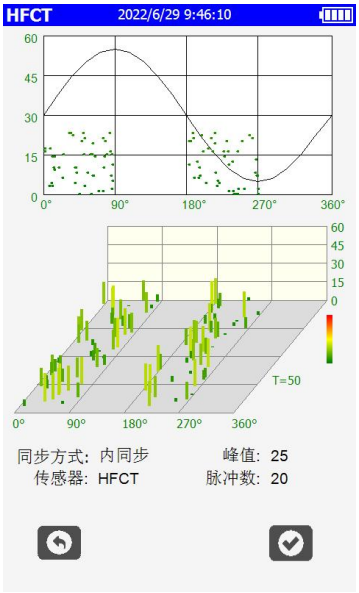
different sensors, and the threshold data can be adjusted by clicking "+" or "-" after the corresponding item when entering the threshold setting interface.

Threshold settings

After the parameters are set, click √ to return to the main test interface.

Save

During the test, if you want to save the PRPS map (the time domain map and PRPD map have been presented in the test interface), you can click the save button.



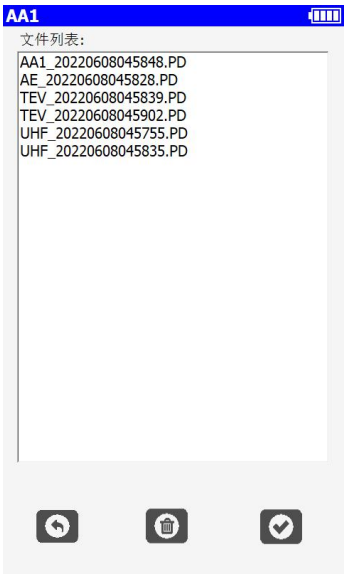
save interface

The save interface contains the PRPD/PRPS map, synchronization mode, peak, sensor type, pulse number, and the instrument will automatically save this record after pressing the confirm button, and the name of the saved record is named as the sensor type

plus the date and time.

Historical data view

If the historical data needs to be recalled, click the icon in the main test interface, and then a file will pop up to call the resource manager:



View historical data

The historical data is saved in the FLASH chip inside the instrument, and double-clicking the corresponding file name can be transferred to the storage data and spectrum display interface. To delete saved data, simply click to select the file and then tap "Delete".

Number of detections

The establishment of PRPD and PRPS spectra requires multi-cycle data collection, and this value represents the number of cycles that need to be collected to establish the spectra, and this instrument takes 50 times.

Number of pulses

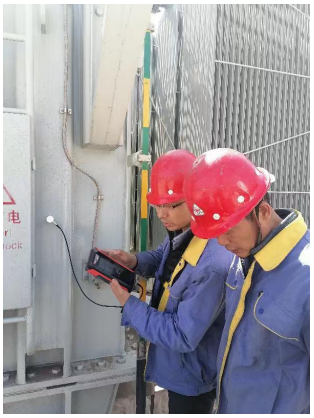
The number of pulses represents the number of discharge pulses detected in a power frequency cycle.

3.3.4 Test with external sensors

When you need to test transformers, GIS, cables and other equipment, you need to connect the corresponding sensor externally, and the host will automatically identify the sensor type when connecting the sensor through the same expansion port.

- **Contact ultrasonic sensors**

External contact ultrasonic sensor



Test diagram of an external ultrasonic sensor

The receiving mode of the contact ultrasonic sensor is different from the built-in open ultrasonic sensor, and the contact surface of the sensor needs to be in good contact with the equipment to be tested. Couplers need to be applied when necessary to ensure that the acoustic resistance between the contact surface and the sensor is as small as possible.

When testing the transformer, the sensor can be absorbed in the transformer box, please do not move the sensor at will, so as to avoid additional noise, do multi-point testing on all sides of the transformer as far as possible, and diagnose the internal discharge of the transformer in an all-round way.

