Know your transformers more accurately.

KINGRUN INSTRUMENT CO., LTD

Tel: 0086 312 5959618 / Fax: 0086 312 5959618

info@kritester.com www.kritester.com

Partial Discharge Tester
GTPD-92

Operation Instructions

Dear users:

Thank you for purchasing the company's partial discharge inspection instrument. Before you use the product for the first time, please read the instruction manual carefully.

The instrument is used to detect local discharges in medium/high voltage (MV/HV) devices. If no discharge is detected, it does not mean that there is no discharge activity in the medium and high voltage equipment. Discharges tend to have an incubation period, and insulation properties may fail for reasons other than partial discharge.

Warning Message:

- Always maintain a safe distance between the high-pressure section and the instrument, probe, and operator.
- Strict compliance with local safety rules.
- In the event of a nearby thunderstorm, measurements should not be taken.
- Do not operate instruments or accessories in an explosive atmosphere.
- When using the product, please follow the instructions.
- After the instrument battery alarm, turn off the system to charge.
- Do not turn on the instrument without permission, as this will affect the warranty of the product. The owner is not responsible for dismantling the factory.
- When storing and storing this instrument, attention should be paid to the ambient temperature and humidity, and it is advisable to place it in a dry and ventilated place, and it is necessary to prevent dust, moisture, shock, acid and alkali and corrosive gases.

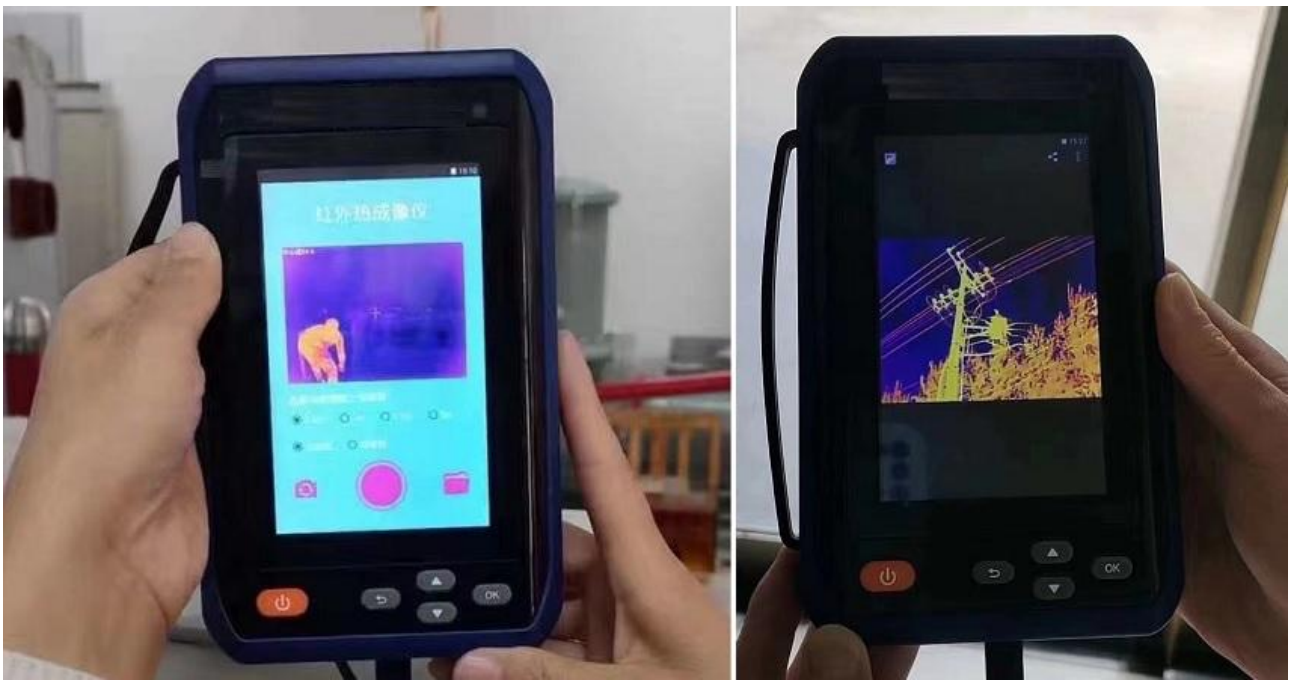
When the instrument is transported, rain erosion should be avoided, and collisions and falls should be strictly prevented.

Contents

Purchase Instructions

The main host of the partial discharge inspector series is equipped with transient ground radio wave and ultrasonic measurement mode, and the two measurement methods of UHF and high frequency current can be selected according to demand. Specifically, it is divided into the following four product models:

- **Partial discharge inspection instrument** is equipped with four measurement methods: transient ground radio wave, ultrasonic wave, UHF and high frequency current.
- **Model A partial discharge inspection instrument** is equipped with measurement methods: ultrasonic and high-frequency current.
- **Model B Partial discharge inspection instrument** is equipped with transient ground radio waves, ultrasonic measurement methods.
- **Model C partial discharge inspection instrument** is equipped with ultrasonic, UHF measurement methods.



1. Product overview

Partial discharge is a pulse discharge that produces a series of physical phenomena and chemical changes such as light, sound, electrical and mechanical vibrations in and around the power equipment. These various physical and chemical changes that accompany partial discharge can provide a detection signal for monitoring the internal insulation status of power equipment. When there is an insulation defect inside the high-voltage electrical equipment, it will be accompanied by the generation of a partial discharge signal. Through the detection and analysis of the partial discharge signal, it can determine whether there is an insulation hidden danger inside the high-voltage electrical equipment and prevent the further expansion of potential accidents.

The partial discharge inspection instrument developed by our company is a multi-functional handheld instrument, which is based on ground radio waves, ultrasonic waves, UHF and high frequency current detection methods, the partial discharge of the test equipment, the partial discharge amplitude and the map waveform can be read out, and the storage and readout functions of the two-dimensional and three-dimensional maps can be better evaluated. Partial discharge tester is suitable for partial discharge detection of electrical equipment such as GIS, switch cabinets, transformers and power cables. The equipment is portable and simple to operate, and all the detections have no impact on the operation of the high-voltage equipment. The product can observe the measurement signal for multiple cycles, identify the frequency of discharge, and analyze through multiple modes to clearly determine the fault.

Partial discharge tester adopts a new appearance design, using the current popular Android system, easier to operate and use, and integrates 5 million cameras to facilitate inspection records; RFID is conducive to expanding the application of the Internet of Things; internal integration of discharge type library, easy to compare and verify the discharge situation.

2. Reference standards

- Partial discharge measurement GB/T 7354
- Field measurement guideline for partial discharge of power equipment DL/T 417
- High voltage test technology Part I: General test requirements GB/T 16927.1
- High voltage test technology Part II: Measuring system GB/T 16927.2

3. Measuring principle

3. 1 Transient ground voltage (TEV).

When the partial discharge phenomenon occurs in the distribution equipment, the charged ions will quickly migrate from the charged body to the grounded non-charged body, such as the cabinet body of the distribution equipment, and generate a current traveling wave on the non-charged body, and quickly propagate in all directions at the speed of light. Affected by the skin effect, the current traveling wave is often concentrated only on the inner surface of the cabinet and does not directly penetrate the metal cabinet. However, when the current traveling wave encounters a discontinuous metal disconnection or insulating connection, the current traveling wave will be transferred from the surface of the metal cabinet to the outer surface, and propagate to the free space in the form of electromagnetic waves, and generate a transient ground voltage on the outer surface of the metal. This voltage can be measured outside the switchgear using a dedicated TEV sensor. TEV sensors are similar to traditional RF coupling capacitors, and Its housing has a dual function of insulation and protection, and the sensor can sense high-frequency pulse current signals. The measuring principle is as follows:

Figure 3-1- TEV detection schematic

3.2 Ultrasound (US).

Before partial discharge occurs, the mechanical stress and particle force of the electric field force insulating medium around the discharge point are in a relatively balanced state. The rapid release or migration of charge when partial discharge occurs causes the electric field to change, upsetting the equilibrium state, causing oscillating mechanical movement of surrounding particles, resulting in sound or vibration signals. The ultrasonic method measures the partial discharge signal by installing an ultrasonic sensor on the outer wall of the equipment cavity. The characteristics of this method are

that the sensor has no connection with the electrical circuit of the device and is not interfered with by the electrical aspects, but it is easily affected by the noise of the surrounding environment or the mechanical vibration of the equipment when used in the field. Due to the large attenuation of ultrasonic signals in the insulation materials commonly used in power equipment, the detection range of ultrasonic detection method is limited, but it has the advantages of high positioning accuracy. The spectrum of sound waves generated by partial discharge is very wide, from tens of Hz to several MHz, where signals with frequencies below 20kHz can be heard by the human ear, and ultrasonic signals above this frequency must be received with ultrasonic sensors. By measuring the sound pressure of the ultrasonic signal, the strength of the discharge is inferred.

