PMDT-PDetector
Partial Discharge Detector

Product Manual

V 5.0.6.9

Power Monitoring and Diagnostic Technology Ltd.

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CONTENTS

1. Product Description

The PDetector is designed to detect the Partial Discharge phenomenon occurring in high voltage electrical equipment (such as GIS, transformers, power cables, and switchgear). If we fail to find a Partial Discharge signal during a test, it does not necessarily mean there are no Partial Discharge phenomena going on within or around the high voltage electrical equipment. Partial Discharge usually has some sort of latency and can be intermittent, and the failure of the insulation performance is not only caused by the Partial Discharge. If a Partial Discharge phenomenon is found in high voltage electrical equipment, the data should be collected and presented in an appropriate format to responsible personnel who can take the needed preventative actions.

Warning (Safety Instructions)

Before using the PDetector and its accessories, the user must read and understand the Product Manual and must pay close attention to the following safety information This is absolutely necessary before proper handling of the device can occur.

- Follow through the safety regulations of the local power companies.
- The instrument and its accessories are limited to testing low potential parts and thus strictly prohibited from making physical contact with any part of the high potential components.
- When carrying out a test, please make sure the targeted electrical equipment is grounded.
- Testing is prohibited, whether it is indoors or outdoors, when a lightning storm is occurring near the substation.
- Do not continue to operate the instrument when damaged.
- During testing, please use the correct connection cable, adaptor and/or connector.
- All cables should be kept in a nice and neat condition during the test to prevent them from linking to the operating mechanism or creating stumbling hazard.

- The instrument should be tested before use to ensure that its functioning normally and can effectively save the collected test data.
- When not testing, the unit must be turned off.
- Never physically, electrically, or mechanically damage the instrument during the testing process, such as heating, increasing voltage, shaking, or tapping the unit.
- Do not use the instrument and its accessories in an environment that is in close proximity with explosive or volatile chemicals.
- Only use the appropriate charger for this instrument
- If the device fails and needs to be repaired, please return it to the manufacturer, PMDT, or an authorized local agent for repair.

2. Partial Discharge

2.1. Partial Discharge

Partial Discharge is an electrical discharge that does not completely bridge the electrodes. The cumulative effect that the discharge causes will gradually deteriorate the insulation's dielectric properties and expand any defects, thus causing it to eventfully lead to insulation breakdown and/or failure. In addition, most mechanical damage also can cause Partial Discharge. Partial Discharge will produce serious harm to electrical equipment insulation, mainly by damaging the insulating material through heat that is being produced by the discharge, the impact of charged particles, verdigris as well as other chemical reactions, rays, etc. This damage to the insulation develops slowly from inception to the resulting conclusion and is affected by many factors. It is a hazard for the high voltage electrical equipment in operation. Partial Discharge mainly includes the following types:

- **Corona**

Corona is a discharge that usually occurs around the high voltage conductor at a high electrical stress area; for example, occurring at sharp edges or points of high voltage transmission lines or high voltage transformers. This high voltage stress to the electrical field produces ionized air around the area allowing corona activity to occur. As high voltage cable terminals of the high voltage electrical equipment are exposed to air, the probability of the corona discharge occurring is relatively high. Corona reflects the characteristics of typical and very uneven electric field and is a very unique self-sustaining discharge form of uneven electric fields. Many external factors will affect the corona inception voltage, such as the shape of the electrodes, applied voltage, gas density, distance between the poles, and the humidity and flow speed of the air.

- **Surface Tracking**

Surface tracking is a discharge that usually appears on the surface of the insulating dielectric and is a special gas discharge. It commonly exists at either or both ends of power cables and insulation bushings. Once the electric field strength of the interior of the insulating medium is lower than the field at the edge of the electrode gap and the breakdown voltage along the surface of the medium is relatively low, then surface tracking will occur at the dielectric surface. Typically, the voltage waveform, electric field distribution, air quality, surface state of the insulating medium, and the environmental conditions will affect the surface tracking activity, causing the magnitude to sometimes completely disappear, typically due to dry warm climates. This type of PD can be intermittent in activity and magnitude but it will always progressively get worse as time goes on.

- **Void**

Void is a discharge that commonly exists inside the solid dielectric insulation. There are defects and problems in material and workmanship at the time of production and processing of insulation medium as well as field installation workmanship (such as terminations, booting or bus transitions completed in the field), leading to void defects inside the insulation medium, such as doped with a small amount of air or impurities in the insulation creating air pockets and particles like dust or dirt, metal shavings, grease etc. (improper stress relief on cable terminations or contaminants under the heat shrink or cold shrink materials). Once insulation is affected by high voltage stress, a partial breakdown or repetitive breakdown of the internal defects can start to occur. Typically, the medium's characteristics, the size of the void, the position and shape of the defect, and types of gas of in the void will affect the occurrence conditions characteristics of the void discharge.

- **Floating Electrode**

Floating electrode is a discharge that typically occurs when there are structural design flaws that exist in the current carrying components of high voltage equipment and/or other reasons that can lead to bad connections, creating heat and deterioration of the conductor that could eventually lead to failure. This component discharges to the ground electrode or an electrode at a lower potential than the component itself, typically another component within the electrical field, but at a lower potential; this is called floating electrode discharge. If floating electrode discharge is occurring on the conductor, usually the field strength near the event will be more concentrated; and thus, causing damage to the surrounding insulation medium. Commonly, the floating electrode discharge tends to occur between a metal high potential electrode and a metal ground potential electrode or a metal lower potential electrode. This activity can occur within any part of the electrical equipment that these characteristics are found.

2.2. Form of Energy in Partial Discharge

Partial Discharge is a pulse discharge or "spark". The process of Partial Discharge is accompanied by the charge transfer and loss of power. In addition to these effects, it also can produce forms of energy like electromagnetic radiation, ultrasound, light, heat, and the emergence of a new product in the form of white powder residue, carbon tracking, Nitric Oxide Gas and Ozone, and Verdigris affect (green discoloration and corrosion/degradation of various components around the discharge location caused by the Nitric Oxide gas mixing with moisture creating Nitric Acid). Therefore, for these phenomena, the basic methods of Partial Discharge testing include electrical measurements (TEV, UHF, and HFCT), acoustic measurements, visual inspection, and chemical detection methods. Among these, electrical and acoustic measurement methods are more widely used.

Detailed List of Partial Discharge Emissions:

- **Electric** (TEV, UHF, HFCT sensors)
- **Light** (in certain conditions, discharge sparking can be seen through the observation window or vent)
- **Heat** (infrared, due to the fully enclosed structure of switchgear, the testing is limited to line of sight many components cannot be accessed to view online)
- **Acoustic** (ultrasonic sensor)
- **Gases** (smell of ozone and Nitrous Oxide)

For these tests though, practical application is often not ideal. This is due mainly because onsite, the magnitude of the electronic noise is greater than the magnitude of the PD signal; there for making it difficult to distinguish the true Partial Discharge signal. Eliminating the noise effectively is the best way to improve the results of the Partial Discharge detection device.

2.3. Partial Discharge Detection Technology

2.3.1. TEV (Transient Earth Voltage) Testing Method

When a Partial Discharge phenomenon occurs in switchgear, charged particles will quickly migrate to the ground non-charged body from the charged body, such as the equipment cabinet and generate a high-frequency electric current carrying wave on a non-charged body, and spreads as rapidly as the speed of light in all directions. Affected by skin effect, the current traveling waves tend to focus only on the inner surface of the metal cabinet, while not penetrating into the metal cabinet directly. However, when the current carrying waves encounter a discontinuous metal to disconnect or insulated connections, it will be transferred from the inner surface to the outer surface of the metal cabinet and spread to the free space as the form of electromagnetic waves, and then generate Transient Earth Voltage in the outer surface of metal cabinet. TEV's range is usually between a few millivolts and a few volts, but within a few nanoseconds rise time. The probe can be provided on the outer surface of the working switchgear for detecting the Partial Discharge activity.

The TEV sensor is a metal plate covering with PVC material in the front. The first role of PVC material is to act as an insulating material, and the second is to protect and support the sensor. When measuring PD with the TEV sensor, place the sensor squarely on the metal surface (grounded cover panels) of the switchgear cabinet completing the capacitive coupling creating a 90° angle between the testing device and the equipment being tested. The metal cabinet can be regarded as one part of a flat plate capacitor. The TEV sensor can be regarded as second part of a flat plate capacitor, with the space filled as the PVC material creates the space between the two plates of a capacitive coupling.

The capacitive coupling to the surface of the metal cabinet will induce the same amount of charge on the metal plate of the TEV sensor as is traveling across the ground plane, and induces an electrical signal or TEV signal that was created by the PD Activity. That induced signal is transmitted by the capacitive coupling to the device and converts that TEV signal to a high-frequency signal which is the direct ratio to the discharge intensity or magnitude by detection impedance. After sampling the equipment under test, you can get characteristic parameters of the discharge intensity and repetition rate of Partial Discharge in the switchgear equipment. Because its detection principles utilize capacitive coupling, TEV sensors must make a completely flush coupling to effectively measure TEV signals produced by PD.

2.3.2. AE Ultrasonic Testing Method

An ultrasonic signal is an oscillating wave of sound pressure that is within a frequency greater than the upper limit of the human ear, thus it's not something you can pick up without the device by listening except in some severe cases. From the perspective of energy, Partial Discharge is a process that consists of an instantaneous release of energy. Electrical energy is produced in the form of sound, light, heat, and electromagnetic energy. It can complete discharges instantly when an electrical breakdown occurs in an air gap. Meanwhile, electrical energy converts into heat instantly and the gas in the center of the discharge begins to expand from the resulting heat and propagates outward in the form of sound waves.

An isothermal zone, with a higher temperature than the environment, is formed within the propagation area after being heated. The gases begin to shrink after cooling down and subsequent waves are produced. The frequency and intensity of the subsequent waves are lower and include various frequency components. They have a very wide frequency bandwidth and the ultrasonic frequency is greater than 20 kHz. As the area of Partial Discharge is relatively small, the location of the sound being produced by the Partial Discharge is the point source.

There are two distinct AE Ultrasonic sensors: AE Ultrasonic Contact Sensor and an Internal AE Ultrasonic sensor. AE Ultrasonic Contact Sensors are mounted to the outside of power equipment to detect the induced vibration phenomena of the ultrasonic signals spreading through the surface of the equipment being tested. It is mainly used for PD detection of sealed electrical equipment such as GIS, Power Transformer, and Power Cables. However, it can be easily influenced by the ambient noise or mechanical vibration of the equipment. Internal AE Ultrasonic sensors are utilized to detect the vibration phenomena of the ultrasonic signals spreading in the air. It is mainly used for PD detection of electrical equipment which allows for the passage of air to escape from the housing of the electrical equipment, such as switchgear and outdoor electrical equipment. It can convert the ultrasonic signals into audible sound though heterodyne techniques. It is better to determine the existence of the PD as well as the location through listening to the characteristic sound and is not influenced by the disturbance signals.

Since the ultrasonic signal attenuates greatly in the common-used insulation materials of the electrical equipment, the detection range of AE ultrasonic testing is limited; however, it has the advantage of pinpointing the positioning with greater accuracy than with any other means.

2.3.3. UHF Testing Method

The insulating dielectric of electrical equipment has very high structural integrity. The rising edge of the discharge signal has a very short rise time, generally less than 1ns. The frequency bandwidth of a typical Partial Discharge signal spectrum's frequency is from a few Hz to hundreds of MHz or even higher than 1GHz. Pulse waves of a discharge propagates not only in the form of transverse electromagnetic waves (TEM waves), but also in the form of the transverse electric wave (TE wave) and transverse magnetic wave (TM wave). The UHF signal produced with Partial Discharge can effectively propagate along the waveguide.

UHF detection method is utilized to detect the UHF electromagnetic wave signals (300MHz-1.5GHz) produced by the PD in the electrical equipment. External/Internal UHF sensors are utilized according to the different conditions of the electrical equipment under test. Since the bandwidth of the on-site disturbance signals are mainly below 300MHz, the UHF detection method is effective for avoiding the disturbance signals. It has high sensitivity and can help to determine the PD defect type as well as assist in locating the source.

2.3.4. HFCT Testing Method

High frequency current spreads to the ground along the ground strap when PD occurs within the electrical equipment. HFCT detection method picks up the high frequency current signals though mounting HFCT sensors on the ground straps. HFCT sensors are usually made of Rogowski coils, which have multiple conductive coils around the ring's magnetic core material. High frequency alternating electromagnetic field is caused through the method previously described and an induced voltage occurs when the high frequency current goes through the center of the magnetic core. Since there is no direct electrical connection between the measuring circuit of the HFCT sensors and the target power cables, it is a non-intrusive method to detect Partial Discharge; therefore, it is not necessary to interrupt the targeted electrical equipment.