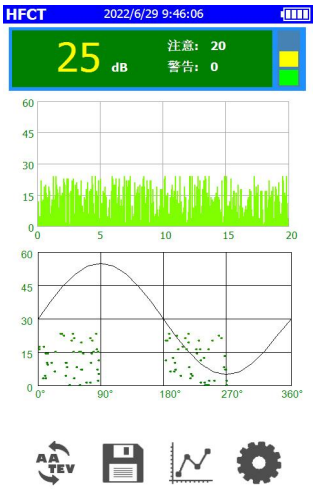
When testing the GIS ultrasonic signal, the contact ultrasonic sensor can be placed on the GIS metal tank, the multi-point test can be done on the tank body, and the discharge position can be judged by the detection amplitude.

Note that the contact ultrasonic sensor is very sensitive, do not collide or knock on the sensor, otherwise it will cause permanent damage.

- **High Frequency Current Sensors (HFCT)**

The high-frequency current sensor (hereinafter referred to as HFCT) is mainly used to measure the partial discharge signal of the cable, due to the special structure of the cable, the ultrasonic and high-frequency partial discharge signal can not be obtained from the outer layer of the metal armor, so the partial discharge signal can be obtained from the grounding wire. The unit of partial discharge when testing with HFCT is pC.

HFCT Wiring

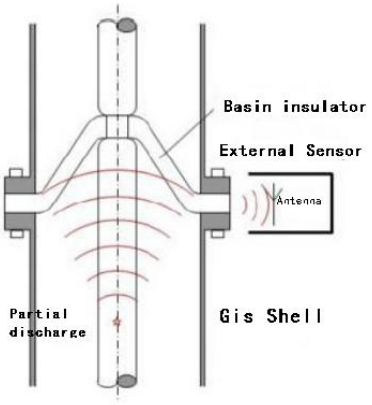


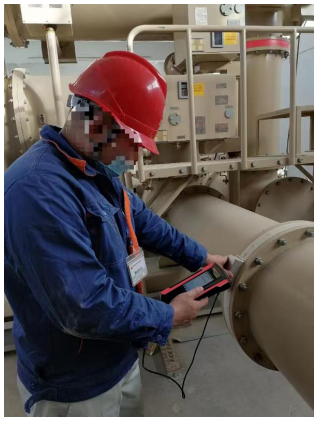
HFCT test interface

- **Ultra-High Frequency Sensors (UHF)**

The insulation strength and breakdown field strength of power equipment insulators are very high. When partial discharge occurs in a very small range, the breakdown process is very fast, which will produce a very steep pulse current, its rise time is less than 1ns, and the electromagnetic wave whose frequency is as high as several GHz. The basic principle of ultra-high frequency (UHF) method for partial discharge detection is to detect the ultra-high frequency electromagnetic wave (300MHz ≤ f ≤ 3GHz) signal generated by partial discharge in power equipment through UHF sensor, so as to obtain the relevant information of partial discharge and realize partial discharge monitoring. According to the different conditions of the field equipment, the built-in UHF sensor and the external UHF sensor can be used. The following figure shows a schematic diagram of the basic principle of UHF detection. Because the corona interference in the field is mainly below the 300MHz band, the UHF method can effectively avoid the corona interference in the field, has high sensitivity and anti-interference ability, and can realize the electrification detection, location and defect type identification of partial discharge.

The UHF sensor is used to receive the partial discharge signal inside the GIS tank. Because the frequency range is 300 ~ 2000MHz, the high frequency signal can not be transmitted to the outside of the tank, so the sensor needs to be close to the insulating basin, observation window and other positions during the test.



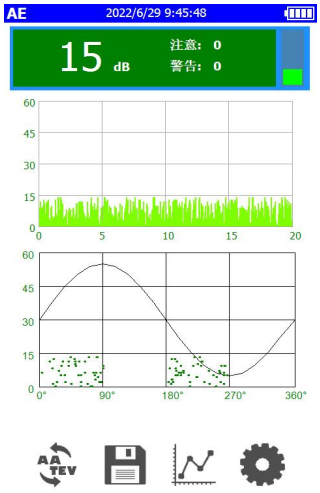


3. 3. 5 Atlas mode description

The atlas can be drawn when any sensor is used, including switchgear ultrasonic / ground wave, transformer ultrasonic, GIS ultrasonic / UHF, cable pulse current testing, etc. The following is a brief explanation of the use of various types of atlas.