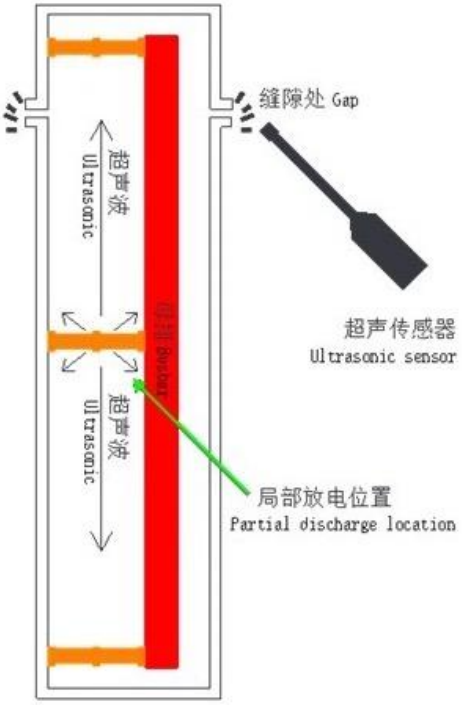


Figure 3-2- US Measurement Schematic

3. 3 Ultra-high frequency (UHF).

The dielectric strength and breakdown field strength in the insulator of the power equipment are very high, and when the partial discharge occurs in a small range, the breakdown process is very fast, and a very steep pulse current will be generated, and its rise time is less than 1ns, and the electromagnetic wave with an excitation frequency of up to several GHz is excited. The basic principle of the UHF detection method is to detect the UHF electromagnetic wave (300MHz ≤ f ≤ 3GHz) signal generated by the UHF sensor when partially discharged in the power equipment. So as to obtain the relevant information of the partial discharge, to achieve the local discharge monitoring. Depending on the field device, both built-in UHF sensors and external UHF sensors can be used. Since the corona interference at the scene is mainly concentrated below the 300MHz frequency band, the UHF

method can effectively avoid the interference such as corona at the scene, has high sensitivity and anti-interference ability, and can realize the advantages of partial discharge live detection, positioning and defect type identification.

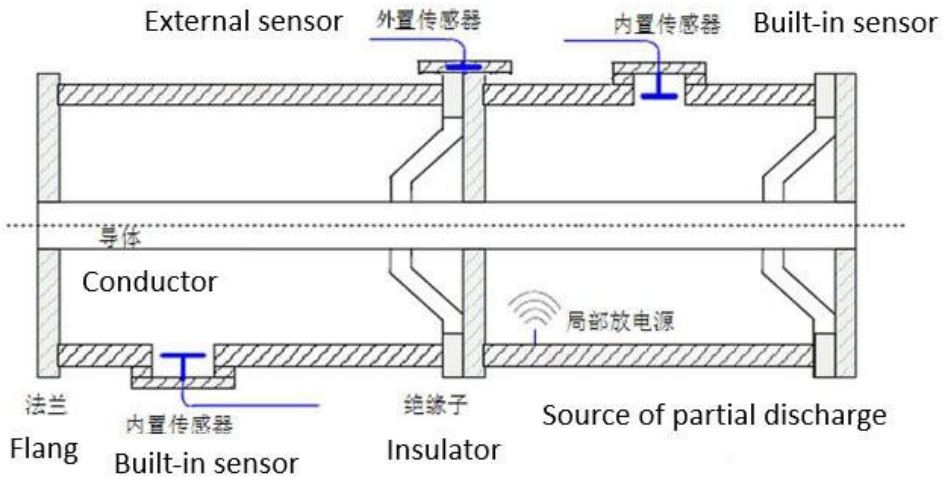


Figure 3-3- UHF measurement schematic

3.4 High Frequency Current Transformer (HFCT).

High-frequency current transformers are mainly used for partial discharge detection of high-voltage electrical equipment, using the principle of pulsed current. Since most high-voltage electrical equipment has distributed capacitance on its high and low voltage sides or grounding parts, when a discharge occurs in the high field strength area, it will couple to the grounding part and enter the earth through the ground wire. The HFCT is stuck on the ground wire and detects the pulse current signal generated by its PD to obtain partial discharge information of the device being detected. It is mainly used for partial discharge signal detection of cables, transformers, reactors, GIS, switchgear and other medium and high voltage equipment. The detection of the grounding wire of the electrical equipment using HFCT is a non-invasive detection method, and the equipment to be tested does not need to be shut down, which is simple and reliable.

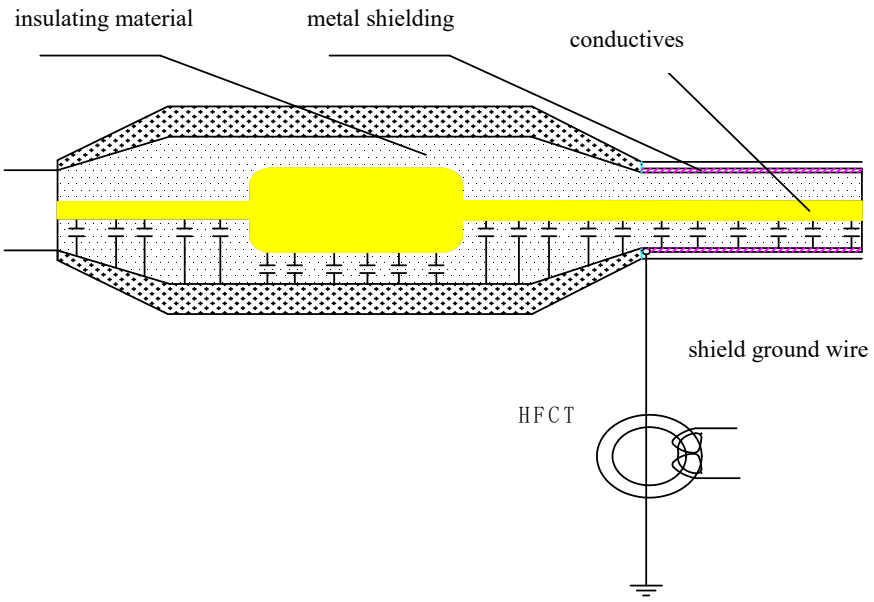


Figure 3-4- HFCT measurement schematic 1

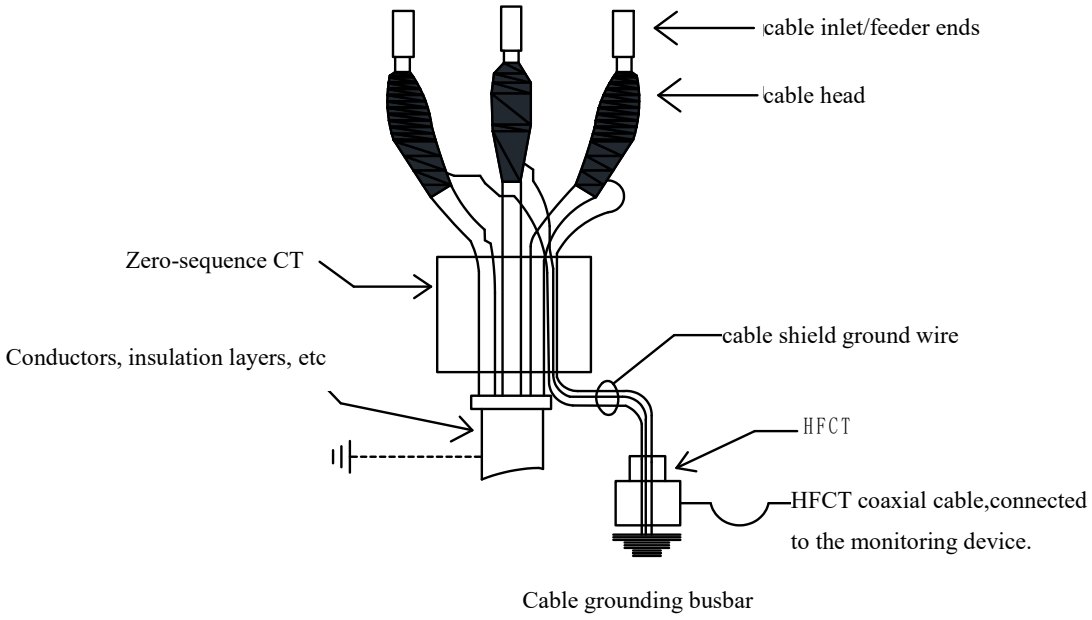


Figure 3-5- HFCT Measurement Schematic Figure 2

4. Technical parameters

table 4- 1Technical data sheet

Host parameters	
Detect channels	4 channels: 1 TEV, 1 US, 1 UHF (wireless, optional), 1 X HFCT (wireless, optional)
Sampling accuracy	12bit
Synchronization mode	Internal synchronization external synchronization optical synchronization
TEV	
Detect bandwidth	3M-100MHz
Measuring range	0～60dB
Measurement error	±2dB
Resolution	1dB
Maximum number of Pulses per cycle	720
Minimum pulse Frequency	10Hz
Output interface	Standard SMA connects to the host
Non-contact US	
Center frequency	40kHz
Resolution	0.1uV
Precision	±0.1uV
Measuring range	0.5uV～1mV
Output interface	Standard SMA connects to the host
Contact US	
Frequency range	20kHz～300kHz
Output impedance	50Ω
Detection sensitivity	0.1mV