2.3.5. Multi-Methods PD Detection Technology

Actually, no matter what kind of method used, there are some limitations while testing for Partial Discharge. Operational state of high voltage equipment cannot be reflected objectively, comprehensively and truly, and there may be a possibility of reaching a false conclusion. Due to the different types of energy discharges released, practicality and sensitivity of various detection methods are also different, so in the process of Partial Discharge detection, it is necessary to synthesize the above detection means.

3. Functions and Features

Main features of PDetector are as following:

1) Built-in TEV sensors, using TEV testing method to detect abnormal internal activities of high-voltage equipment, including:

- **Amplitude detection mode:** display the dB value of Partial Discharge, with green, yellow, and red to indicate the severity of the discharge (thresholds can be set)
- **Pulse detection mode**: display dB value, the number of pulses, and the severity of Partial Discharges.

2) AE detection method displays the RMS, PEAK, frequency content, and period, pulse, and waveform spectrums of the ultrasonic signal.

3) UHF detection methods have three modes of operation to display PD data; Amplitude and Periodic Spectrum; UHF PRPD and PRPS Spectrums Detection.

4) UHF Amplitude Detection mode can display the magnitude of UHF signals. And different colors can indicate the severity of PD.

5) Under UHF Periodic Spectrum Detection mode, during one period of Power frequency, PD Periodic Spectrum can be displayed which help to determine PD type and severity of PD.

6) Under UHF PRPD and PRPS Spectrums Detection mode, PRPD2D and PRPS3D Spectrums are displayed. PRPD and PRPS are the classical spectrums to determine PD type and evaluate the severity of PD in the insulation system.

7) Accumulating function, under the PRPD/PRPS test mode, users can enable the accumulating function, then the PRPD spectrum can do the pulse signals accumulation which is better for analysis of the PD type.

8) HFCT detection methods have three modes of operation to display PD data. HFCT Amplitude Detection mode can display magnitude of PD signal. HFCT Periodic Spectrum Detection mode shows periodic spectrum of PD in one cycle of power frequency.

9) Screen Recording function. Under PRPD/PRPS Screen Recording mode, users can record up to 5 minutes of video of PRPD/PRPS spectrum, the recording will help to see the dynamic PD signals and do a better analysis.

10) With the data storage function, Partial Discharge test data, which including ultrasonic testing data, UHF and HFCT detection patterns, background noise, environmental information, etc., can be instantly stored in the PDetector. Corresponding equipment information provided for Partial Discharge testing data should be documented and correlated with the test results saved.

11) Data saved is convenient to be able to reference later.

12) Light sync function helps the PD spectrum to synchronize with the field power frequency as a reference.

13) Power source sync function uses the field power to synchronize the PD spectrum wirelessly.
14) Small size, light weight, easy to carry and use, and rapid on-site detection of Partial Discharge phenomenon of high voltage electrical equipment.

15) Intelligent Patrol function: PDetector has the function of creating test jobs and test task from the PDetector software, download to the device, conduct the testing job, and then upload the data back to the software. This ensures your data will be organized and helps carry out the testing job efficiently.

4. Instrument Operation

4.1. General Introduction

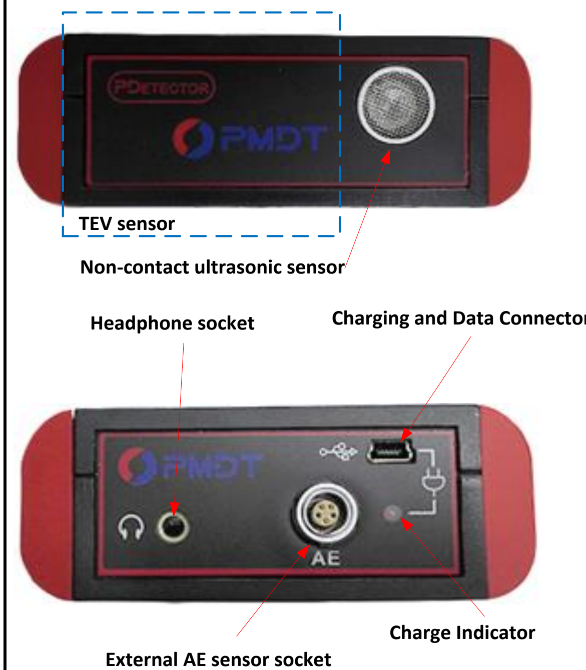
The PDetector has several accessories that work in conjunction with the main unit. This main unit and accessories are described in more detail in the following section and table.

Figure 4.1. PDetector Main Unit and Accessories

<table>
<tr><th>Name</th><th>Function</th></tr>
<tr><td>


</td><td>

Main Unit



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<tr><td>


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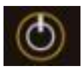
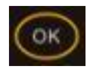
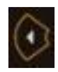
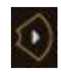
UHF sensor for detecting electromagnetic wave signals due to Partial Discharge, the picture shows the wireless UHF signal processor acquisition transmitter, connected with the UHF sensor by a cable, which transmits data to the host.

</td></tr>
</table>

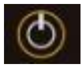
	Ultrasonic contact sensors for detecting the surface vibration produced when an ultrasonic signal is generated by Partial Discharge spreads through the surface of the equipment being tested.
	HFCT sensor detects pulse current signals generated by Partial Discharge; the sensor is of clamp structure, easy in application and removal. The following is the wireless HFCT signal processor acquisition transmitter connected to the HFCT sensor by a cable, sending data to the host. 
	**Power synchronization device** After the device is inserted into the power outlet, the main unit can synchronize the frequency signal with the device wirelessly.

	**Self-checker** The device can be used to troubleshoot the equipment. Determines whether TEV and ultrasound testing application is functioning normally with a simple pass/fail result.
	**Headphones** Used under the AE Ultrasonic detection mode, allows user the ability to hear the ultrasonic signal the PDetector is picking up through headphones when in operation.
	**Data Cable** • Can be connected to the charger, and charge the device • Can be connected to the computer and allow the user to move the test data into the data analysis software
	**Optional accessories** **Ultrasonic Dish with Laser** Pointer uses a parabolic dish to collect airborne ultrasonic signals, which can effectively detect Partial Discharge activity from a distance.

<table>
<tr><td></td><td>Optional accessories
Ultrasonic Extension Microphone for ultrasonic testing of hard to reach locations on switchgear, and other parts that the main unit cannot effectively reach. Pay attention to ensure adequate safe distance when in use from any high potential components.</td></tr>
<tr><td colspan="2"> Power button  Return key  Confirm button

 Up button  Down button  Left button  Right Button</td></tr>
</table>

4.2. Startup and Shutdown

The power button  is located in the lower left corner of the device panel. Press and hold this button to turn on the device. Press and hold the button again to turn off the device. Note that the user must press and hold the power button for a few seconds during the powering-up and powering-down processes until the device displays the main menu.

4.3. Charge the Batteries

When the main unit or HFCT/UHF signal processor indicates low battery, the instrument should be recharged. The charging port is located at the lower end of the device, and shares a mini USB connector with the data interface. There is a charging indicator light to indicate the current state of charging process:

- When the light is ON, indicates the device is being charged
- When the light is OFF, it indicates that the device is not in the charging state or it is fully charged
- While the device is charging, you should turn it off
- While the device is charging, do not perform any tests

4.4. Main Menu

The main unit displays the main menu after entering the normal operating state. Main menu displays the following: **TEV Detection**, **AE Detection**, **UHF Detection**, **HFCT Detection**, **Intelligent Patrol**, and **System Settings** as selectable fields. The current option is highlighted on the main menu, by pressing  and  buttons on the device you can highlight a specific option, and then select 

on the device to enter the next level of function menus. Press 

button on the device to return to

the previous menu. The current time and battery status are displayed at the bottom of the screen.

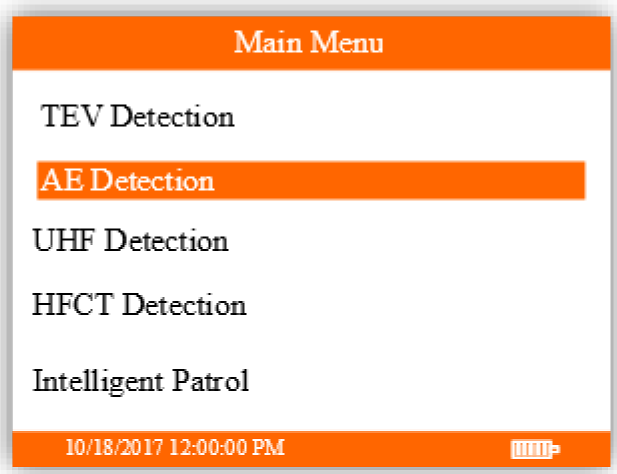
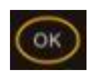


Figure 4.2. Main Menu Options

4.4. System Settings

Select System Settings from Main Menu, then press OK button 

to complete the selection.

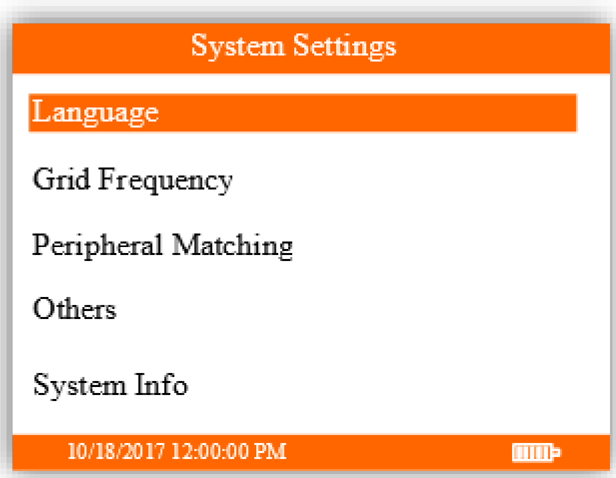


Figure 4.3. System Settings Options

4.4.1. Language Setting

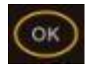
In **System Settings**, select **Language** and press  button on the device to enter the corresponding interface. You can press  and  buttons on the device to select other language and change the setting.

Figure 4.4. Language Options

4.4.2. Grid Frequency

Select **Grid Frequency** from the **System Settings** and press **OK** button and enter the corresponding interface. The current selection is the one first highlighted when entering this setting, press the **Up** and **Down** button to select power grid frequency for your test site. ***50*** or ***60 Hz*** is supported by the main unit. Press **OK** button to confirm.

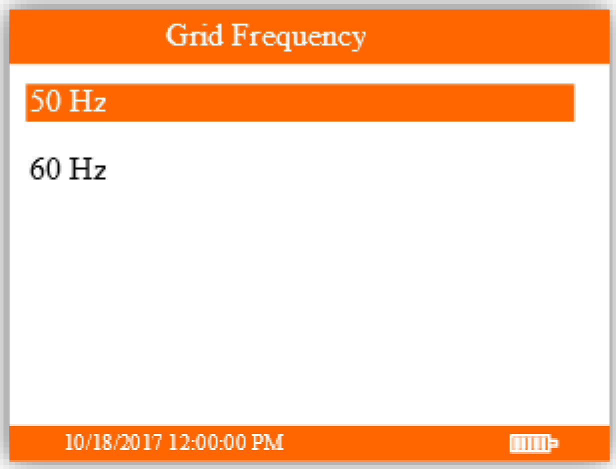


Figure 4.5. Grid Frequency Options

4.4.3. Peripheral Matching

The main unit can work with the Ultrasonic Signal Processor, UHF Signal Processor, HFCT Signal Processor signal and external synchronizer. Peripheral matching steps are usually performed at the factory; however, users can manually perform these as well.

Figure 4.6. Main Unit Search to Connect with UHF Processor

Figure 4.7. Unsuccessful matching with UHF Processor

Figure 4.8. Successful matching with UHF processor

AE/HFCT/External Synchronize Device peripheral matching with the main unit share the same procedure as the matching with UHF Processor.

4.4.4. Others

The Others option from the Main Menu allows the user to set various settings prior to testing to ensure accuracy for options such as time and date, screen brightness, etc.

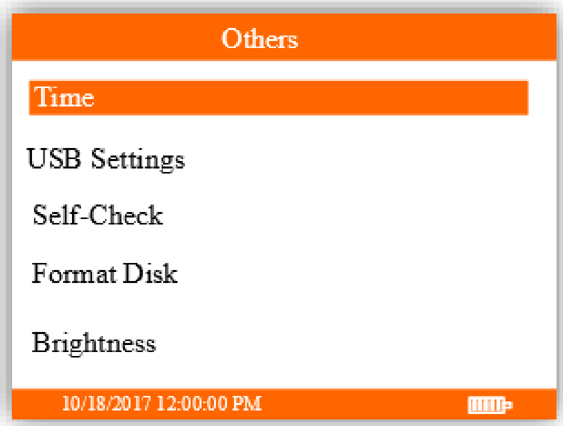
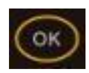
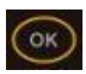
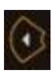
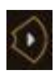


Figure 4.9. Others Option Menu

Time: In the **System Settings** screen, select **Others** and press  button on the device to enter the corresponding interface. With the current option of the sub-menu is highlighted, the user can press  to enter. Once the desired options are selected, the user can press  and  buttons on the device to change the setting.