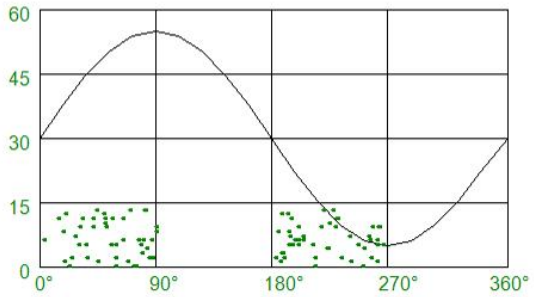
Time domain signal waveform and PRPD spectrum

After the product is turned on, the time-domain signal waveform and PRPD phase map are displayed by default, as shown in the figure below:

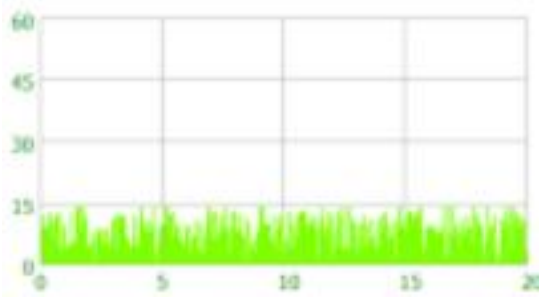


Time-domain signal waveforms and PRPD phase maps

The upper part of the interface is the time-domain signal waveform area, which displays the collected signals in real time, and the lower part is the PRPD phase map. With the change of time, the PRPD atlas will constantly redraw the relationship between the discharge signal and the phase. The significance of the PRPD atlas is that it can be used to analyze whether the discharge characteristics of the current equipment have the correlation between 50Hz and 100Hz and the repeatability of the discharge signal in the phase interval according to the relationship between the



phase and the discharge amplitude.

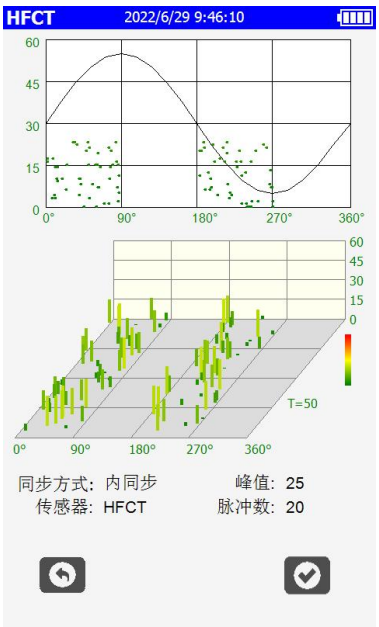


Time-domain waveforms

PRPD atlas

PRPS atlas

PRPS atlas is a three-dimensional map related to discharge amplitude, phase and time, which can fully reflect the one-to-one corresponding relationship among the three, and can more vividly reflect the characteristics of current equipment discharge. Combined with PRPD atlas, it is more convenient to analyze which discharge type the current discharge belongs to.

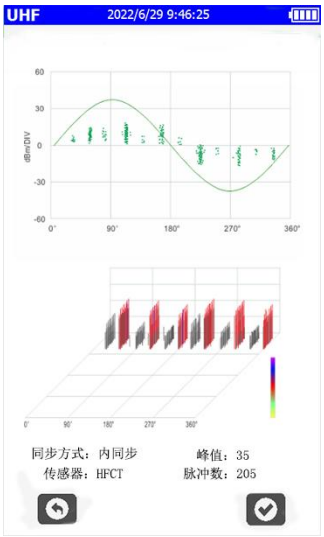


PRPD and PRPS atlas

In the default test interface, pressing the icon "" will restart the atlas data statistics, complete the set number of cycles (which can be set in the setting interface), and automatically form the PRPS graph and pop up the PRPD and PRPS atlas display interface after data sampling.