Measuring range	0.1mV～1V
Output interface	Standard SMA connects to the host
UHF（optional）	
Detect bandwidth	300MHz～1.5GHz
Output mode	BNC Interface - Signal Conditioning Unit, Wireless Connection to Host
Receiving mode	Antenna reception
Transmission mode	coaxial cable
Detection sensitivity	<-60dBm
HFCT（Optional）	
Detect bandwidth	1M-30MHz
Transmission Impedance	>5mV/mA(10MHz)
Output impedance	50Ω
Measuring range	-20~80dB
Measurement error	±1dB
Resolution	1dB
Output interface	BNC Interface - Signal Conditioning Unit, Wireless Connection to Host
Hardware	
Display screen	5.0 inch TFT true color LCD screen
Resolution	800×480
Operate	Touch / button
Storage	TF card
Interface	3.5mm Stereo headphone jack
Power supply	DC-12V/2A DC power supply
Extended function	USB-TypeC/500 Million cameras/RFID/WIFI/Bluetooth
Power supply	
Internal power supply	Battery powered（4800mAH 7.4V）
Normal work hours	About 7 hours, full charge time about 3 hours

Size	
Lenth × width × hight	235mm×133mm×48mm
weight	0.85kg
environment	
Work Ambient temperature	-20℃～50℃
Store ambient temperature	-40℃～70℃
Humidity	10%-90%（Non-condensing）
Altitude	≤3000m

5. Basic operation of the instrument

5.1 The instrument on/off

Press the  button and the splash screen appears on the screen.

To turn off the instrument, press and hold the  button.

5.2 Summary information

After the device enters the normal operating state, the main system menu is displayed. The main menu interface displays options such as "Transient Ground Wave", "Ultrasonic Wave", "UHF", "High Frequency Current", "Detection Record", "System Settings" and so on. Above the interface, the current time and battery level status are displayed.

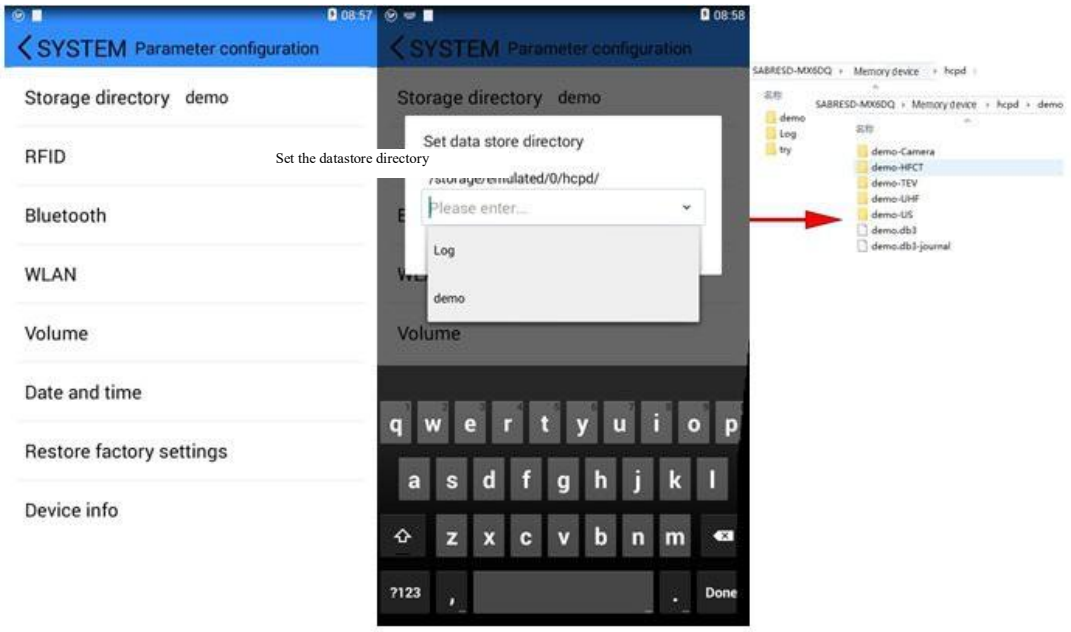
5.3 System settings

The system settings interface browses and sets the basic information of the system.

- **Storage directory**

  The location where the database files and picture files were saved during the experiment.

  Note: The record data can be viewed in "Home - Inspection Record". If you create a new directory that already exists, the data in the previous directory will be directly emptied, so please proceed with caution. All data storage paths are in /storage/emulated/0/hcpd/



Set the datastore directory

.

- **RFID**

The system can connect with RFID devices to achieve intelligent reading and writing operations of corresponding data.

- **Bluetooth**

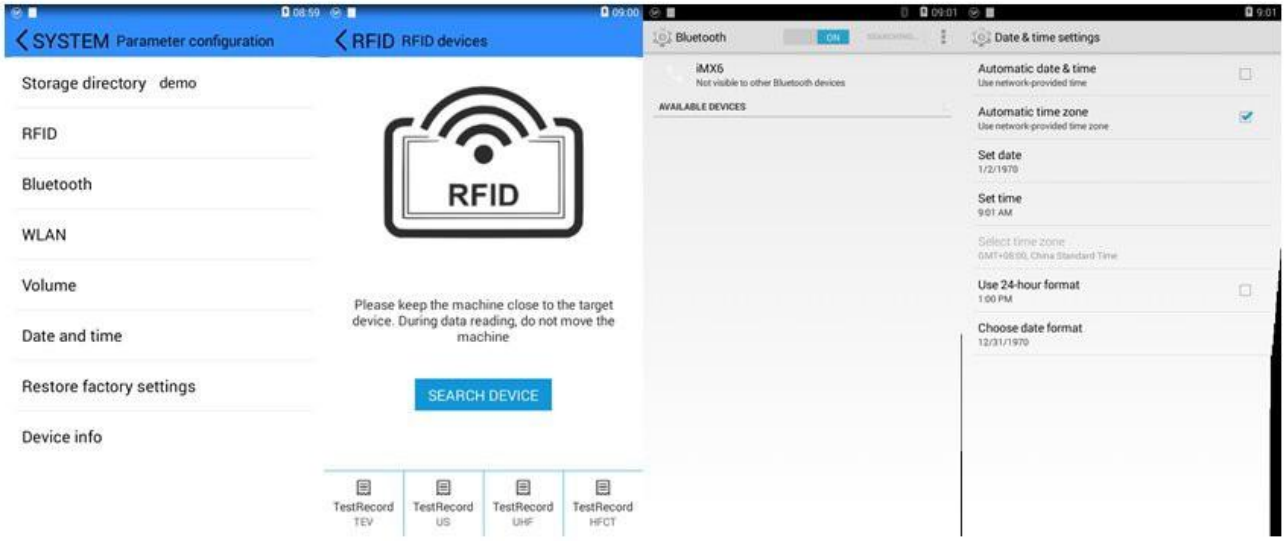
Search for and connect to available Bluetooth devices around you.

- **Volume**

Adjust the system output volume.

- **Date and time**

The time and display date modification of the system .



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- **Restore Factory settings**

Clean up the data and pictures generated during the experiment in the system, and use caution before exporting the data.

- **Device information**

  Software version, hardware version, and system release date.

5.4 TEV measurements

There are 4 kinds of display diagrams for TEV test: waveform plot, PRPD plot, PRPS plot, and statistical plot. In the running state, click the [Display Mode] button in the bottom control area to switch between different display graphs (the default waveform graph display), and the four display graphs process the discharge data synchronously.

- **Title area**

  Channel being measured, measurement mode, synchronization mode, gain level. Click  on the icon to set the relevant parameters of the TEV test.

- **Data area**

  The maximum, background, and current values in the current measurement.

- **Historical extremum zone**

  The maximum value of the most recent 20 cycles in the current measurement process.

- **Chart area**

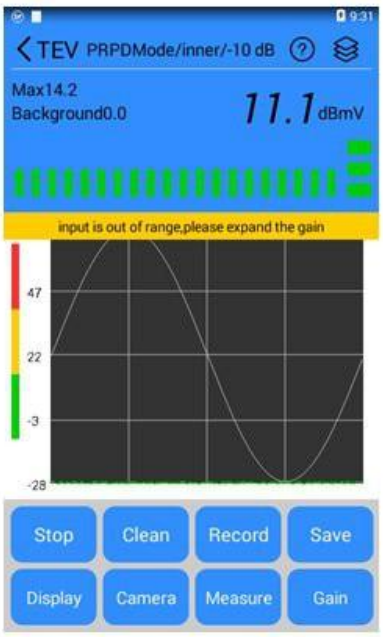
  Waveform chart - the current measurement data waveform, according to the number of cycles in the [Settings] settings display the corresponding number of cycles, according to the discharge characteristics to determine whether to discharge, while through the [Zoom out / Zoom in] key can be amplified or reduced to adjust the waveform.