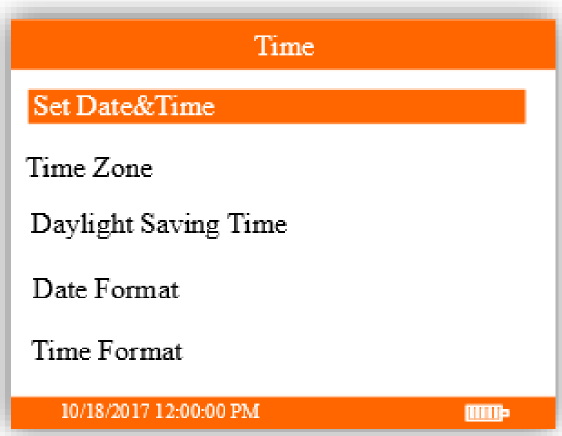


Figure 4.10. Time Option Menu

For **Time**, the user can format all settings as preferred. Date &Time, Time Zone, Daylight Saving Time, Date Format, and Time Format should be set accordingly.

USB Settings: It is very important to set the USB port of the main unit. Highlight **USB Settings**, and press the **OK** button to enter the corresponding interface. In the current options, Time will be highlighted, press the direction button **Up** and **Down** to adjust, and press the **OK** button to confirm.

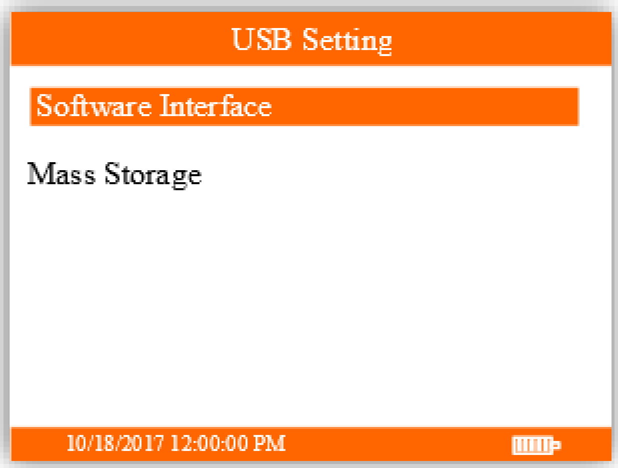
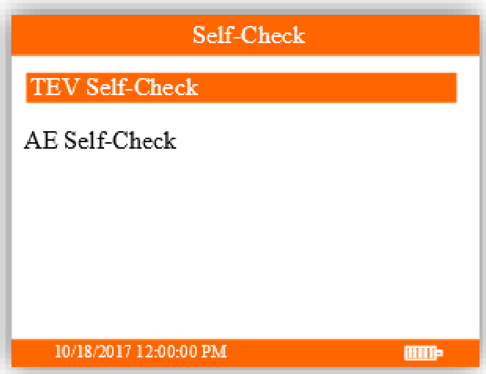


Figure 4.11. USB Settings Option Menu

- **Software Interface**: the mini USB Port will be used for connecting the PDetector with the software. Using the **Up** and **Down** buttons to highlight and press **OK** button to confirm the selection.
- **Mass Storage**: the mini USB port will operate as the Removable disk. When connect to computer, the information stored in the Main Unit can be read by computer. Using the **Up** and **Down** buttons to highlight and press **OK** button to confirm the selection.

Self-Check: Self-Check function operates in conjunction with the self-checker USB drive. By using the self-checker with the USB data cable for charging and data transmission, connect the data cable to the Mini USB port at the bottom of device and the USB port to the Self-Checker. Make sure the self-checker drive is in close contact with the TEV and ultrasonic sensors at the top position of the device.



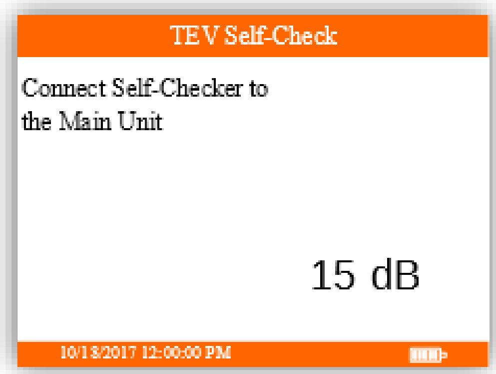


Figure 4.12. TEV Self-Check

Within the self-check menu options, the user can choose to conduct a TEV self-check or ultrasonic wave AE self-check. In the TEV self-check menu option, place the self-check drive close to the TEV and ultrasound probe at the top of the device. When the system is normal and self-check is working properly, the screen should display the words ***self-checker passed***. If the self-check drive is placed in the position for approximately 10 seconds and passing displays, the sensor validation fails.

Format Disk: When internal memory storage system is not functioning correctly, the user will need to format it to re-establish the storage system's proper operation. This will delete all previously stored files.

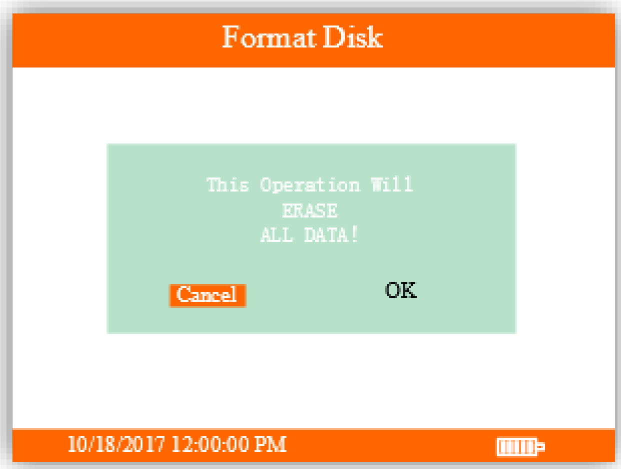
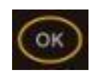
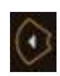
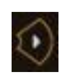


Figure 4.13. Formatting Disk

Brightness and Key Sound: In the **System Settings** screen, select **Others** and press 

button on the device to enter the corresponding interface.

In the current option of the sub-menu is highlighted, you can press 

to enter. Once the desired options are selected, the user can press  and  buttons on the device to change the setting.

- ***Brightness***: control color LCD screen backlight brightness with three adjustable levels.
- ***Key Sound***: controls volume of the tone accompanied with the pressing of the buttons on the device.

Select Background Color: the background color of the screen can be changed from white (**WHT**) to black (**BLK**) through the same selection process.

4.4.5. System Information

In **System Settings**, highlight **System Info** and press  button on the device to enter the corresponding interface. On this screen, it shows the product model, software version, serial number, and other information.

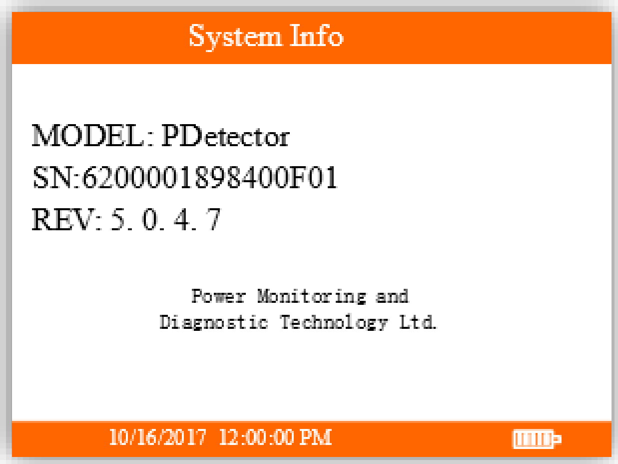


Figure 4.14. System Information for the PDetector Main Unit

4.5. Online PD Testing

Online Partial Discharge testing positions should be imposed on electric power equipment. For different HV equipment, such as GIS, power cable connectors, transformers, etc., the testing positions will be different and will be based according to the structure of the power equipment. PDetector can be used to detect PD for: GIS, switchgear, transformers, bus (joint, wear casing wall, supporting insulation), circuit breakers, and other electrical equipment such as CTs, PTs and cable terminations.

4.6. TEV Detection

On the **Main Menu** screen, highlight **TEV Detection** and press the  button on the device to enter the corresponding interface.

TEV Detection has two modes of operation: amplitude detection and pulse detection. Amplitude detection screen can display the amplitude and severity of the PD using the traffic light system by displaying green, yellow, and red colored indicator lights.

4.6.1. TEV Amplitude Detection

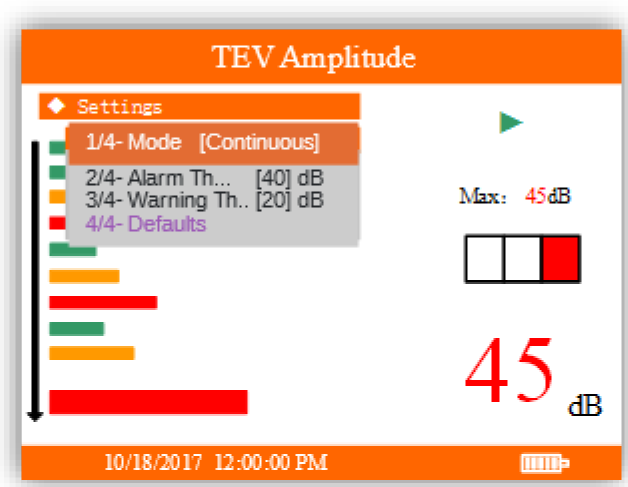


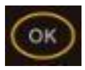
Figure 4.15. TEV Amplitude Detection

- ***Amplitude***: Displays measured TEV value in dB unit.
- ***Color indicator***: Indicates the measured intensity of the TEV results. Green indicates normal; yellow indicates warning; and red indicates an alarm. The thresholds for the traffic light system can be set in the TEV Setting interface.
- ***Data history***: In a different color bar graph to display the last 10 measurements.
- ***Maximum reading***: During TEV mode detection, this displays the maximum of the last 10 readings obtained while in operation.
- ***Detection indication***: With a flashing green arrow or a red double bar indicator,

this tells the user if it is continuously testing or paused.

Parameter Settings:

On the detection screen, press  button on the device to enter **TEV Amp Detection Settings** interface.

- ***1/4 – Mode***: Switching mode to **Continuous** or **Single-shot**. When in Single-shot mode, press  button on the device to trigger single-shot signal detection.
- ***2/4 – Alarm Threshold***: The alarm threshold setting in the TEV detection screen.
- ***3/4 – Warning Threshold***: The warning threshold setting in the TEV detection screen.
- ***4/4 – Defaults***: Press  button on the device to reset the parameters to the system's default settings.

4.6.2. Pulse Detection

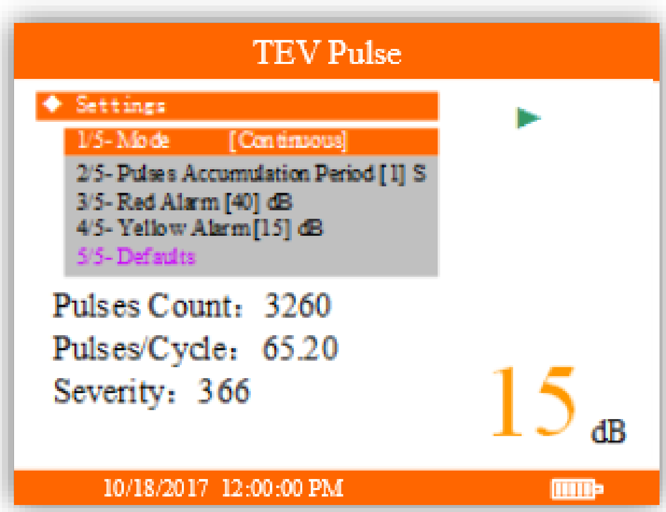


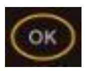
Figure 4.16. TEV Pulse Detection

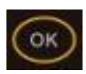
- ***Amplitude***: Displays in dB the measured TEV value.

- ***Pulse count***: Shows the total number of pulse counts during the "count time"
- ***Pulses/Period***: Shows the average TEV number of pulses for every period.
- ***Discharge Severity***: Shows the severity of the discharge, the value is amplitude (mV) x pulses/period.

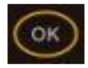
Parameter Settings:

In the Detection screen, press  button on the device to enter the **TEV Pulse Detection Parameter Setting** interface.

- ***1/5 – Mode***: Switching mode to **Continuous** or **Single-shot**. When in Single-shot mode, press  button on the device to trigger single-shot signal detection.