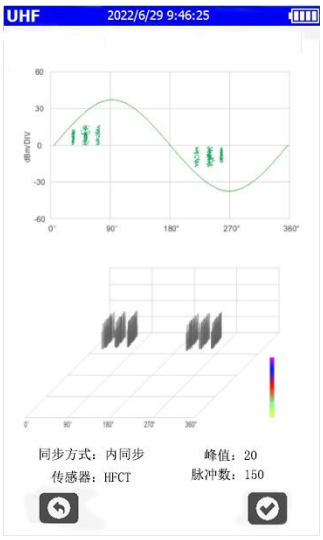
3.3.6 Typical discharge types and discharge patterns

Free metal particle discharge

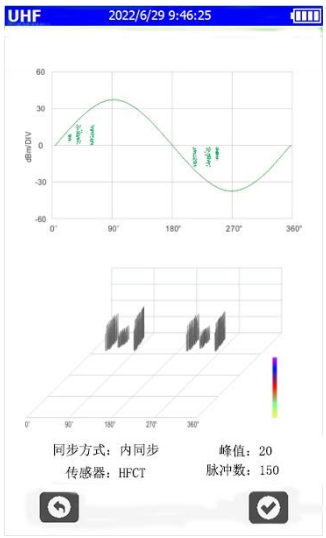


The discharge of free metal particles is the partial discharge between metal particles and metal particles and the partial discharge between metal particles and metal parts. The amplitude distribution of this kind of discharge is wide, the discharge time interval is unstable, its polarity effect is not obvious, and there is discharge signal distribution in the whole power frequency cycle phase.

Suspended Potential Discharge

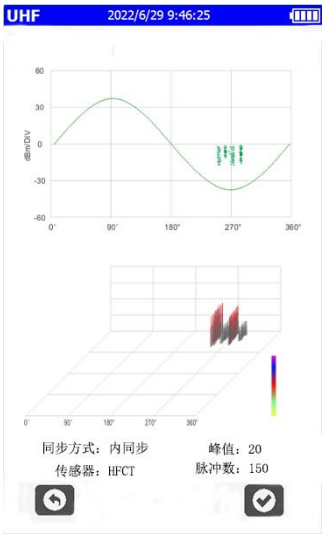


The discharge of suspended potential body is the partial discharge produced by loose metal parts, the amplitude of this kind of discharge pulse is stable, and the time interval of adjacent discharge is basically the same. When the suspended metal body is asymmetric, there is a polarity difference between the positive and negative half-wave detection signals



Discharge of the internal air gap of the insulator

The internal air gap discharge of insulator is mainly caused by solid insulation internal cracking, air gap and other defects, which has less discharge times and low cycle repeatability. The discharge amplitude is also dispersed, but the discharge phase is stable and there is no obvious polarity effect.



Metal tip discharge

The metal tip discharge is the SF6 corona discharge caused by the concentration of electric field due to the metal burr or tip with high or low potential. This type of discharge has many times, small dispersion of discharge amplitude and uniform time interval. The initial discharge usually occurs only in the negative half cycle of the power frequency phase.

3.3.7 Optional sensor list

The external sensors that can be connected to this product are as follows:

Contact ultrasonic sensor		Used for partial discharge detection of transformers, GIS, motors, etc. Frequency: 40 ~ 150kHz
High frequency current sensors		Used for cable partial discharge detection Frequency: 1 ~ 30MHz
UHF sensors		Used for GIS partial discharge detection Frequency: 300-2000MHz
Flexible, non-contact ultrasonic sensor		used for switchgear partial discharge detection Frequency:20~200kHz
Wave condenser		Used for insulator, overhead line detection Frequency: 20~ 200kHz

The above sensors are connected through the multi-function sensor interface at the bottom of the host, and the host will select the sampling channel of the corresponding sensor according to the different types of sensors connected, to truly realize the purpose of one machine for multiple purposes.

3.4 Charging

The charging of this product must use a lithium battery charger with an output voltage of 5V. When plugging in the charger to charge this product, the charging indicator under the main unit is red, and when the instrument battery is fully charged, the lower indicator turns blue.