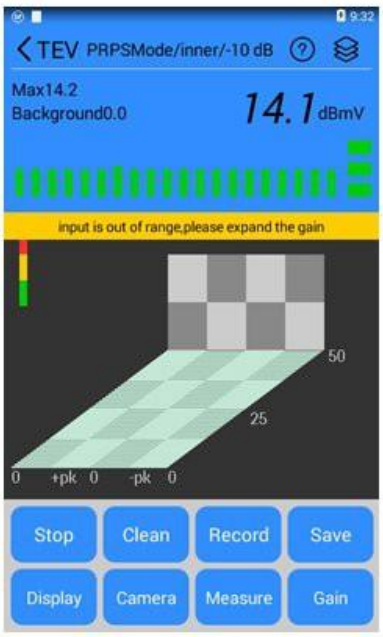
  PRPD plot - two-dimensional spectrum, discharge phase distribution spectrum, showing the relationship between discharge level, phase and peak frequency, of which the vertical axis represents the discharge level, the horizontal axis represents the phase 0-360 degrees, and different pixel colors represent different peak frequencies.

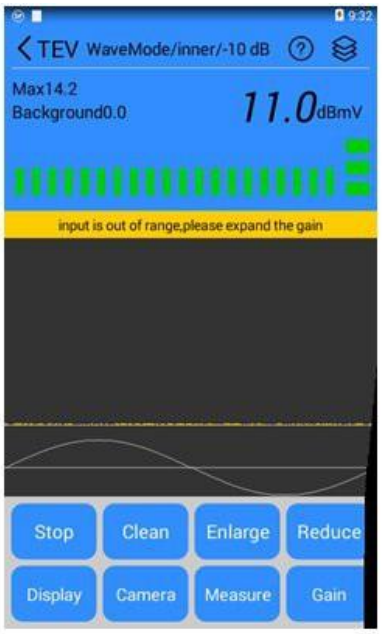
  PRPS plot - three-dimensional spectrum, pulse sequence map, showing the relationship between time, phase and discharge level, the vertical axis represents the discharge level, the horizontal axis represents the phase, the Z axis represents time, the pulse different colors represent the size of the discharge level, and the right color logo represents the different colors used by different percentages of the vertical axis. This mode allows you to distinguish between interference and discharge, as well as changes in signals with different phases over time.

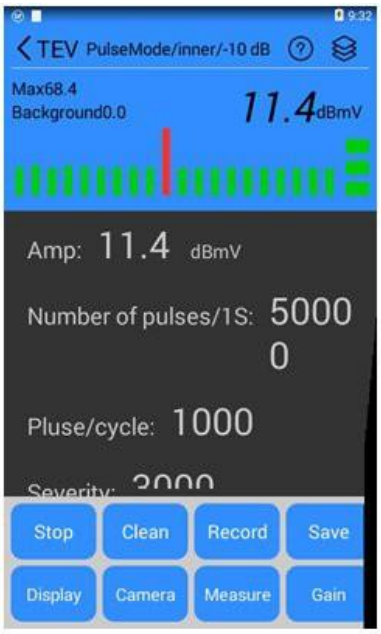
  Chart—Displays the pulse count and the number of pulses per week at the 50Hz main

frequency.









- **Control area.**
  - Run/Stop — Sets the system acquisition status to run or stop.
  - Clean —Clears the waveform plot and maximum value drawn on the current page.
  - Enlarge/Reduce—Enlarge or reduce the waveform plot drawn in the chart.
  - Display—Toggles how the live icon area is displayed.
  - Camera—Turn on the camera to take a live photo recording.

- Measure—Set the system to switch between continuous acquisition and single acquisition.
- Gain—Sets the gain level of the system sensor, -10dB, 14dB, 35dB.
- Record—Saves the current trial data as background data.
- Save—Saves data and pictures of the current test process.

- **TEV settings**
  - Warning Value—Sets the yellow Traffic Light threshold.
  - Alarm Value—Sets the red Traffic Light threshold.
  - Initial Range—Sets the initial range of the atlas display, which changes dynamically with the acquired data.
  - Noise Threshold—The amount of noise filtered during data processing.
  - Number of Cycles —Sets the number of cycles processed in a single shot in waveform mode.
  - Statistics Period—Sets the time for a single acquisition in the statistics mode.
  - Background Threshold—Sets the filtering threshold according to the actual situation on site.
  - Synchronization mode—The synchronization mode of setting the system operation is divided into external synchronization, internal synchronization, and optical synchronization.
  - Display Unit—Sets the display unit of data display to be divided into dBmV, dBm, and mV.

5.5 US measurements.

The US test has four kinds of display charts: waveform graph, PRPD plot, amplitude mode and pulse mode, click the bottom control area [Display Mode] key to switch different display graphs (default waveform graph display), and the four display graphs synchronously process discharge data.

- **Title area**

  Displays the channel being measured, the measurement mode, the synchronization method, and the gain level. Click the icon  to set the relevant parameters of the US test.

- **Data area**

  Displays valid values, background values, 50Hz, 100Hz, and current values during the current measurement.

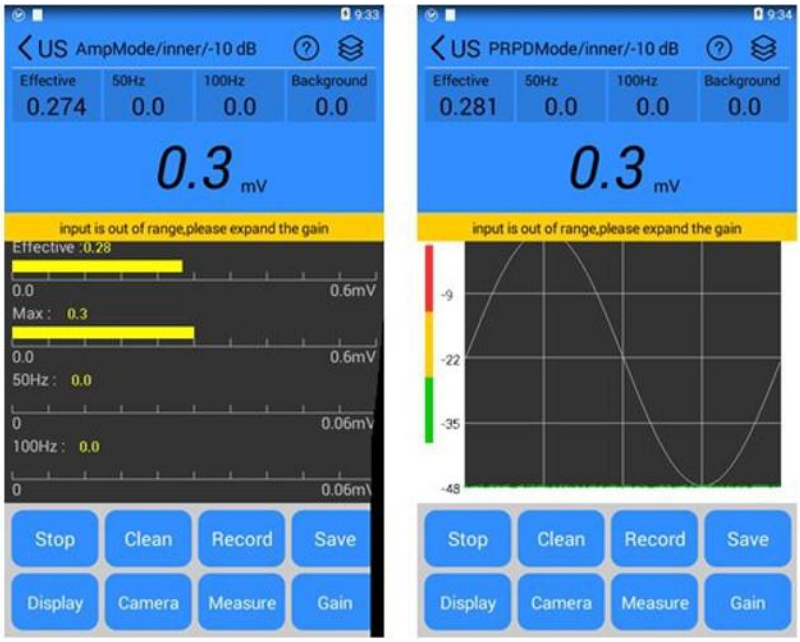
- **Chart area**

Waveform Plot—The waveform detection mode is used to diagnose and analyze the original waveform of the signal under test so that it can intuitively observe whether there is an abnormality in the signal under test. According to the number of cycles in the [SYSTEM] setting, the corresponding number of cycles is displayed, and the discharge characteristics are used to determine whether to discharge, and the waveform can be enlarged or reduced by the [Enlarge/Reduce] key.

PRPD plot—Since the generation of the partial discharge signal is related to the power frequency electric field, the power frequency voltage can be used as a reference quantity to determine whether the partial discharge is caused by the internal discharge of the device by observing whether the phase of the measured signal has a aggregation effect.

Amp mode—Continuous mode is used to investigate instruments and locate the source of ultrasonic signals, and is the most widely used detection method in partial discharge ultrasonic detection. The characteristics of the signal under test can be detected quickly, the display is intuitive, and the response speed is fast. This mode determines whether the device under test has partial discharge and the possible types of discharges by combining the sizes of different parameter values.

Pulse mode—Particles in devices such as GIS rise and jump under the action of an electric field. Particles produce sound when they move. Pulse pattern detection is used to measure the flight time of particles. The system measures the interval between the pulse signals, and according to the amplitude and time interval, it is represented by a point in the spectrum, and finally the pulse distribution statistics are performed.



- **Control Area**
  - Run/Stop — Sets the system acquisition status to run or stop.
  - Clean —Clears the waveform plot and maximum value drawn on the current page.
  - Enlarge/Reduce—Enlarge or Reduce the waveform plot drawn in the chart.
  - Display—Toggles how the live icon area is displayed.
  - Camera —Turn on the camera to take a live photo recording.
  - Measure—Set the system to switch between continuous acquisition and single acquisition.
  - Gain—Sets the gain level of the system sensor, -10dB, 14dB, 35dB.
  - Record—Saves the current trial data as background data.
  - Save—Saves data and pictures of the current test process.
- **US settings**
  - Warning Value—Sets the yellow Traffic Light threshold.
  - Alarm Value—Sets the red Traffic Light threshold.
  - Initial Range—Sets the initial range of the atlas display, which changes dynamically with the acquired data.
  - Noise Threshold—The amount of noise filtered during data processing.
  - Number of Cycles —Sets the number of cycles processed in a single shot in waveform mode.
  - Background Threshold—Sets the filtering threshold according to the actual situation on site.