- ***2/5 – Pulse Accumulation Period***: Set the time length of the pulse count, it can be 1 or 2 seconds (s); the system defaults it to 1s.
- ***3/5 – Alarm Threshold***: The alarm threshold setting in the TEV detection screen.
- ***4/5 – Warning Threshold***: Yellow light shows the warning threshold setting in the TEV detection screen.
- ***5/5 – Defaults***: Press  button on the device to set the parameters to the system's default settings.

4.7. AE Detection

Select **AE Detection** in the main menu and press the  button on the device to enter the AE Detection interface.

There are four modes of operation under AE Detection: **AE Amp Detection**, **AE Phase Spectrum**, **AE Fly Spectrum**, and **AE Waveform**.

4.7.1. AE Amplitude Detection

The amplitude detection mode can display the RMS and PEAK values of the measured signal in a frequency cycle, and the relevance between measured signal with frequency content (x1) and frequency content (x2). Through a combination of different parameters, the experienced user can quickly determine whether there is abnormal Partial Discharge occurring within the device and what the possible discharge type might be.

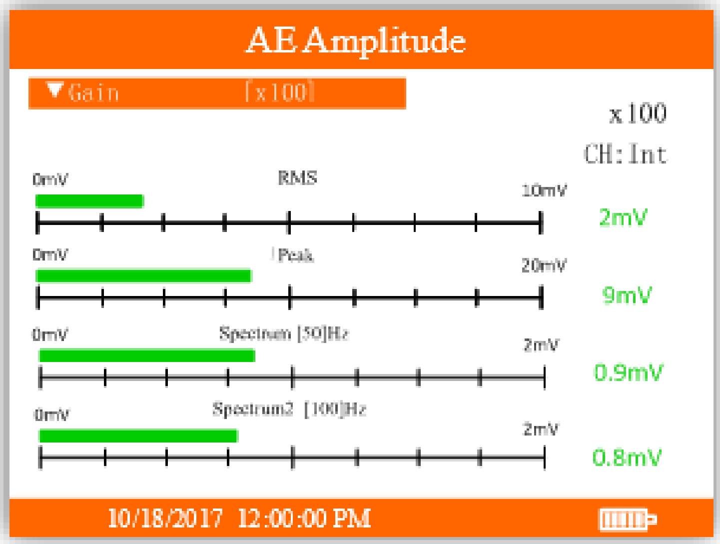


Figure 4.17. AE Amplitude Detection

- ***RMS***: RMS signal in a frequency cycle
- ***PEAK***: Peak signal in a frequency cycle

- ***Frequency content 1***: Degree of correlation with the frequency content (x1)
- ***Frequency content 2***: Degree of correlation with the frequency content (x2)

Parameter settings:

From the detection screen, press the DOWN button on the device to enter amplitude detection parameter setting interface.

- ***1/13 – Gain***: Adjusting the magnification of the input signal, to accommodate the input signal of a different size. With 3 settings to choose from that adjusts the gain, x1, x10, x100. When using the magnification of x100, the test range is between 2-20 mV; when using the magnification of x10, the test range is between 10 to 200 mV; when using the magnification of x1, the test range is between 50-1000 mV.
- ***2/13–Mode***: Switch mode to "continuous" or "trigger", when in the "trigger" mode, press the OK button on the device to trigger single signal detection.
- ***3/13 – Trigger value***: Set the waveform signal amplitude threshold displayed.
- ***4/13 –Volume***: Set the volume of the ultrasonic signal output to the headphone. Consists of volume levels from 1 to 9.
- ***5/13 – Unit***: Select a unit of measurement to be displayed as either mV or dB.
- ***6/13 – Frequency components***: Select frequency that displays the frequency component. Optional frequency is 10 ~ 500Hz.
- ***7/13 – Noise test***: Test the noise signal value of the background environment, this will be superimposed with the effective signal value as to ignore until the signal amplitude is higher than the background noise, as in the red background.
- ***8/13 – Clear Noise***: The recorded background noise measurement value measured before, and cancels overlay display.
- ***9/13 – Save data***: Save the current measurement data displayed. Note: When this dropdown menu is opened, the value displayed on screen at that moment is frozen and won’t continue to take data until the menu is closed.

- ***10/13 – Scan & Save RFID***: Scroll down until you highlight **Scan & Save RFID** function. After selecting this, put the device back near the RFID tag. The device automatically reads the relevant information of high voltage electrical equipment information stored on the tag, and saves the current data and relevant information of electrical equipment.
- ***11/13 – Load Data***: Allows the PDetector to display data that is stored on the unit.
- ***12/13 – Deleting Data***: Delete the directory or file of data selected.
- ***13/13 – Defaults***: Press 

 button on the device to set the parameters to the system's default settings.

4.7.2. AE Phase Spectrum Detection

Because of the Partial Discharge signal being generated and that the power frequency of the electric field is relevant, it can be used as a reference for the amount of power frequency present by observing whether the occurrence phase of the tested signal has an aggregation effect to determine whether the signal is produced due to the internal discharge inside the asset. This mode is primarily used for further confirmation that the specific phase occurred by an abnormal signal. This is done in order to determine whether there is a correlation between the abnormal signal and power frequency voltage; and then determine whether the abnormal signal is a Partial Discharge signal and, if so, find out potentially what type of Partial Discharge it might be.

Phase spectrum detection uses a synchronous trigger signal of the grid frequency to measure the pulse signal and according to the pulse amplitude and phase of the relative triggered signal, by marking a point in the spectrum and creating the pulse distribution statistics. Different points display different colors according to the probability of a pulse in the peripheral region. This happens after pressing the **OK** button on the device to trigger a single acquisition and after the completion of populating the device with at least 1,000 pulses to complete the data acquisition process and stops automatically after it has acquired all 1,000 pulses. The horizontal axis of a phase spectrum detection mode represents the phase angle (0-360 °), and the vertical axis represents the signal amplitude.

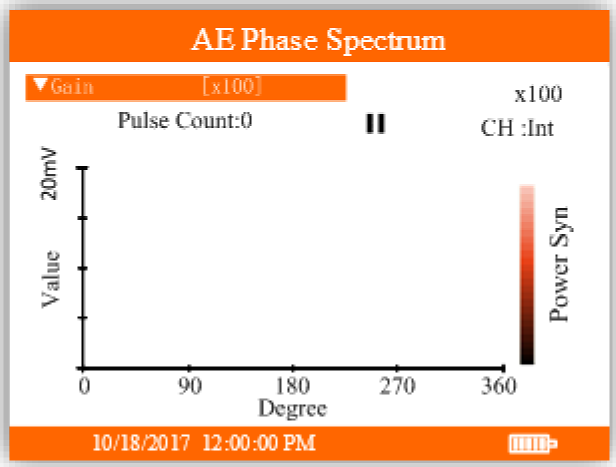
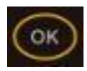


Figure 4.18. AE Phase Spectrum

Parameter settings:

In the detection screen, press  on the device to enter the phase spectrum detection parameter setting interface.

- ***1/10 – Gain***: Adjust the input signal amplification to accommodate input signal of different sizes. With 3 settings to choose from that adjusts the gain, x1, x10, x100.
- ***2/10 – Trigger Threshold***: Set the waveform signal amplitude threshold displayed.
- ***3/10 – Blocking Time***: The off time using in triggering samples.
- ***4/10 – Phase Offset***: Set relative offset of the measured pulse signal to the phase grid.
- ***5/10 – Frequency Synchronization***: Select the trigger source of synchronous grid phase.

- ***6/10 – Save Data***: Saves the currently displayed measurement data on the device's internal storage.
- ***7/10 – Scan & Save RFID***: Scroll down until you highlight & select **Scan &Save RFID**, put the device back near the RFID tag. The device automatically reads the relevant information of high voltage electrical equipment information stored on the tag, and saves the current data and relevant information of electrical equipment
- ***8/10 – Load data***: Allows the PDetector to display data that is stored on the unit.
- ***9/10 – Deleting Data***: Delete the directory or file of data selected.
- ***10/10 – Defaults***: Press  button on the device to set the parameters to the system's default settings.

4.7.3. AE Fly Spectrum Detection

Particles in high voltage equipment will jump and fly because of the effects of the electric field on the particles. Every time the particles collide, a wideband transient acoustic pulse will be transmitted, which will propagate back and forth within the enclosure. Acoustic signals of such particles are the mixed signals which are generated by the Partial Discharge of the end particles and particles collision within then closure. Pulse mode can record the time and the pulse amplitude generated in the case when the particles collide within the enclosure, and display in the form of flying spectrum. AE Fly Spectrum is used to measure the time of flight of the particles.

PDetector measures the gap between the pulse signals, and depending on the magnitude and the time interval, using a point in spectrum to show the output and displaying the pulse distribution statistics. Different points display different colors according to the probability of a pulse in the peripheral region. Operation is similar to the phase spectrum detection. After pressing the **OK** button on the device to trigger a single acquisition, the PDetector collects up to 1,000 pulses to complete a data acquisition process and stops automatically. The horizontal axis of AE Fly Spectrum mode represents time, and the vertical axis represents signal amplitude.

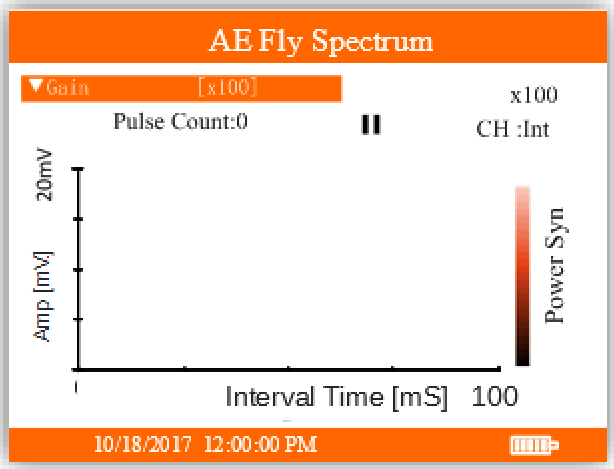
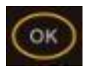


Figure 4.19. AE Fly Spectrum

Parameter Settings:

From the detection screen, press the DOWN button on the device to enter the AE Fly Spectrum parameter setting interface.

- ***1/11 – Gain***: Adjust the input signal amplification to accommodate the input signal of different sizes. With 3 settings to choose from that adjusts the gain, x1, x10, x100 to adjust the gain.
- ***2/11 – Trigger Threshold***: Sets the waveform signal amplitude threshold displayed.
- ***3/11 – Gating Time***: The sample time after the signal reaches the trigger amplitude.
- ***4/11 – Blocking Time***: The off time using in triggering samples.
- ***5/11 – Interval Time***: The maximum time difference between two pulses
- ***6/11 – Scale***: To choose the Y-axis scale from X1, X2 or X4
- ***7/11 – Save data***: Save the current measurement data.

- ***8/11 – Scan & Save RFID***: Scroll down until you highlight "Scan &Save RFID" function, after selecting this, put the device back near the RFID tag. The device automatically reads the relevant information of high voltage electrical equipment information stored on the tag, and saves the current data and relevant information of electrical equipment.
- ***9/11 – Load Data***: Allows the PDetector to display data that is stored on the unit
- ***10/11 – Deleting Data***: Delete the directory or file of data selected.
- ***11/11 – Defaults***: Press 

button on the device to set the parameters to the system's default settings.

4.7.4. AE Waveform

AE Waveform spectrums display envelope waveform spectrums of the ultrasonic signal. When collecting the data, period frequency synchronizes to trigger, so you can examine the correlation between envelope signals and the grid. The horizontal axis of the AE Fly Spectrum mode represents the frequency period number and the vertical axis represents the signal amplitude.

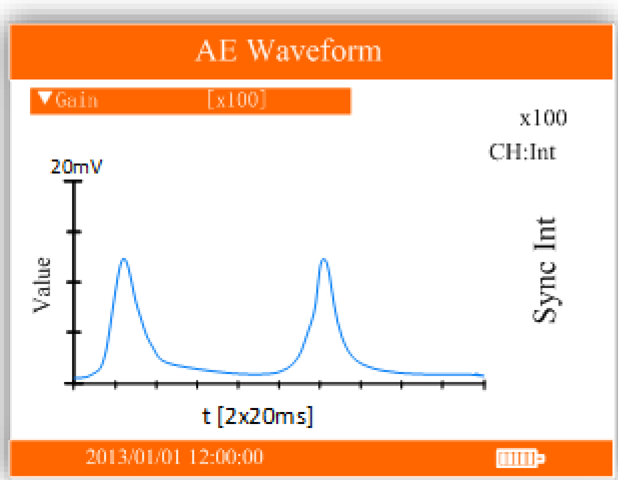
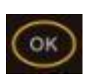


Figure 4.20. AE Waveform

Parameter Settings:

From the detection screen, press the DOWN button on the device to enter the waveform spectrum detection settings interface.