In order to ensure the service life of the battery of this instrument, when it is not used for a long time, it is recommended that customers charge it every two months and maintain the battery of the instrument.

Appendix I Test Report Template

(1) Switchgear test report template

1. Basic Information							
transformer substation		Entrusting unit		Test unit		Run number	
Experimental nature		Date of the trial		Experimenters		Test site	
Report date		Compiler		Reviewers		Approver	
Test the weather		Ambient temperature		relative humidity			
Second, the equipment nameplate							
Manufacturer			Date of manufacture			Factory number	
Device model			Rated voltage				
3. Test data							
serial number	Detection location	Detection data	Atlas files		Whether there is a discharge or not		Load current
1					Yes/No		
2					Yes/No		

3				Yes/No	
4				Yes/No	
5				Yes/No	
Feature analysis					
conclusion					
remark					

(2) Transformer test report template

1. Basic Information							
transformer substation		Entrusting unit		Test unit		Run number	
Experimental nature		Date of the trial		Experimenters		Test site	
Report date		Compiler		Reviewers		Approver	
Test the weather		Ambient temperature		relative humidity			
Second, the equipment nameplate							
Manufacturer			Date of manufacture			Factory number	
Device model			Rated voltage				
3. Test data							
serial number	Detection location		Atlas files		Whether there is a discharge or		Detect spikes

			not	
1			Yes/No	
2			Yes/No	
3			Yes/No	
4			Yes/No	
5			Yes/No	
…….			Yes/No	
Feature analysis				
conclusion				
remark				

(3) Cable test report template

1. Basic Information							
transformer substation		Entrusting unit		Test unit		Run number	
Experimental nature		Date of the trial		Experimenters		Test site	
Report date		Compiler		Reviewers		Approver	
Test the weather		Ambient temperature		relative humidity			
Second, the equipment nameplate							
Manufacturer		Date of manufacture				Factory number	

Device model		Rated voltage			
3. Test data					
serial number	Detection data	Atlas files		Whether there is a discharge or not	Detect spikes
1				Yes/No	
2				Yes/No	
3				Yes/No	
4				Yes/No	
5				Yes/No	
……				Yes/No	
Feature analysis					
conclusion					
remark					

(4) GIS test report template

1. Basic Information					
transformer substation		Entrusting unit		Test unit	
Experimental nature		Date of the trial		Experimenters	

Report date		Compiler		Reviewers	
Test the weather		Ambient temperature		relative humidity	
Second, the equipment nameplate					
Manufacturer		Date of manufacture		Factory number	
Device model		Rated voltage			
3. Test data					
serial number	Detection location	Detection data	Whether there is a discharge or not	Atlas files	
1			Yes/No	atlas	
2			Yes/No	atlas	
3			Yes/No	atlas	
4			Yes/No	atlas	
5			Yes/No	atlas	
…….			Yes/No	atlas	
Feature analysis					
conclusion					
remark					

Appendix II Test Methods for Partial Discharge of Switchgear

TEV (Transient Ground Voltage) detection principle

Partial discharge in the insulation layer of the high-voltage switchgear will produce electromagnetic waves, and the metal shell of the switchgear will shield a large part of this electromagnetic wave, but there is still a small part will be transmitted through the seam of the metal shell or the gas-insulated switch gasket, and a ground wave will be generated through the outer surface of the metal shell of the equipment to the ground. Ground waves typically range from a few millivolts to a few millivolts to somewhere in between, and rise in a few nanoseconds. The probe can be installed on the outer surface of the switchgear in the working state to detect partial discharge activity.

TEV (Transient Ground Voltage) detection site

Middle switchgear: front middle, front down, rear upper, rear middle, rear down.

Switchgear at both ends: side up, side middle, side down.

Note: The detection part should be the metal surface of the switch cabinet body, and there is no object between the instrument and the cabinet when laminating.