- Synchronization mode—The synchronization mode of setting the system operation is divided into external synchronization, internal synchronization, and optical synchronization.
- Display Unit—Sets the display unit of data display to be divided into dBmV, dBuV, mV, and uV.
- Sound Monitoring—Sets whether to play ultrasonic audio.
- Ultrasound Type—Sets the sensor frequency, 40KHz and 80KHz.
- Flight Threshold— Sets the threshold for the displayed waveform signal amplitude.
- Open Time—The sampling time after the signal reaches the trigger amplitude. 100~1000us time adjustable.
- Shutdown Time—The closing time used to trigger sampling. 2~100ms time adjustable.
- Flight cycle — 5/10 cycles.

5.6 UHF measurement

There are 3 kinds of display diagrams for UHF test: waveform diagram, PRPD diagram, PRPS diagram. In the running state, click the [Display] button in the bottom control area to switch between different display graphs (default waveform graph display), and the three display graphs process the discharge data synchronously.

- **Title area**

  Displays the channel being measured, the measurement mode, the synchronization method, and the gain level. Click the icon  to set the relevant parameters of UHF test.

- **Data area**

  Displays the maximum, background, and current values during the current measurement.

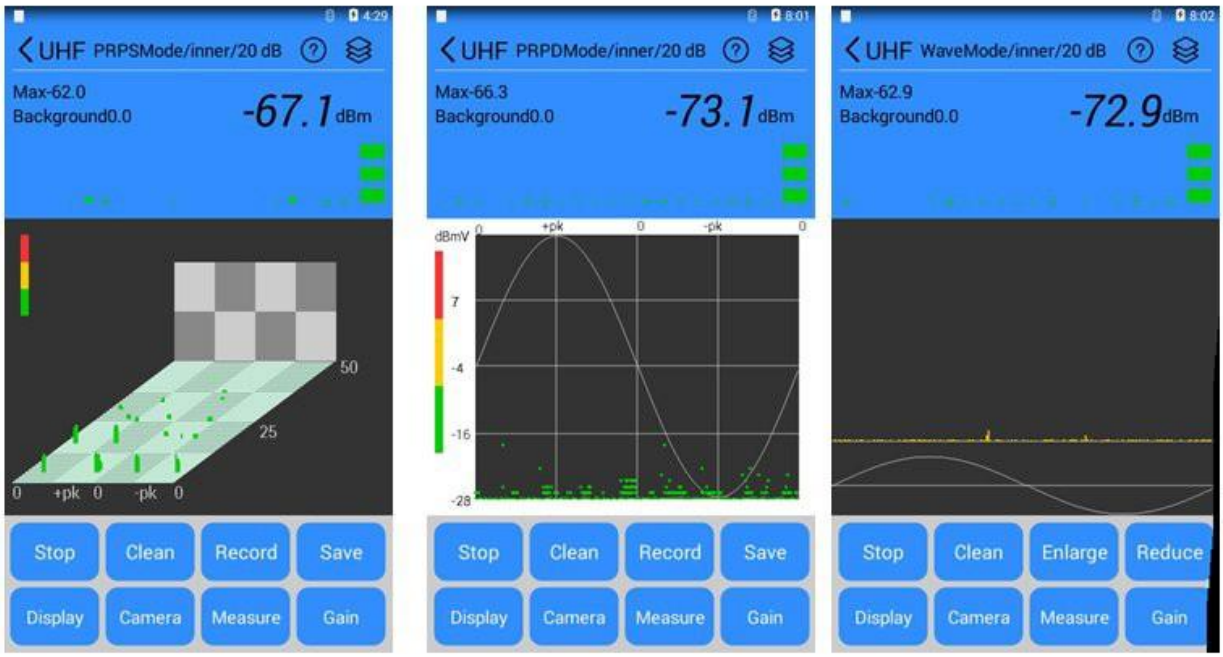
- **Historical extreme area**

  Displays the maximum value of the most recent 20 cycles during the current measurement

- **Chart area**
  - **Waveform Mode** —displays the current measurement data waveform, displays the corresponding number of cycles according to the number of cycles in [Settings], determines whether to discharge according to the discharge characteristics, and at the same time, the waveform can be enlarged or reduced by the [Zoom In/Zoom out] key.
  - **PRPD Mode** - two-dimensional spectrum, discharge phase distribution spectrum, showing the relationship between discharge level, phase and peak frequency, of which the vertical axis represents the discharge level, the horizontal axis represents the phase 0-360 degrees,

and different pixel colors represent different peak frequencies.

- **PRPS Mode** - three-dimensional spectrum, pulse sequence map, showing the relationship between time, phase and discharge level, the vertical axis represents the discharge level, the horizontal axis represents the phase, the Z axis represents time, the pulse different colors represent the size of the discharge level, and the right color logo represents the different colors used by different percentages of the vertical axis. This mode allows you to distinguish between interference and discharge, as well as changes in signals with different phases over time.



- **Control area**
  - Run/Stop — Sets the system acquisition status to run or stop.
  - Clean — Clears the waveform plot drawn on the current page, and the maximum value.
  - Enlarge/Reduce—Enlarge or reduce the waveform plot drawn in the chart.
  - Display—Toggles how the live icon area is displayed.
  - Camera —Turn on the camera to take a live photo recording.
  - Measure—Set the system to switch between continuous acquisition and single acquisition.
  - Gain—Sets the gain level of the system sensor, -11.5dB, 4dB, 20dB.
  - Record—Saves the current trial data as background data.
  - Save—Saves data and pictures of the current test process.
- **UHF settings**

- Warning Value—Sets the yellow Traffic Light threshold.
- Alarm Value—Sets the red Traffic Light threshold.
- Initial Range—Sets the initial range of the atlas display, which changes dynamically with the acquired data.
- Noise Threshold—The amount of noise filtered during data processing.
- Number of Cycles —Sets the number of cycles processed in a single shot in waveform mode.
- Background Threshold—Sets the filtering threshold according to the actual situation on site.
- Measurement Band—Set the measurement band, pass-through, low-pass, high-pass.
- Synchronization mode—The synchronization mode of setting the system operation is divided into external synchronization, internal synchronization, and optical synchronization.
- Display Unit—Sets the display unit of data display to be divided into dBmV and dBm.

5.7 HFCT measurements

There are three kinds of display diagrams for HFCT test: waveform diagram, PRPD diagram, and PRPS diagram. In the running state, click the [Display] button in the bottom control area to switch between different display graphs (default waveform graph display), and the three display graphs process the discharge data synchronously.

- **Title area**

  Displays the channel being measured, the measurement mode, the synchronization method, and the gain level. Click the icon  to set the relevant parameters of the HFCT test.

- **Data area**

  Displays the maximum, background, and current values during the current measurement.

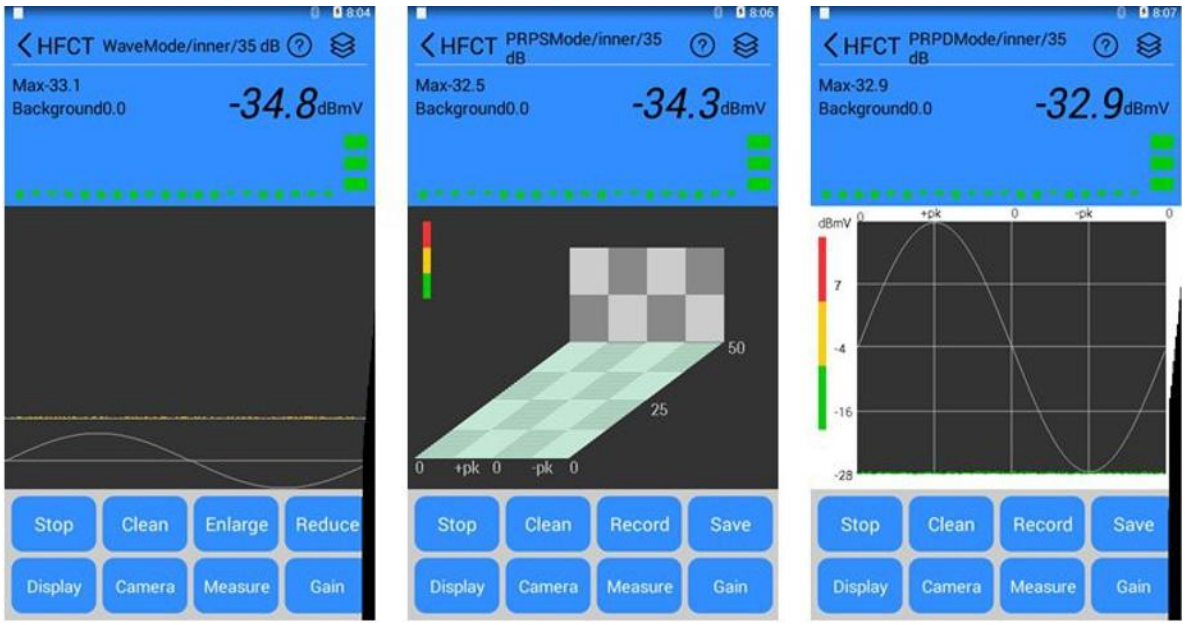
- **Historical extremum area**

  Displays the maximum value of the most recent 20 cycles during the current measurement

- **Chart area**
  - **Waveform Mode**— displays the current measurement data waveform, displays the corresponding number of cycles according to the number of cycles in [Settings], determines whether to discharge according to the discharge characteristics, and at the same time, the waveform value can be enlarged or reduced by the [Enlarge / Reduce] key.
  - **PRPD Mode** - two-dimensional spectrum, discharge phase distribution spectrum, showing

the relationship between discharge level, phase and peak frequency, of which the vertical axis represents the discharge level, the horizontal axis represents the phase 0-360 degrees, and different pixel colors represent different peak frequencies.