- ***1/11 – Gain***: Adjust the magnification of the input signal to accommodate the input signal of different sizes. With 3 settings to choose from that adjusts the gain, x 1, x10, x100 to adjust the gain.
- ***2/11–Mode***: Switch mode to continuous or trigger, when in the trigger mode, press the OK button on the device to trigger single signal detection.
- ***3/11 – Trigger Threshold***: Set the waveform signal amplitude threshold displayed.
- ***4/11 – Sampling Time***: Set a trigger acquisition time. 1 to 10 is the adjustable frequency period.
- ***5/11 – Amplitude Range***: Set the maximum wave amplitude displayed in the interface.
- ***6/11 – Frequency Synchronization***: Select the trigger source of synchronous grid phase. [Light], [power] are the two options.
- ***7/11 – Save Data***: Save the current measurement waveforms.
- ***8/11 – Scan & Save RFID***: Scroll down until you highlight **Scan &Save RFID** function, after selecting this, put the device back near the RFID tag. The device automatically reads the relevant information of high voltage electrical equipment information stored on the tag, and saves the current data and relevant information of electrical equipment.
- ***9/11 – Load Data***: Allows the PDetector to display data that is stored on the unit.
- ***10/11 – Deleting Data***: Delete the directory or file of waveform data selected.
- ***11/11 – Defaults***: Press 

button on the device to set the parameters to the system's default settings.

4.8. UHF Detection

From the **Main Menu** screen, highlight **UHF Detection** and press  button on the device to enter the UHF Detection interface. There are three modes of operation under UHF Detection: **Amplitude Detection**, **Phase Spectrum Detection**, and **PRPD/ PRPS Spectrum Detection**.

4.8.1. Amplitude Detection

Enter the UHF amplitude detection interface. There are two modes of operation under amplitude detection: continuous and single shot. The amplitude detection screen can display amplitude, and the severity of the PD using the traffic light system: green, yellow, and red lights.

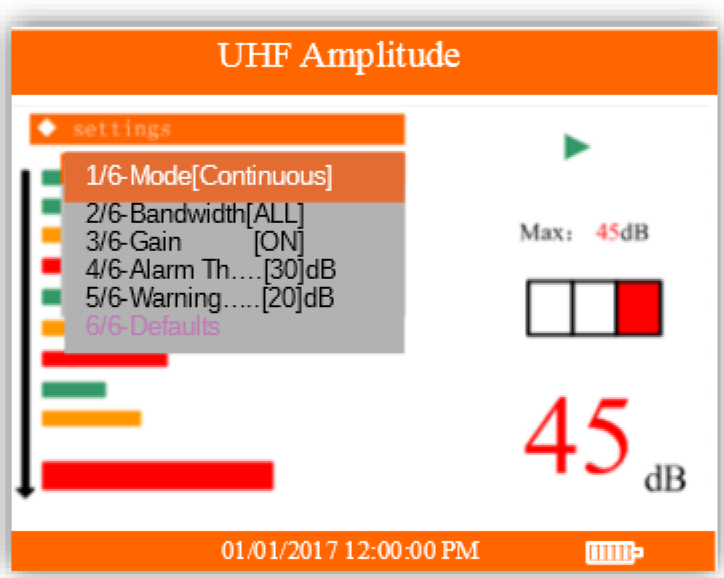


Figure 4.21. UHF Amplitude Detection

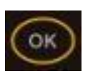
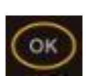
- ***Amplitude***: Displays the current UHF signal in dB.
- ***Color indicator light***: The traffic light system indicates the measured amplitude of the UHF signal. Green indicates normal; yellow indicates warning; red indicates an alarm. The threshold can be set in the UHF Setting interface.

- ***History***: Displays the last 10 UHF signals on a bar display
- ***Maximum reading***: While in this operation using the UHF sensor, this displays the maximum of the last 10 signal readings obtained while in operation.
- ***Test instructions***: This is a display flashing green arrow or red double parallel bar indicator, which informs the user if it is continuously testing or not.

*__Note__: If the PDetector does not receive a signal from the Signal Processor, it will display ***No Signal*** on the screen. The user will need to sync the two devices together to ensure proper operation.

Parameter Settings:

From the **UHF Amp Detection** screen, press the  button on the device to enter the corresponding interface.

- ***1/6 – Mode***: Switching mode to ***Continuous*** or ***Single-shot***. When in Single-shot mode, press  button on the device to trigger single-shot signal detection.
- ***2/6 – Bandwidth***: Bandwidth selection function. The machine has a built-in multi-band analog signal filter. You can select full, low, or high band pass filtering.
- ***3/6 – Gain***: Open pre-amplifier when UHF signals are too weak.
- ***4/6 – Alarm Threshold***: Red light shows the alarm threshold setting in the (UHF) Detection screen.
- ***5/6 – Warning Threshold***: Sets the background value for the device, allowing for any readings below the background to show up as green until it surpasses the background value where it either displays yellow for warning if it has not met the threshold for alarm to display red.
- ***6/6 – Defaults***: Press  button on the device to set the parameters to the system defaults.

4.8.2. UHF Single-Cycle Spectrum

There are two modes of operation under Spectrum detection: **Continuous** or **Single-shot**, and the severity of the PD using the traffic light system: green, yellow, and red lights.

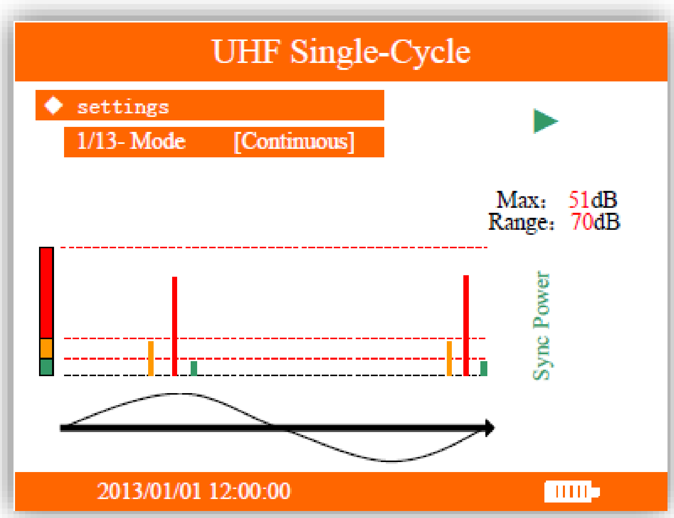
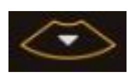
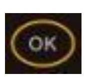


Figure 4.22. UHF Single-Cycle Detection

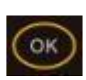
Parameter Settings:

From the **UHF Spectrum Detection** screen, press  button on the device to enter **UHF Detection Parameter Settings** interface.

- ***1/13 – Mode***: Switching mode to **Continuous** or **Single-shot**. When in **Single-shot** mode, press 

button on the device to trigger single-shot signal detection.
- ***2/13 – Bandwidth***: Bandwidth selection function, the machine has a built-in multi-band analog signal filter; the user can select full, low, or high band pass filtering.
- ***3/13 – Gain***: Open pre-amplifier when UHF signals are too weak.
- ***4/13 – Frequency Sync Mode***: Users can select **Light** or **Power** synchronization. When you select **Light** synchronization, you need to align the light sensitive sensor of the UHF signal conditioner to the fluorescent and other power

frequency lights. When you select **Power** synchronize, you need to plug the chargers in the outlet. The green light should flash on the charger, which means the charger is transmitting the synchronization signal.

- ***5/13 – Alarm Threshold***: Red light shows the alarm threshold setting in the UHF detection screen.
- ***6/13 – Warning Threshold***: Sets the background value for the device, allowing for any readings below the background to show up as green until it surpasses the background value which then it will display either yellow for warning or red for alarm depending on the value.
- ***7/13 – Scale***: In order to facilitate the observation of small signals, you can adjust the vertical amplitude size.
- ***8/13 – Phase***: Angle can be adjusted. This can help to determine more vividly map type of discharge mode.
- ***9/13 – Save Data***: Save the current data displayed on the screen.
- ***10/13 – Scan & Save RFID***: Scroll down until you highlight **Scan &Save RFID** function, after selecting this, put the device back near the RFID tag. The device automatically reads the relevant information of high voltage electrical equipment information stored on the tag, and saves the current data and relevant information of electrical equipment.
- ***11/13 – Load Data***: View data previously detected. Shows each one as a file. The detection results are sorted by the date/time it was acquired.
- ***12/13 – Delete Data***: Delete data previously detected.
- ***13/13 – Defaults***: Press 

button on the device to set the parameters to the system defaults.

4.8.3. UHF PRPD2D-PRPS3D

PRPD stands for Phase Resolved Partial Discharge. It is the figure of phase - maximum discharge capacity –discharge times. It shows the 2D phase distribution status of each discharge Interval.

PRPS stands for Phase Resolved Pulse Sequence. It is the percentage of phase - period - maximum discharge capacity. It shows the 3D phase distribution status of the percentage of the maximum discharge capacity of each cycle; the map refreshes in real-time.

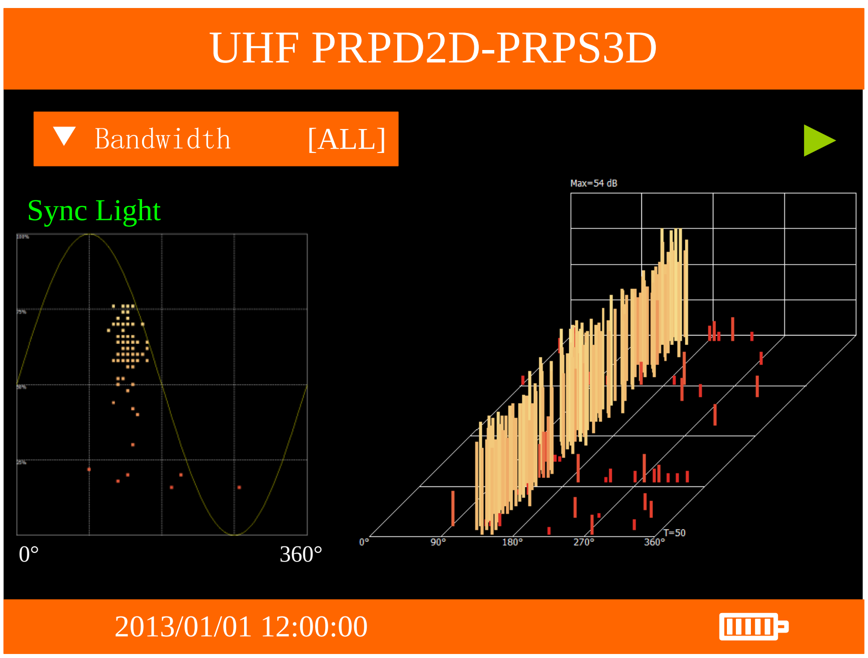


Figure 4.22. UHF PRPD2D-PRPS3D Spectrums

Parameter Settings:

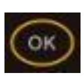
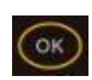
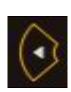
From the **UHF Spectrum Detection** screen press  button on the device to enter **UHF Detection Parameter Setting** interfaces.

- ***1/13 – Bandwidth***: Bandwidth selection function, the machine has a built-in multi-band analog signal filter; you can select full, low, or high band pass filtering.
- ***2/13 – Gain***: Open pre-amplifier when UHF signals are too weak.
- ***3/13 – Frequency Sync Mode***: You can select **Light** or **Power** synchronization. When you select **Light** synchronization, you need to align the light sensitive sensor of the UHF signal conditioner to the fluorescent lamp and other power frequency lights. When you select **Power** synchronize, you need to plug the chargers in the outlet. When the green light is flashing on the charger, which means the charger is transmitting the synchronization signal.
- ***4/13 – Phase***: Phase angle of the pulses can be adjusted. This can help to determine more vividly map type of discharge mode.
- ***5/13 – Accumulate***: The accumulation enable switch can be selected to turn on or off, while under the recording mode, the function will be turned on automatically.
- ***6/13 – Screen Recording time***: Screen recording time can be set as 1 minute, 2 minutes, 3 minutes, 4 minutes or 5 minutes.
- ***7/13 – Save Data***: Save the current being collected with the device.
- ***8/13 – Scan & Save RFID***: Scroll down until you highlight **Scan &Save RFID** function, after selecting this, put the device back near the RFID tag. The device automatically reads the relevant information of high voltage electrical equipment information stored on the tag, and saves the current data and relevant information of electrical equipment.
- ***9/13 – Load Data***: View data previously collected. Shows each one as a file. The detection results are sorted by the date/time the data was collected.

- ***10/13 – Delete Data***: Delete data previously collected.
- ***11/13 – Playback Recording***: Screen record playback function will let you the screen recording file of local storage for playback.
- ***12/13 – Delete Recording***: Delete the saved local screen recording file.
- ***13/13 – Defaults***: Press  button on the device to set the parameters to the system defaults.