TEV (Transient Ground Voltage) detection method

Before the test: first on the metal body that is not grounded, adhere to its surface, and measure the current environmental value. When the ambient value is too large, we should find out the interference source and remove the interference source before testing.

During the test: Attach the top of the instrument to the test point of the switch cabinet, stand still for a period of time, click Save, and the instrument will automatically generate the result. The test is tested at multiple points on each test surface as much as possible to ensure that the values are true and valid.

The reference basis for used to judge TEV (Transient Ground Voltage)

TEV readings	Description
High background reading, i.e. greater than 20dB Note: Background readings are readings when the sensor is not attached to the cabinet	(a) high levels of noise may mask the discharge in the switchgear; (b) External sources of interference should be eliminated as much as possible before re-testing, possibly due to external influences
All readings for switchgear and background reference < 20dB	There is no partial release, and it is rechecked once a year
The relative readings of the switchgear and background reference readings are 20~29dB	The device has a slight partial discharge
The relative value of the switchgear and background reference readings is 29~40dB	If the equipment has a medium partial discharge, it should be reported to the team or special responsibility to shorten the inspection cycle
The relative readings of the switchgear and background reference readings are 40~50dB	If there is a serious partial discharge of the equipment, it should be reported to the team or special responsibility to shorten the inspection cycle, and the source of partial discharge should be checked when there is a power outage
The relative readings of the switchgear and background reference are 50~60dB	If there is a serious partial discharge of the equipment, it should be reported to the team or special responsibility, shorten the inspection cycle, and stop the power

	for maintenance as soon as possible

The principle of ultrasonic testing

Electrical breakdown occurs in the air gap, the discharge can be completed in an instant, at this time the electrical energy will also be converted into heat energy in an instant, the gas in the discharge center will expand under the action of heat energy, and propagate outward through sound waves, and the gas in the propagation area is heated to form an isothermal zone, and its temperature exceeds the ambient temperature; When these gases begin to shrink after cooling, they will produce follow-up waves, which have relatively low frequency and intensity, contain various frequency components, have a wide frequency band, and the frequency of ultrasonic waves is greater than 20kHz. Because the area of partial discharge is relatively small, the source of partial discharge sound is the discharge source.

Ultrasound inspection of the site

It usually detects the front, middle, front, back, back, middle, and back door gaps of the cabinet.

Ultrasonic testing methods

Before the test: Aim the instrument at the air at a position of 2-3 meters away from the switch cabinet, and record the current environmental value for a period of time. When the ambient value is too large, we should find out the interference source and remove the interference source before testing.

During the test: the ultrasonic sensor on the top of the instrument is attached to the gap of the switch cabinet, and the current test value is recorded for 2-3s, and the test value is compared with the environmental value, when the value is greater than 6 dB, it should be combined with the TEV comprehensive judgment.

Ultrasound judgment reference basis

Ultrasound readings	Description
0dB, no discharge sound	There is no partial discharge of the device
0 ~ 6dB， there is a short discharge sound	There is a slight discharge in the equipment, which should be concerned in the later stage
More than 6dB, there is a discharge sound	If there is obvious discharge in the equipment, it should be judged in combination with the TEV test

Appendix III Test Methods for Partial Discharge of Transformers

The principle of contact ultrasonic testing

Under the power frequency or test voltage, once the internal discharge of the transformer occurs, it will be accompanied by a certain ultrasonic signal. This signal spreads rapidly in a short period of time with the help of the surrounding medium. Therefore, a contact ultrasonic sensor is placed on the transformer housing, and the discharge signal is converted into an electrical signal through the sensor, and then the discharge level inside the transformer is measured.

Contact ultrasonic inspection site

on the casing of the transformer

Contact ultrasonic testing method

Before the test: first detect the ambient value in the air, when the ambient value is too large, we should find out the interference source, eliminate the interference source before testing.

During the test: the contact ultrasonic sensor is attached to the transformer housing and stationary for 2-3s, the current test value is recorded, and saved.