- **PRPS Mode** - three-dimensional spectrum, pulse sequence map, showing the relationship between time, phase and discharge level, the vertical axis represents the discharge level, the horizontal axis represents the phase, the Z axis represents time, the pulse different colors represent the size of the discharge level, and the right color logo represents the different colors used by different percentages of the vertical axis. This mode allows you to distinguish between interference and discharge, as well as changes in signals with different phases over time.



- **Control area**

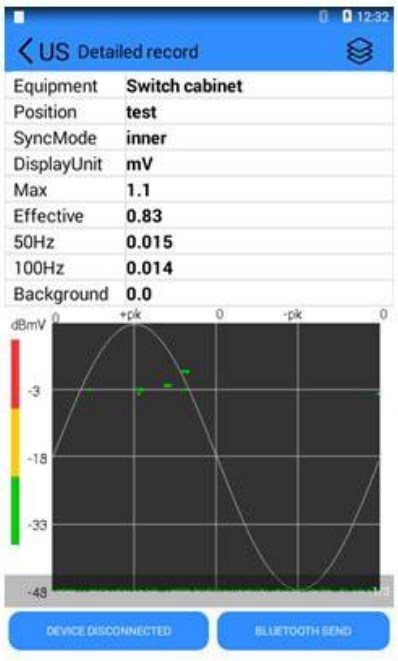
- Run/Stop — Sets the system acquisition status to run or stop.
- Clean — Clears the waveform plot drawn on the current page, and the maximum value.
- Enlarge/Reduce—Enlarge or reduce the waveform plot drawn in the chart.
- Display—Toggles how the live icon area is displayed.
- Camera—Turn on the camera to take a live photo recording.
- Measure—Set the system to switch between continuous acquisition and single acquisition.
- Gain—Sets the gain level of the system sensor, -35dB, -10dB, 14dB, 35dB.
- Record—Saves the current trial data as background data.
- Save—Saves data and pictures of the current test process.

- **HFCT settings**

- Warning Value—Sets the yellow Traffic Light threshold.
- Alarm Value—Sets the red Traffic Light threshold.
- Initial Range—Sets the initial range of the atlas display, which changes dynamically with the acquired data.
- Noise Threshold—The amount of noise filtered during data processing.
- Number of Cycles —Sets the number of cycles processed in a single shot in waveform mode.
- Background Threshold—Sets the filtering threshold according to the actual situation on site.
- Synchronization mode—The synchronization mode of setting the system operation is divided into external synchronization, internal synchronization, and optical synchronization.
- Display Unit—Sets the display unit of data display to be divided into dBmV, dBm, and mV.

5.8 History viewing

Click the [History] button to enter the save data interface, record all the maps containing each piece of data, as well as the record type, synchronization method, device name, task number, time, unit put value, background and background threshold all details. The action button allows you to perform a series of actions on the history.



5.9 Use of external synchronization

In the field test, in order to get a stable and accurate phase, you can use the external synchronization trigger method, in the system settings, the trigger method is changed to external synchronization, the wireless synchronization transmitter is connected to the test power supply, click to run, at this time the discharge phase is a stable and accurate phase.

Note: When wireless synchronous connection test power supply, it should be wired strictly according to the LNE indication.

5.10 The use of sensors

- **TEV sensor**

TEV sensors can sense the transient voltage on the metal cabinet of the switchgear to form a certain high-frequency induced current. Attach the TEV sensor to the metal cabinet when use.

TEV sensor

- **Non-contact ultrasonic sensors**

Non-contact ultrasonic sensors detect ultrasonic waves that propagate through the air during a partial discharge. It is required that there must be a good air path between the discharge power supply and the sensor, and the switchgear with good sealing and no air holes and air gaps will not be detected. When used, the sensor is attached to the switch cabinet to prevent ultrasonic movement from generating a disturbing signal, and the ultrasonic probe is aimed at the gap of the device for detection.

Non-contact ultrasonic sensors

- **Contact ultrasound sensors**

When the contact ultrasound sensor is used, a couplant is applied to the ultrasonic sensor, the sensor is placed in the sensor holder, and the measured position is fixed with a bandage on the GIS.

Contact ultrasound sensors

- **High Frequency Current Transformer (HFCT).**

High-frequency current transformer (HFCT) is a front-end coupling device for discharge measurement, and the principle of primary cable threading is: according to the arrow identification on the HFCT, it is penetrated from the front (with a signage surface) of the high-frequency current transformer, and the back side is pierced out of the ground. The HFCT signal conditioning unit is connected via BNC.

High frequency current transformer（HFCT）

- **UHF sensors（UHF）**

UHF sensors can sense UHF radio signals and use them by strapping (or manually) fixing the UHF sensor to a basin insulator.The UHF signal conditioning unit is connected via BNC.

UHF sensors UHF-IV

5.11 Instrument charging

Measuring host: Use the DC12V power adapter, before use, the device should be charged. The time required for a full charge is about 4 hours. Once the battery is full, the indicator light goes off. When the charger is plugged in, it is not recommended to measure with the instrument.

Signal conditioning unit: Using the DC12V power adapter, there is a corresponding power indicator on the panel when charging.

Note: When charging the built-in battery of this instrument, you must use the special power adapter equipped with this instrument to charge, and you must not use other power sources, otherwise it may cause damage to the battery or the instrument!

6. Detection process

6.1 TEV partial discharge detection process

1) Device connection: Connect the various components of the tester and fix the sensor.
2) Power-on detection: After power-on, the system self-tests to confirm that each detection channel is working properly.
3) Set parameters: click [System Settings], through the settings storage directory function to create

a new file name to save the test data, all the measurement data in the later stage are stored in this file; then return to the [TEV] module to enter the measurement interface, click the icon in the upper right corner to set the TEV measurement process in detail.

4) Background detection: Connect the TEV sensor, attach the sensor to the grounded metal body (not the measurement source), press the [Stop] button when the signal is stable, and then click [Record Background] to record the background value.
5) Signal Detection: Press the sensor close to the detection site. The main parts of the switchgear where discharge occurs are the busbar (connection, wall bushing, support insulation, etc.), circuit breaker, CT, PT, cable and other equipment corresponding to the position of the cabinet wall of the switchgear, most of these devices are located in the middle and lower part of the front panel of the switchgear, the upper, middle and lower part of the rear panel, the upper, middle and lower part of the side panel (switch cabinet TEV The detection site is shown in Figure 6-1).
6) Abnormal diagnosis: When a signal is detected through the waveform mode, the partial discharge should be diagnosed and analyzed, and the periodicity of the signal should be observed to record and analyze the signal by changing the measurement mode.
7) Data recording: the data is saved through the recording function of the instrument: the [Inspection Record] module in the home page can view the corresponding test data for later analysis.
8) Generate report: Connect the Type-c data cable, run the random report generation software, click the export data function, you can export all the data in the test process to the PC, and generate an inspection report according to the database and graphic information.