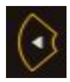
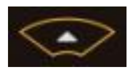
Quick save button: under the detecting interface, we can use quick save button  to save data directly.

Screen Recording function:

- **Step 1:** Under the UHF PRPD2D-PRPS3D interface, pressing the up button  about 2 to 3 seconds, system will enter the screen recording interface.
- **Step 2:** After entering the screen recording interface, PDetector should be connected to the processor of UHF; then the progress bar will move, the progress bar time is based on processor signals, and it is normal that the time is not synchronized.
- **Step 3:** Press  or , the system will withdraw from the recording mode and save the screen recording file automatically. Also, when the recording time exceeds the setting time, the system will withdraw, save file automatically also. The saved recording data can be reviewed by using ***Replay*** function, and the local data can be deleted by **Deleting the screen** function also.
- **Step 4:** Playback of recording file, in the screen recording playback interface, the progress bar has four buttons: fast forward, rewind, play and pause; press  to choose play / pause, press  to rewind, press  to fast forward. Button

can be long pressed, fast forward and rewind schedule can be decided according to the progress bar; after fast forward and rewind button is loosened, fast forward or rewind button color turns from green to blue. In this process, the PRPD map refreshes the data until the current progress is completed, and when the load is complete, the blue color turns to green and record continues to play, PRPS does not refresh during loading; press 

to exit the current record play screen.

NOTE: These four buttons  、  、  、  are invalid during the recording.

4.9. HFCT Detection

4.9.1. HFCT Amplitude Detection

Enter the HFCT amplitude detection interface. There are two detection modes of operation under amplitude detection: continuous and single shot detection. The amplitude detecting interface can display the amplitude, and the green, yellow and red to indicate the severity of the discharges.

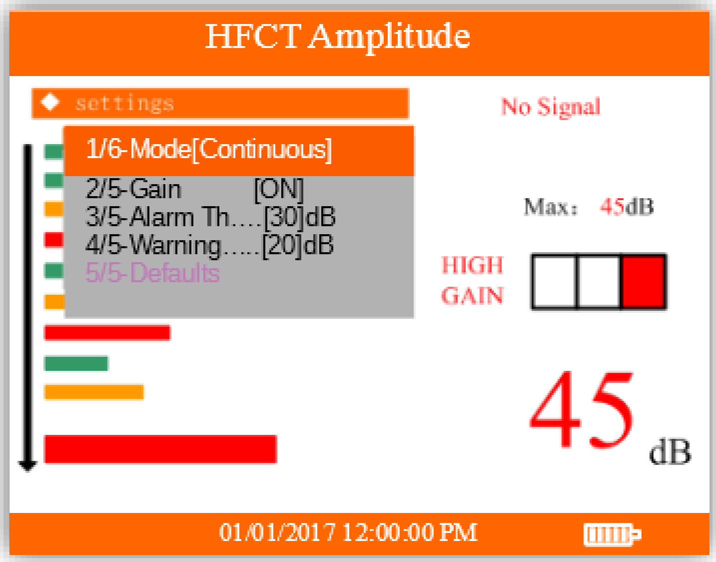


Figure 4.23. HFCT Amplitude Detection

- **Amplitude**: Use the form of dB to display the current high-frequency current value.
- **Color indicator light**: The traffic light system indicates the measured severity intensity of the high-frequency results. Green indicates normal; yellow indicates warning; red indicates an alarm. The threshold of color light can be set in the high-frequency setting interface.
- **History**: In a different color bar graph to display the last 10 measurements.

- **Maximum reading**: Record under the detection mode, the maximum amplitude for the last 10 readings obtained.
- **Detection instructions**: With a flashing green arrow indicator, the unit tells the user if it is continuously testing or not in single shot mode.

Note**: If the PDetector does not receive a signal from the Signal Processor, it will display ***No Signal on the screen. The user will need to sync the two devices together to ensure proper operation.

Parameter settings:

In the detection interface, press the DOWN button on the device to enter the high-frequency current detection parameter setting interface.

- ***1/5 – Mode***: Switch mode to **continuous** or **single**; when in **single** mode, press the OK button on the device to trigger single signal detection.
- ***2/5 – Gain***: Adjust proper times of amplification.
- ***3/5 – Alarm Threshold***: Red alarm options: Set the alarm threshold of red light on in the high-frequency current detecting interface.
- ***4/5 – Warning Threshold:*** Set the alarm threshold of green light on in the HFCT interface. When the detection signal is between the background signal and red warning signal, the yellow light is on and the tester is in the state of warning.
- ***5/5 – Defaults***: Press the OK button on the device and set the value under the interface to revert to the system's default settings.

4.9.2. HFCT Single-Cycle Spectrum

There are two modes of operation used to detect HFCT spectrums: continuous and single shot detection, with green, yellow, and red signals to indicate the severity of the discharge on the detection interface.

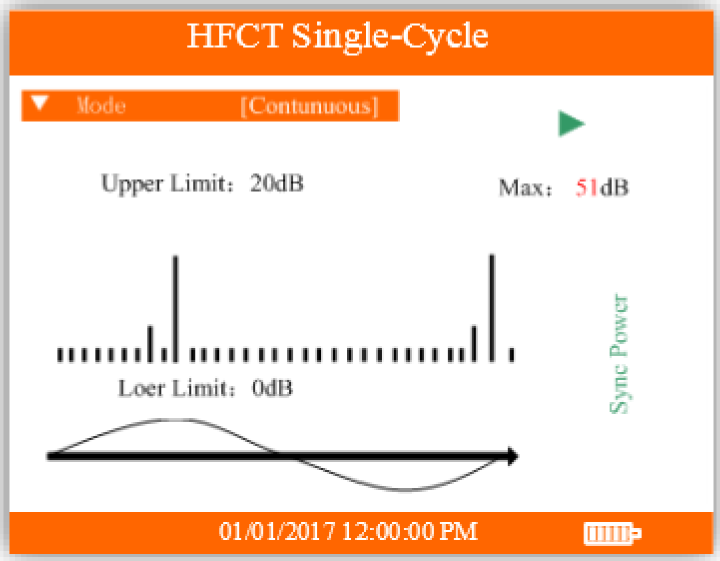


Figure 4.24. HFCT Single-Cycle Spectrum

Parameter settings:

From the detection interface, press the DOWN button on the device to enter UHF detection parameter setting interface.

- ***1/11 – Mode***: Switch mode to **continuous** or **single shot**; when in a single shot mode, press the **OK** button on the device to trigger single signal detection.
- ***2/11 – Gain***: Adjust proper times of amplification.
- ***3/11 – Frequency Sync Mode:*** Select **light** or **power** synchronization. When you select the **light** sync, you need to align the light-sensitive sensor of the HFCT receiver on a fluorescent lamp; when you select **power** sync, you need to plug the power charger on a power outlet. When the green light on the charger is flashing, that is the indicator that the device is transmitting the synchronization

signal. When no light or power synchronization, it will automatically switch to the **internal** sync.

- ***4/11 – Alarm Threshold***: Red alarm options: Set in the interface of HFCT detection, the alarm threshold with red light on.
- ***5/11 – Warning Threshold***: Set the alarm threshold of green light on in the HFCT detecting interface. When the detection signal is between the background signal and red warning signal, the yellow light is on and the tester is in the state of warning.
- ***6/11 – Phase***: Adjustable power frequency phase angle displayed on the spectrum and adjusting the phase angle can help identify discharge type by looking at the pattern aligned properly to the spectrum.
- ***7/11 – Save Data***: Save the detection spectrum results of the current interface.
- ***8/11 – Scan & Save RFID***: Scroll down until you highlight **Scan&Save RFID** function, after selecting this, put the device back near the RFID tag. The device automatically reads the relevant information of high voltage electrical equipment information stored on the tag, and saves the current data and relevant information of electrical equipment.
- ***9/11 - Load data***: View the saved results of detection spectrum, each test result saved as a file; the data is sorted by the date/time it was taken.
- ***10/11 – Delete Data***: Remove the acquisition results of the data stored on the device.
- ***11/11 – Defaults***: Press the OK button on the device and set the value under the interface to revert to the system's default settings.

4.9.3. HFCT PRPD2D_PRPS3D

PRPD stands for Phase Resolved Partial Discharge. It is the figure of phase - maximum discharge capacity – discharge times. It shows the phase distribution status of each discharge Interval.

PRPS stands for Phase Resolved Pulse Sequence. It is the percentage figure of phase - period - maximum discharge capacity. It shows the phase distribution status of the percentage of the maximum discharge capacity of each cycle; the map refreshes in real time.

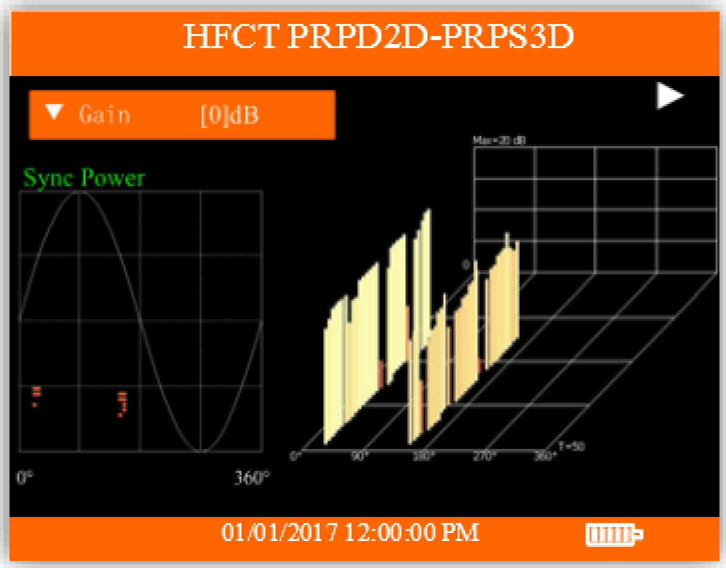


Figure 4.25. HFCT PRPD2D-PRPS3D spectrum

Parameter Settings:

In the detection interface, press the DOWN button on the device to enter the high-frequency current detection parameter setting interface.

- ***1/12 – Gain***: Adjust proper times of amplification.
- ***2/12 – Frequency Sync Mode***: Select **light** or **power** synchronization. When you select the **light** sync, you need to align light-sensitive sensor of the high-

frequency current receiver on fluorescent lamp or other civil electricity; when you select **power** sync, you need to plug the power charger on the civil electricity socket. When the green light on the charger is flashing, that is transmitting synchronization signals. When no light or power synchronization, it will automatically switch to the internal sync.

- ***3/12 – Phase***: Phase angle of the pulses can be adjusted. This can help to determine more vividly map type of discharge mode.
- ***4/12 – Accumulate***: The accumulation enable switch can be selected to on or off, and under the recording mode, the switch would be on default.
- ***5/12 – Screen Recording time***: Screen recording time can be set as 1 minute, 2 minutes, 3 minutes, 4 minutes and 5 minutes.
- ***6/12 – Save Data***: Save the current data.
- ***7/12 – Scan & Save RFID***: Scroll down until you highlight **Scan & Save RFID** function, after selecting this, put the device back near the RFID tag. The device automatically reads the relevant information of high voltage electrical equipment information stored on the tag, and saves the current data and relevant information of electrical equipment.
- ***8/12 – Load Data***: Select saved data, read and display.
- ***9/12 – Deleting Data***: Delete the directory or file of waveform data selected.
- ***10/12 – Playback Recording***: It is used for loading the recording file save in local memory space for playback.
- ***11/12 – Delete Recording***: Delete the saved local screen recording file.
- ***12/12 – Defaults***: Press the **OK** button device and set the value under the interface to revert to the system's default setting.

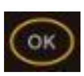
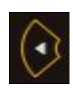
Quick save button: Under the detecting interface, we can use quick save button  to save data directly.

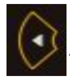
Screen Recording function:

- **Step 1:** Under the UHF PRPD2D-PRPS3D interface, long pressing the up button  about 2 to 3 seconds, we will enter the screen recording interface.

- **Step 2:** After entering the screen recording interface, PDetector should be connected to the processor, then the progress bar will move, the progress bar time is based on processor signals, and it is normal that the time is not synchronized.

- **Step 3:** Press  or , the system will withdraw from the recording mode and save the screen recording file automatically. Also, when the recording time exceeds the setting time, the system will withdraw, save file automatically too; The saved recording data can be reviewed **Replay** function in the menu, and the local data can be deleted by **deleting the screen** function also.

- **Step 4:** Playback of recording file, in the screen recording playback interface, the progress bar has four buttons: fast forward, rewind, play and pause; press  to choose play / pause, press  to rewind, press  to fast forward. Button can be long pressed, fast forward and rewind schedule can be decided according to the progress bar; after fast forward and rewind button is loosened, fast forward or rewind button color turns from green to blue, in this process, the PRPD map refreshes the data until the current progress is completed, and when the load is complete, the blue color turns to green and record continues to play, PRPS does not refresh during loading; press  to exit the current record play screen.