Reference basis for contact ultrasound judgment

Ultrasound readings	**Description**
Readings <6dB	No partial discharge
6dB < reading< 15dB	There may be a slight partial discharge of the device
15dB < reading	There is a severe discharge in the device

Appendix IV Test Methods for Partial Discharge of Cables

The principle of high-frequency detection

When a partial discharge occurs in a power cable, a pulsed current is typically generated on the ground down conductor. The high-frequency pulse current signal flowing through the grounding down conductor is detected by a high-frequency current sensor, and the partial discharge detection of the cable is realized.

Cable partial discharge detection site

Partial discharge detection method for cables

Test: Directly clamp the high-frequency current sensor into the grounding outer sheath of the cable or the grounding shield of the cable, detect for 5~10 seconds, press the save button after the reading is stable, and save the current measurement data.

Cable partial discharge detection judgment

1. First, according to the phase spectrum characteristics, determine whether the measurement signal has typical discharge spectrum characteristics or is significantly different from the background or other test locations, and if so, continue to analyze and process as follows:
2. Cross-sectional comparison of partial discharge signals of the same type of equipment. The test amplitude and test spectrum of the partial discharge signal

detected by similar equipment in a similar environment should be similar, and similar equipment in the same substation can also be compared horizontally;

3. Longitudinal comparison of historical data from the same device. By measuring the PD signal of the same device multiple times over a long period of time, it is possible to track the deterioration trend of the insulation state of the device, and if the measured value increases significantly, or if there is a typical PD spectrum, it can be determined that there is an anomaly in this test point.
4. If a signal with partial discharge characteristics is detected, it is judged to be an abnormal signal when the discharge amplitude is small, and a defective signal when the discharge characteristics are obvious and the amplitude is large.

Appendix V Test Methods for GIS UHF Partial Discharge

UHF detection principle

Partial discharge in GIS will produce electromagnetic waves, and the metal shell of GIS will shield a large part of this electromagnetic wave, but there is still a small part of it will propagate through the insulated plate or observation window of the metal shell with a frequency of up to several GHz, and the rise time is several nanoseconds. The probe can be installed in the insulated basin of the GIS in the working state to detect partial discharge activity.

UHF detection site

The insulating basin or observation window of each gas chamber of the GIS.

GIS partial discharge detection and judgment

a) First, according to the phase spectrum characteristics, determine whether the

measurement signal has typical discharge spectrum characteristics or is significantly different from the background or other test positions, and if so, continue to analyze and process as follows: Eliminate external environmental interference, and compare the detection signal with the detection signal in the air when the sensor is placed on the insulating basin, and if the signal is consistent and the signal is small, it can be basically judged as external interference. If it is different or larger, further testing is required.

b) Detect the signals of adjacent intervals, and preliminarily locate the partial discharge part according to the amplitude of each detection interval (i.e., signal attenuation characteristics).

c) If necessary, you can use tools to tie the sensor to the insulating basin for long-term detection, the time is not less than 15 minutes, further analyze the peak pattern, and three-dimensional detection pattern, and comprehensively judge the discharge type.

The instrument itself has a discharge analysis reference, and the discharge type can be analyzed according to the discharge characteristics. When the conditions are available, the ultrasonic partial discharge instrument is also used for accurate positioning.

Appendix VI Test Methods for Partial Discharge of Overhead Lines and Insulators

Ultrasonic concentrator detection principle

When the high-voltage equipment is partially discharged, ultrasonic energy will be generated, which is radiated to the surroundings through the air, and the ultrasonic concentrator sensor can effectively receive the ultrasonic signal generated by the discharge, and realize the partial discharge detection of the overhead equipment according to the amplitude of the signal.

Ultrasonic concentrator sensor detection method

Before the test: Detect the ambient value in the air. When the environmental value is too large, we should find out the interference source and eliminate the interference source before testing.

During the test: point the ultrasonic concentrator at the sample and stand still for 2-3s to record the current test value and save it.

Ultrasonic concentrator judgment reference basis

Ultrasound readings	**Description**
Readings <6dB	No partial discharge
6dB < reading< 15dB	There may be a slight partial discharge of the device
15dB < reading	There is a severe discharge in the device