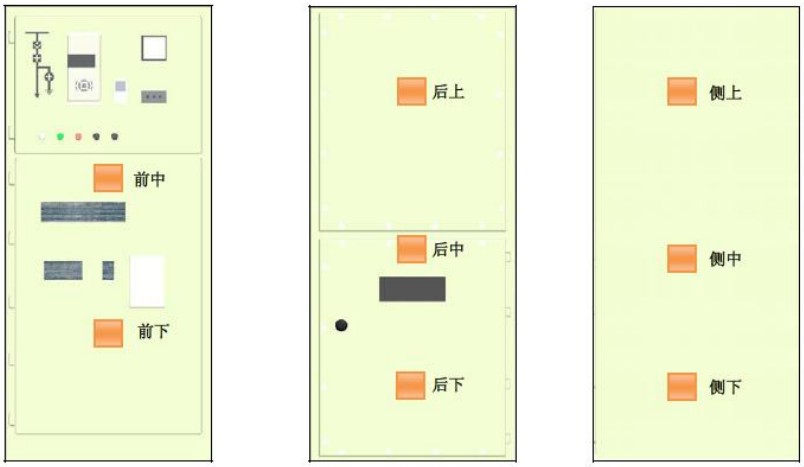


Figure 6-1- Schematic diagram of the TEV detection site

6.2 US partial discharge detection process

1) Device connection: Connect the various components of the tester and fix the sensor.
2) Power-on detection: After power-on, the system self-tests to confirm that each detection channel is working properly.
3) Set parameters: Click [System Settings] to create a new file name for saving test data by setting the [Storage Directory] function, and all the measurement data in the later stage is stored in this file; by setting the [Ultrasound Type] function, you can configure the processing of data during the test. Then return to the [US] module to enter the measurement interface, click the icon in the upper right corner to set the parameters of the US measurement process in detail.
4) Background detection: Point the sensor at an open place, press the Stop button when the signal remains stable, and then click Record Background to record the background value.
5) Signal detection: The ultrasonic sensor probe is scanned along the gap in the cabinet to observe the waveform change.
6) Abnormal diagnosis and analysis: When a periodic signal is detected, analyze, observe the size of the 50Hz frequency component and 100Hz frequency component in continuous detection mode, and compare it with the background signal to see if there is a significant change. And carry out partial discharge diagnosis and analysis, including by applying phase detection mode, time domain waveform detection mode to determine the type of discharge, or move the sensor position, look for the maximum value of the signal, and identify the possible discharge location.

Table 61- US Test Defect Criteria

parameter		**Partial discharge defects**	**Corona defects**	**normal（No discharge）**
Continuous detection mode	Valid values	high	Higher	low
	Cycle peak	high	Higher	low
	50Hz Frequency correlation	Yes	Yes	No
	100Hz Frequency correlation	Yes	weak	No
Phase detection mode		Regular, two-cluster signal in a circumferential wave and an equal amplitude	Regular, a cluster of large signals in a circle of waves, and a cluster of small signals	Irregular
Waveform detection mode		Regular, there are periodic pulse signals	Regular, there are periodic pulse signals	Irregular

7) Data recording: Connect the Type-c data cable, run the random report generation software,

click the export data function, you can export all the data in the test process to the PC, and generate an inspection report according to the database and graphic information.

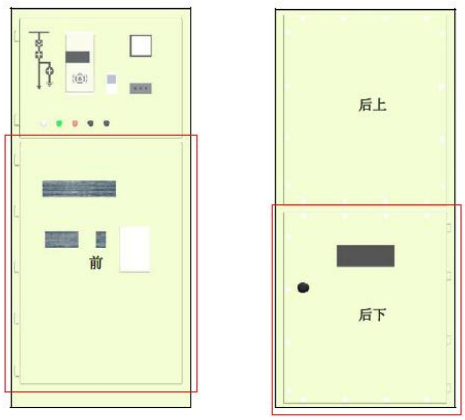


Figure 6-2 Schematic diagram of the US detection location

6.3 Combined US and TEV detection.

In order to more effectively detect the partial discharge of high-voltage switchgear and power frequency test transformers and their discharge types, the ultrasonic (US) measurement method should be used in combination with the transient ground voltage (TEV) measurement method. After a long period of laboratory physical simulation of the discharge phenomenon of the switchgear, its respective characteristics were found (see the table below).

Table 6- 2 Differences of US and TEV testing

Discharge model	TEV	US
Discharge model along the surface	Insensitive	Sensitive and effective.
Insulator surface discharge model	Insensitive	Sensitive and effective
Tip discharge model	Sensitive and effective	More Sensitive and effective
Corona discharge model	Sensitive and effective	Sensitive and effective
Insulator internal defect model	Sensitive and effective	Insensitive

6.4 HFCT partial discharge detection process

1) Device connection: Connect the various components of the tester and fix the sensor.
2) Power-on detection: After power-on, the system self-tests to confirm that each detection channel is working properly.
3) Set parameters: click [System Settings], through the settings [Storage Directory] function to create a new file name to save the test data, all the measurement data in the later stage are stored

in this file; then return to the [HFCT] module to enter the measurement interface, click the icon in the upper right corner to HFCT Detailed parameter settings are carried out during the measurement process.

4) Connect the device: After entering the [HFCT] module, a dialog box will pop up to select the connected device, and the machine has three connection methods:< automatically scan >, < manually enter >, < use the last matched device >, each of which can be connected directly Test equipment.
5) Background detection: Connect the HFCT sensor, press the [Stop] button when the signal remains stable, and then click [Record Background] to record the background value.
6) Access sensor: The HFCT sensor is stuck on the ground wire of the device, and according to the arrow identification on the HFCT, it is penetrated from the front (with a signage surface) of the high-frequency current transformer, and the ground is threaded out on the back.
7) Signal detection: Observe whether the measured waveform is periodic and compare it with the background signal to see if there is a significant change.
8) Abnormal diagnosis: When an abnormal signal is detected through the waveform mode, the partial discharge should be diagnosed and analyzed, and the signal should be recorded and analyzed by changing the measurement mode.
9) Data recording: the data is saved through the recording function of the instrument: the [Inspection Record] module in the home page can view the corresponding test data for later analysis.
10) Generate report: Connect the Type-c data cable, run the random report generation software, click the export data function, you can export all the data in the test process to the PC, and generate an inspection report according to the database and graphic information.

6.5 UHF detection process

1) Device connection: Connect the various components of the tester according to the equipment wiring, and fix the sensor.
2) Power-on detection: After power-on, the system self-tests to confirm that each detection channel is working properly.
3) Set parameters: click [System Settings], through the settings [Storage Directory] function to create a new file name to save the test data, all the measurement data in the later stage are stored in this file; then return to the [UHF] module to enter the measurement interface, click the icon in the upper right corner to get UHF Detailed parameter settings are carried out during the

measurement process.

4) Connect the device: After entering the [UHF] module, a dialog box will pop up to select the connected device, and the machine has three connection methods:
   a) < automatically scan >, < manually enter >, < use the last matched device >, each of which can be connected directly Test equipment.
5) Background detection: Attach the UHF sensor to the grounded metal body (not the measurement source). When the signal is stable, press the Stop button, and then click Record Background to record the background value. You can set a background threshold based on the background value to account for noise interference, etc.
6) Signal detection: Observe the detected signal, if the signal is found to be no abnormality, save a small amount of data, exit and change the detection position to continue to the next point of detection; if the signal is found to be abnormal, extend the detection time and record multiple sets of data to enter the abnormal diagnosis process.
7) Abnormal diagnosis: When a signal is detected through the waveform mode, the partial discharge should be diagnosed and analyzed, and the periodicity of the signal should be observed to record and analyze the signal by changing the measurement mode.
8) Data recording: the data is saved through the recording function of the instrument: the [Inspection Record] module in the home page can view the corresponding test data for later analysis.
9) Generate report: Connect the Type-c data cable, run the random report generation software, click the export data function, you can export all the data in the test process to the PC, and generate an inspection report according to the database and graphic information.

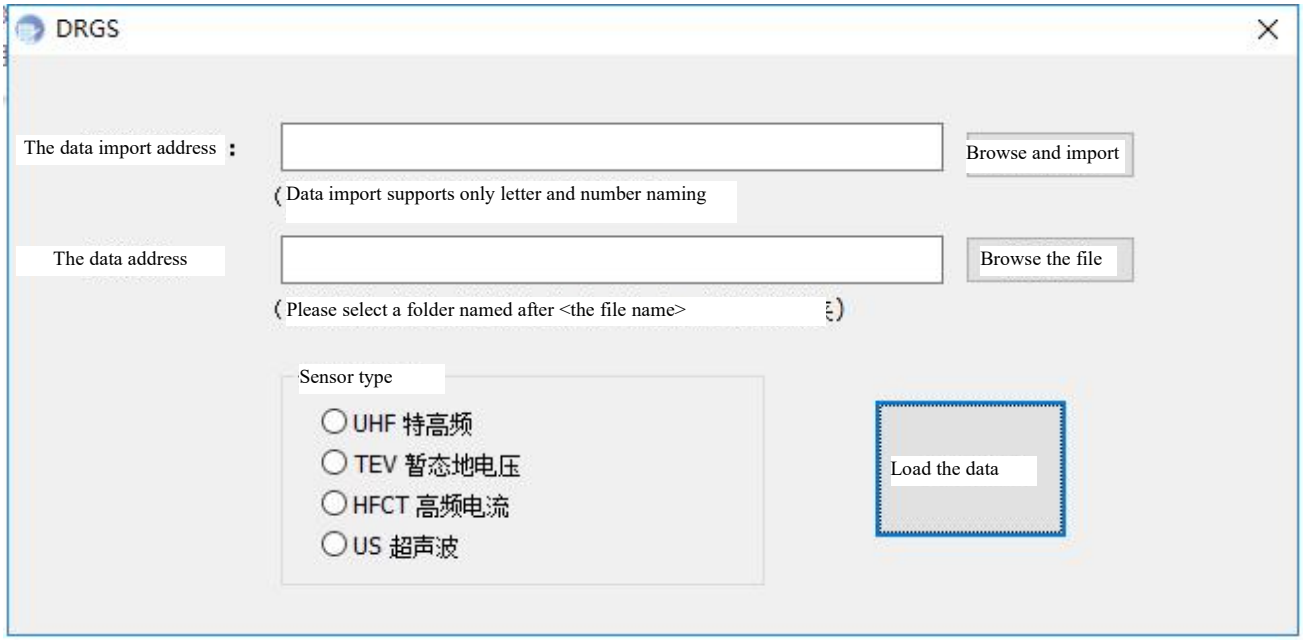
Table 6-3 Partial discharge mapping analysis and diagnosis of typical defects