NOTE: The four buttons , , ,  are invalid during the recording.

***Warning:** *For user safety protection, users should not substitute any part or whole of the PDetector or accessories since PDetector and accessories are devices strictly used only as instructed in this manual herein. No exceptions in order to protect users from harmful mishandling and usage*.

***Note:** *Since PDetector is an independent machinery equipment, and the system itself can not accurately obtain the voltage phase, under normal circumstances which can only use the internal power frequency signal generator to simulate the frequency cycle time. Because the system frequency is not precisely50Hz, so there is a phase difference between the system voltage and power frequency period generated in the machine. In a long pattern detection mode, the case of the phase shift may occur.*

In order to be able to get the system frequency phase, PDetector is equipped with three synchronization methods, including internal synchronization, light synchronization and wireless power synchronous mode. Internal synchronization is a power frequency signal simulated within the host device. When you select the light Sync, you need to align light-sensitive sensor of the signal receiver on fluorescent lamp or other civil electricity, and charger not only has the function of charging, but also has wireless power synchronization. Plug it in 110V/220V AC power outlet and indicator light is flashing. Then send out radio signals with synchronous power frequency phase, using the main unit to get the signal and through the signal to achieve radio synchronization. This method cannot be affected by the strength of the fluorescent light, but needs 110V/220V AC power outlet in the test environment.

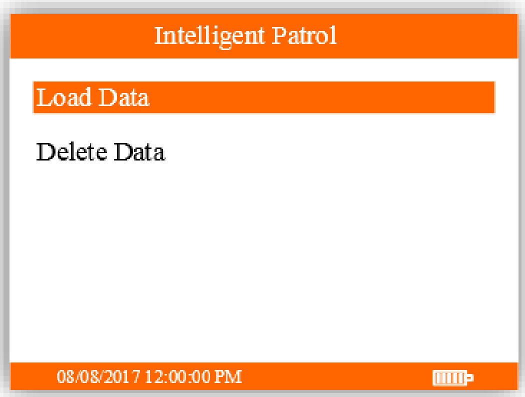
4.10. Intelligent Patrol

4.10.1. Intelligent Patrol

With the integrated data management software, the test jobs can be configured on the computer and downloaded to the PDetector via mini USB cable.. The test job information includes the name of the substation and switchgear, which are to be tested. The operator can load the test job and carry out the testing according to pre-configured testing procedure. The test data can also be uploaded to a computer via a data interface to the software system. Please refer to *PDetector Software Manual* for the detailed configuration and download methods.

4.10.2. Load Data

Press the Load Data, using ,  to choose and download the test task from PC-based software..



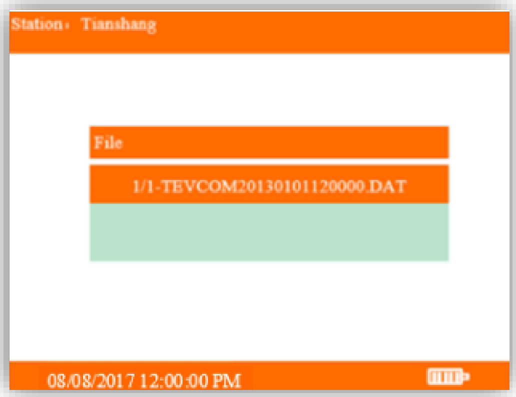


Figure 4.26. HFCT PRPD2D-PRPS3D spectrum

- **Detecting site**: the exact location of the switchgear for detecting operations.

  Press **Test Position**, enter the Switchgear selecting menu, you can choose different switchgear within the substation to detect, in front of each name of the switchgear, there is a total number of all the switchgear and the serial number of the current switchgear, such as 1/3, 2/3, etc. you can press UP or DOWN button on the device to change different equipment. Press the OK button on the device and enter the detection screen after you finish choosing the switchgear to detect.

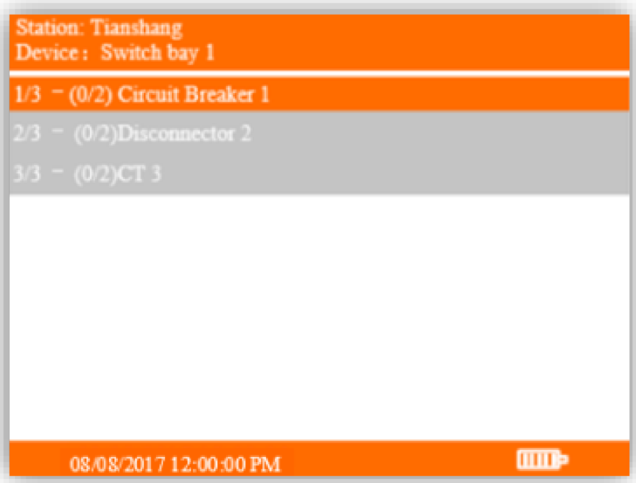


Figure 4.27. Testing Job by Equipment

The PD test position is the place on the high voltage electrical equipment where you shall put the detection instrument on. The test position is different with different high voltage electrical equipment. It is chosen according to the structure of different high voltage electrical equipment. For TEV detection of switchgear, the main test position is the middle part and lower part of the front face panel, the upper part, middle part and lower part of the back-face panel, and the upper part, middle part and lower part of the side face panel. The detection position for TEV detection shall near the observant window of the metal face panel and other parts which the PD signals are easy to leak out from. For AE ultrasonic detection, you shall move the AE ultrasonic sensor along the gap of the switchgear to scan for any signals escaping.

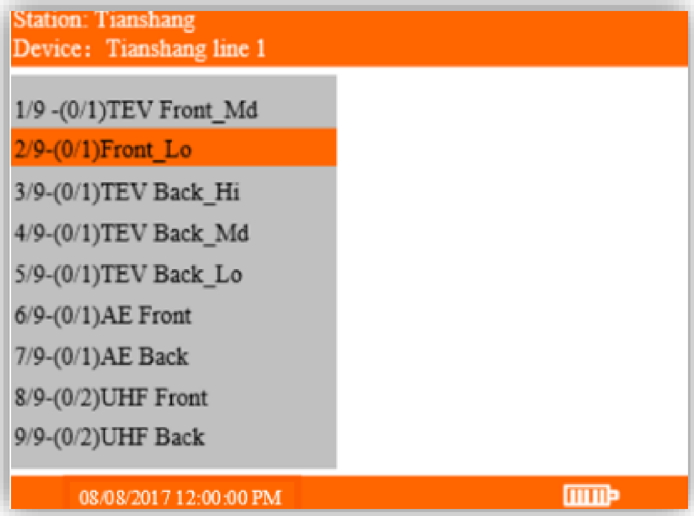


Figure 4.27. Testing Job by Test Point

Enter the test menu, press the up button and down button on the device to choose the test positions, such as front middle part, front lower part, and then press the ok button on the device to save the data detected into the data sheet configuration.

When finishing testing the switchgear, as said above, press the ESC button on the device, then you can reenter the switchgear choosing menu to choose the next switchgear to detect. Press ESC for multiple times to gradually exit the test interface.

For the data communication between the data collected and the computer, please refer to the *PDetector Software Manual*.

4.10.3. Delete Data

Delete data previously collected using the RFID option.

5. Field Testing Options and Data Analysis

5.1. TEV Sensor Field Testing and Data Analysis

5.1.1. TEV Field Testing

TEV is applicable to 3-45kV switchgear testing and in the testing process, the TEV sensor is used by making contact with the outer surface of the equipment being tested, which does not affect the normal operation of the equipment. Due to the presence of outside noise interfering in the operating environment of the switchgear, the background noise needs to be verified before conducting the test on the equipment.

TEV background detection: Before starting the test for Partial Discharge in the switchgear, the background noise level of the system should be tested. The test point should be in the open air and should be selected 1 meter above the switchgear, metal background values should be taken from the surface of metal products such as metal doors, metal gates, and other non-switchgear equipment, testing the different points' background values in different positions of switch room and also being able to test in place where background values are need to be tested.

Switchgear PD TEV Detection: When using TEV detection, the testing location is the point on the electrical equipment that the sensor makes direct contact with the surface. The detection point is different due to different type of electrical equipment, which is based on the configuration of the power parts. In the switchgear Partial Discharge testing process, the location of all electrical equipment should first be determined, mainly testing Partial Discharge of busbar (connections, wall bushing, supporting insulator), circuit breakers, CT, PT, cable joints and other equipment, most of these parts are located in the middle and lower parts of the front face panel of the switchgear and the upper, middle and lower parts of the back panel. We should conduct Partial Discharge detection in these locations of the switchgear. Test points are shown in Figure 5.1. In the testing process we should ensure that the sensor and switchgear metal panels are **in close contact,** and the sensor should be as close to the observation windows, ventilation louvers and other parts of metal panel that the PD signal can easily escape from. If the detected value is large in magnitude, **it is recommended to measure more than three times to make sure the test results are consistent.**

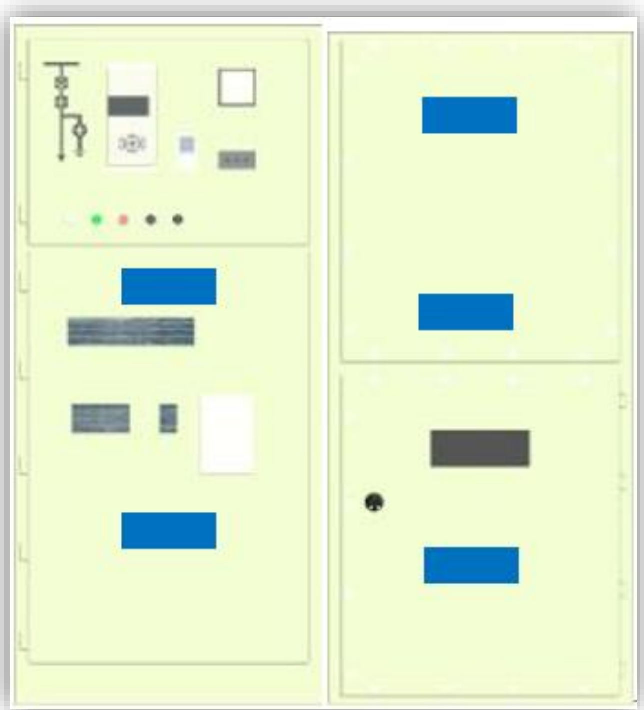


Figure 5.1. Selecting switchgear testing points (Blue points are TEV measurement points)

5.1.2. TEV Data Analysis

By comparing the TEV detection data with other relevant information, you can determine if there is PD. Test results of switchgear should be compared with detected data of other switchgear of the same types or compared with previous test data of itself for trending. If the test data is larger in magnitude than other switchgear of the same type, or than the previous results, it shows that there is discharge activity in this switchgear, and then infer the possibility of failure. According to a large number of experiments and on-site testing experience, we have concluded the following ways of interpreting data for testing personnel to use:

Threshold Value Determination

Project	Cycle	Standard	Explanation
TEV Detection	1) 6 months to1 year 2) After put into operation 3) After maintenance 4) When deemed necessary	1) test value<10dB, no failure 2) 10 <test value <20dB, attention, shorten the testing cycle 3) the test values> 20dB, using the UHF method for testing, to determine the signal type initially, or use acoustic-electric combination detection, to determine the signal source 4) test values in the context of a stable situation – background values> 10d, using the UHF method for testing, to determine the signal type initially, or acoustic-electric combination detection, to determine the signal source	Each station should use the same testing instrument for all switchgears during testing. UHF Partial Discharge detection and localization testing can be carried out when there are unusual circumstances while collecting test data to make a comprehensive judgment. 1) The new electrical equipment should be tested once after being put into operation for a week. 2) The relative value: Numerical difference between the value of the equipment under test and environmental value(metal). 3) A more permanent on-line monitoring solution that can be carried out when there are abnormalities within the system. **[Attention should be attached that TEV detection only test the signal through the capacitive**

		5) The value of this test - the last cycle test values> 10dB automatically determined by the software after data enters the computer.	**coupling sensor, which can simply display the amplitude of the discharge, no further analysis of the signal type is provided; Being able to conduct UHF detection for abnormal signals, analysis and determine the type of signals.]**

Horizontal Comparison Method

Horizontal analysis techniques are applied to compare and analyze the same test results of indoor switchgear, and it's used to find the switchgear that has higher probability of defects.

Indoor switchgear generally shows a horizontal shaped arrangement according to the order number. Since the majority of indoor switchgear are from the same manufacturer, the operating life is also not so different from one to the other, operating environment and electromagnetic environment are also essentially the same, it can be considered that the switchgear which are under normal operation, the insulation level of the switchgear should not be significantly different. Therefore, by calculating the overall average level of the same test result done multiple times, and measuring the degree of deviation from the overall average level for each of the switchgear, it can be determined whether there are insulation defects within.