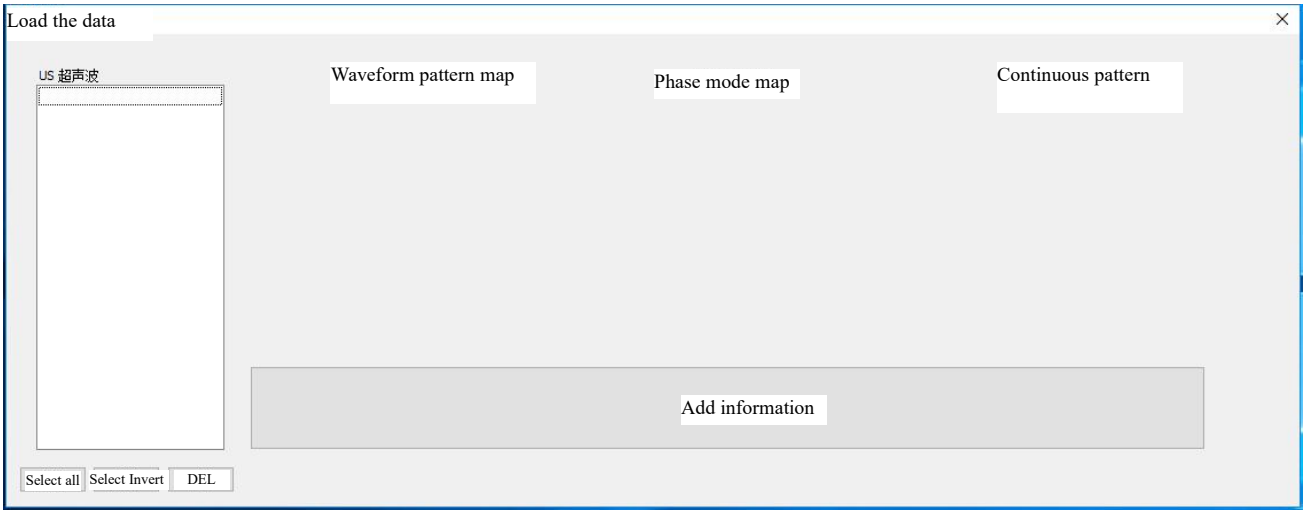
Discharge type	Regularity
Corona discharge	The polarity effect of the discharge signal is very obvious, usually in the negative or positive half axis of the power frequency phase, the discharge signal strength is weak and the phase distribution is wide, and the number of discharges is large. However, a discharge signal may also occur in the other half-axis at higher voltage levels, with higher amplitudes, narrower phase distributions, and fewer discharges.
Suspension discharge	The discharge signal usually appears in the positive and negative semi-axes of the power frequency phase, and has a certain symmetry, the discharge signal is large and the time interval of adjacent discharge signals is basically the same, the number of discharges is small, and the discharge repetition rate is low. The PRPS atlas has the distribution characteristics of "inner eight characters" or "outer eight characters".

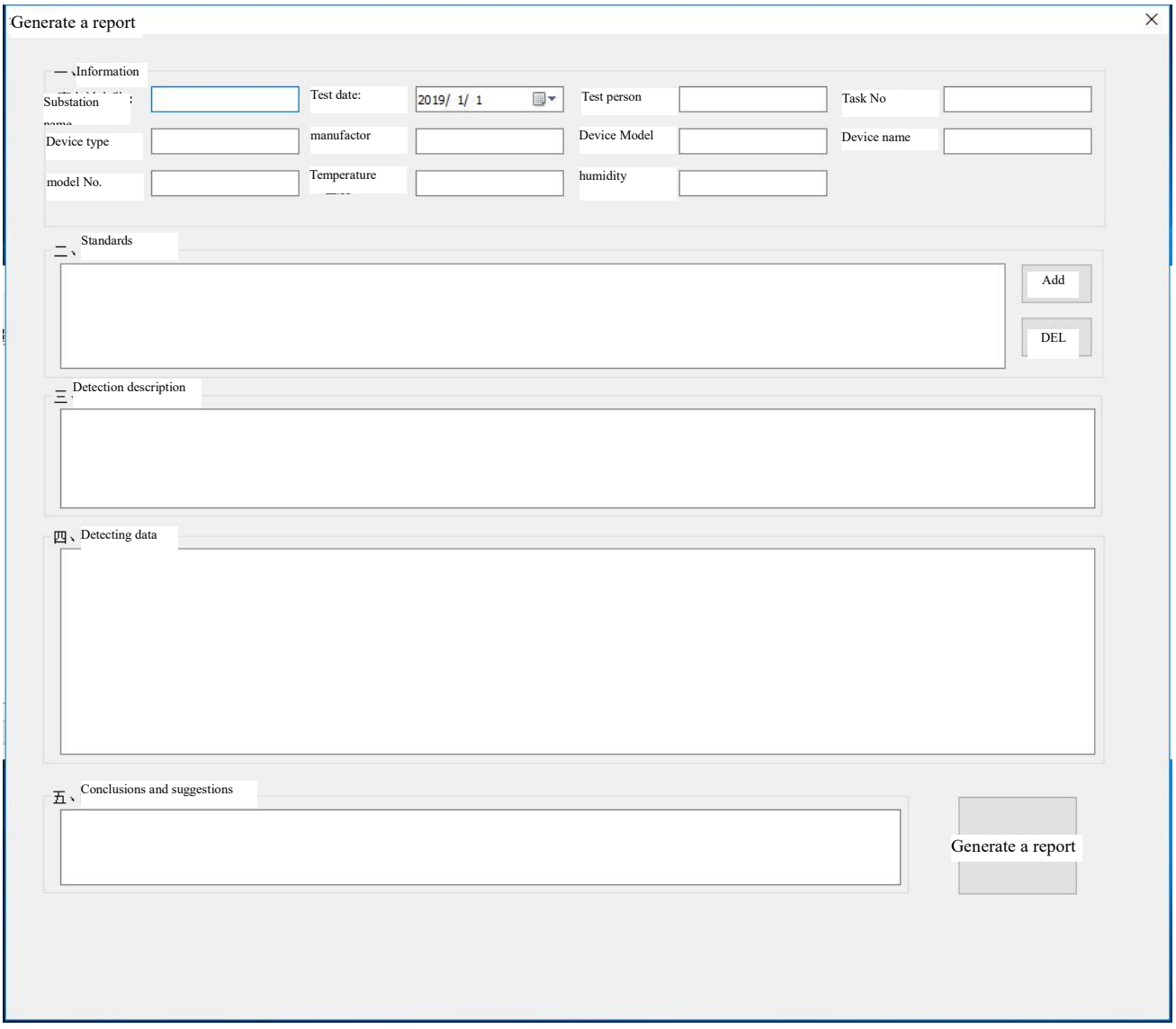
Particle discharge	The polarity effect of the discharge signal is not obvious, there is a distribution in any phase, the number of discharges is small, the amplitude of the discharge signal is not obvious, and the time interval of the discharge signal is unstable. The amplitude of the discharge signal increases but the discharge interval decreases by increasing the voltage level.
Hole discharge	The discharge signal usually appears in both positive and negative half-weeks of the power frequency phase, and has a certain symmetry, and the amplitude of the discharge signal is more dispersed and the number of discharges is less.

6.6 Generate a report process

Open the report generation software and connect your device to your computer. Click the Browse and Import button to export the data and pictures from the experiment process to this unit. Then click the Browse For Files button to select the directory where to export the files. After selecting the sensor type,Click the Load Data button. Import the experiment data into the software. Fill in the necessary information according to your needs and generate a report.




Load the data
US 超声波
Waveform pattern map
Phase mode map
Continuous pattern
Add information
Select all
Select Invert
DEL


Generate a report
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Substation
Test date:
2019/ 1/ 1
Test person
Task No
Device type
manufactor
Device Model
Device name
model No.
Temperature
humidity
二、Standards
Add
DEL
三、Detection description
四、Detecting data
五、Conclusions and suggestions
Generate a report