As there is little difference between the measurement results of each switchgear that are operating under normal circumstances, so basically the horizontal analysis bell curve fluctuates in the overall average, the resulting bell curve should not be very prominent. However, when the test result of switchgear deviates significantly from the overall average, a higher probability of a defect being present can be considered within this switchgear.

Trend Comparison Method (Vertical Comparison Method)

Trend analysis assumes that a certain switchgear insulation level doesn't deteriorate suddenly; continually testing the switchgear should not show a major jump in magnitude. That is the amount of change remains stable and fluctuates up and down around the average level. Therefore, by analyzing the degree of change in the deviation from the average level in a particular Partial Discharge detection data to determine whether there are insulation defects and the defect severity of the switchgear. Trending analysis is based on the continually collect data, the greater the amount of data, the shorter the interval, the more accurate the results.

5.2. AE Ultrasonic Sensor Field Testing and Data Analysis

When Partial Discharge signal generates inside the electric equipment, impact vibration and sound will be produced. AE Ultrasonic measurement method measures Partial Discharge signals by placing ultrasonic sensor on the outside enclosure of the equipment chamber. The characteristic of this method is there isn't any contact between the sensor and electrical circuit of electrical equipment, without noise from electrical aspects, but being susceptible to the ambient noise or mechanical vibration of equipment when used in the field.

Since the attenuation of the ultrasonic signal in the common power equipment insulation material is large and detection range of ultrasonic testing method is limited, but has the advantage of accurately pinpointing the abnormal signal being produced. Ultrasonic sensors are divided into two types; one is the contact-type ultrasonic sensor for collecting data from the fully enclosed high-voltage electrical equipment, such as the GIS, the transformer and another is a non-contact-type ultrasonic sensor used for collecting data from the open or semi-closed high-voltage electrical equipment such as switchgear, cables, transmission lines, etc.

5.2.1. Ultrasonic Field Test

Contact ultrasonic sensor is for collecting data from the metal casing vibration signals that ultrasonic signal generates by Partial Discharge and is produced when propagating in the metal casing of the equipment under test, which needs to be applied by the following methods:

- The sensor should be directly affixed to the outer surface of the equipment and make sure that the contact surface is smooth with no impurities or dirt present;
- Apply a 1mm thick coating of vacuum grease on the sensor's surface, ensure the gelatinous grease layer contains no bubbles; Contact ultrasonic attenuates

quickly in the air. Any small air gap between the sensor and the attachment to the surface may cause the ultrasonic signal not to be effectively measured. The sensors with a coupling staff should be ensured to be fixed onto the case of equipment with no requirement of external force.

- Since the ultrasonic wave attenuates fast, therefor when conducting Partial Discharge ultrasonic testing, the distance between the two testing points should not exceed 1m/3.28ft. For testing of GIS, for example, the testing process should include all the gas chambers, as shown in Figure 5.2.
- When conducting Partial Discharge ultrasonic testing, they should focus on both ends of installed detection equipment, in order to detect potential defects generated during the installation process.

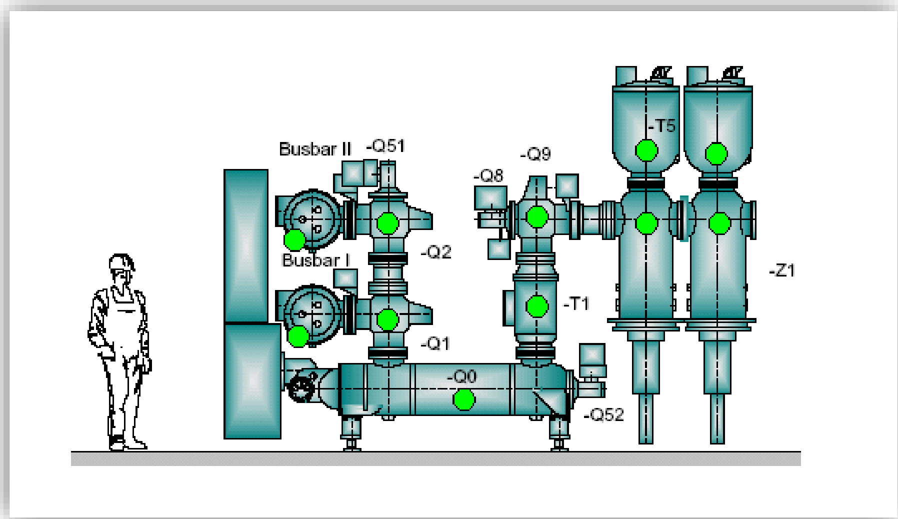


Figure 5.2. GIS AE Ultrasonic Partial Discharge Detection Typical Measuring Points (Green markers shown)

For the application of air-insulated Partial Discharge phenomenon, the spectrum is very low, often only hundreds of kHz. At this time the non-contact ultrasonic sensor is undoubtedly the most sensitive way for detecting Partial Discharge activity. In order to make non-contact ultrasonic work normally, there must be an unobstructed path for the air to flow between the power supply and sensors. **For Partial Discharge activity of internal solid insulation, due to the poor coupling relationship between at attenuation of the insulating medium itself and air - solid, making the ultrasonic signal stimulated by Partial Discharge difficult to propagated to external high-voltage equipment, so non-contact sensors have a difficult time capturing the discharge activity in the internal insulated medium, such as cable head, insulators, and bushings. However, for creepage and surface discharge that occurs due to the outer insulation, the sensitivity of non-contract sensors performs quite well.**

The non-Contact ultrasonic sensor is used for detecting vibration signals through the air that is an ultrasonic signal generated by Partial Discharge when propagating through the air. This sensor is implemented by using the following methods:

The sensor should be close to the outer surface of the equipment (close enough to ensure the air passage between the sensor and equipment). Align the direction of the sensor probe toward the suspected malfunction of the equipment; to test switchgear, for example, the testing process should include all the gas chamber, as shown in 5.3.

- **During the testing process the sensor should remain stationary, avoiding any possibly influencing of the test results because of the sensor jittering;**
- **Non-contact ultrasonic sensor should retain an adequate safe distance with the equipment high voltage parts.**

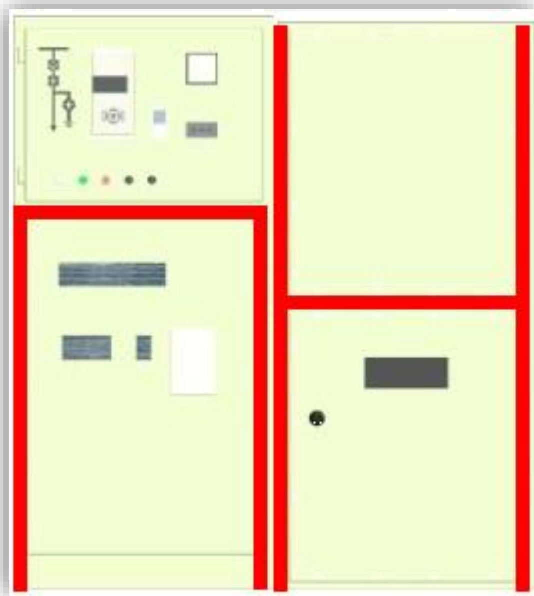


Figure 5.3. Switchgear Ultrasonic Partial Discharge Detection Typical Measuring Points (Red portion shown)

Optional Accessories:

AE Ultrasonic Dish with Laser Pointer: The focused ultrasonic sensor uses parabolic dish to collect ultrasonic signals in the air, which can effectively detect Partial Discharge activity from a safe distant.

Focused ultrasound transducer has a high-precision laser sight, so that it may get a better alignment with the distant high-voltage equipment, and locate the Partial Discharge signals. This dish is transparent, allowing users to observe the equipment being testing without obstruction.

AE Ultrasonic Extension Microphone: For ultrasonic testing, out of reach position or edge, corners, and other testing parts that are difficult to test located on the switchgear. Pay attention to ensure adequate safety distance when in use.

5.2.2. Ultrasonic Data Analysis

When conducting ultrasonic testing, we should pay attention to the real ultrasonic signals generated by the Partial Discharge for the characteristic cracking sounds (hissing sound) that can be heard with the use of the headset. When recording test data, the ultrasonic maximum stability in this test that should be looked at more closely. And in accordance with the sound, amplitude and other characteristic spectrum signals of detection to determine whether there is Partial Discharge and what type it might be. According to many experiments conducted by PMDT and testing experience gained while on-site, we have concluded the following testing criteria for personnel to use:

Project	Cycle	Standard	Explanation
Ultrasonic testing	1) 6months to1 year 2) after put into initial operation 3) After maintenance 4)When deemed necessary	1) Floating electrode discharge; Typical spectrum of this type of defect has the following characteristics: ● In the amplitude detection mode, the signal RMS and PEAK are large. There is an obvious frequency content x1 and frequency content x2, and the frequency content x2is larger than the frequency content x1; ● In the phase detection mode, the signal has an obvious effect of phase aggregation, showing up as two clusters in a power frequency cycle, that is, "bimodal" feature; ● Under waveform detection mode, the signal shows up as a regular pulse signal and two clusters appear within a power frequency cycle with considerable amplitude. 2) Corona defects; Typical spectrum of this type of	When testing, use the same testing instrument. UHF Partial Discharge detection and localization testing can be carried out when there are unusual circumstances, collecting test data to do comprehensive judgment. 1) The new equipment should be tested once after being put into operation for a week. 2) A more permanent on-line monitoring solution that can be carried out when there are abnormalities within the system.

		defect has the following characteristics: ● In the amplitude detection mode, the signal RMS and PEAK are large. There is an obvious frequency content x1and frequency content x2, and the frequency content x1is larger than the frequency content x2; ● Under the phase detection mode, the signal has an obvious effect of phase aggregation, showing up as one cluster in a power frequency cycle, that is, "single peak" feature; ● Under waveform detection mode, the signal shows up as a regular pulse signal and a cluster of a large signal and two clusters of signals that one is of significantly large amplitude and another is significant smaller appear within a power frequency cycle. 3) Free metal particle defect; Typical spectrum of this type	

		of defect has the following characteristics: ● In the amplitude detection mode, the signal RMS and PEAK are large, but the frequency content x1 and frequency content x2 are not obvious; ● In the phase detection mode, the signal doesn't have obvious effect of phase aggregation, similarly distributing evenly in a power frequency cycle; ● Under waveform detection mode, the signal has an obvious high magnitude pulse, but the correlation between this pulse signal and the power frequency voltage is small, which appears with certain randomness. ● Under pulse detection mode, the signal showed obvious "triangular hump" shape.	

Table: Ultrasonic Detection Abnormal Spectrum Analysis

Parameter		Floating Electrode Defect	Corona defects	Particle defects
Amplitude detection mode	RMS	High	A little High	High
	PEAK	High	A little High	High
	frequency content x1	Weak	Have	Have
	Frequency content x2	Have	Weak	Have
Phase detection mode		Regular, two clusters of signal one cycle wave and the amplitude is almost equal	Regular, a cluster of signal one cycle wave or a large signal and small signal	No law
Waveform detection mode		There are laws and a periodic pulse signal	There are laws and a periodic pulse signal	There are certain rules and different cycle pulse signal
Pulse detection mode		No law	No law	Regular, triangular hump shape

5.3. UHF Sensor Field Testing and Data Analysis

The basic principle of unique high-frequency detection method is in detecting UHF electromagnetic waves/signals, with a frequency range between 300MHz ≤ f ≤ 3GHz, generated by Partial Discharge on the power device by using UHF sensors to get relevant information resulting in the occurrence of this phenomenon to achieve Partial Discharge live measurements. Depending on the different equipment in the field, you can use built-in UHF sensors and external UHF sensors. As the on-site corona noise in the air mainly concentrates in the 300MHz band or less, the UHF method can effectively avoid noise on-site, with high sensitivity and anti-jamming capability, enabling Partial Discharge live detection, location, type of defect identification, and so on.

5.3.1. UHF Field Testing

For GIS, the UHF sensor testing point is non-metallic flange insulation pot, such as insulation pot with a metal shield pouring openings available for testing. GIS basin insulators of some manufacturers are shielded, this means that they are not suitable for detection by external sensors, and thus before testing the user needs to confirm whether GIS basin insulator to be tested is masked (i.e. metal cover around the GIS insulation basin). When testing, we should pay attention to the sensor that should be in close contact with the insulator pots and should be placed in the middle of two bolts confining the basin insulator to reduce the shielding of bolt for internal electromagnetic and external static noise produced by the sensors and bolts; While taking measurements, the user should ensure that the sensor maintains contact with pots insulator as much as possible and to not interfere with current readings because of the signal caused by sensor’s movement.

For switchgear, the UHF sensor testing points are the gap on the switchgear, observation windows, vents, etc.

For transformer, due to the structure of the transformer, UHF sensor can only be placed in the vicinity of the transformer casing. Pay attention to keeping a sufficient safe distance during the testing process.

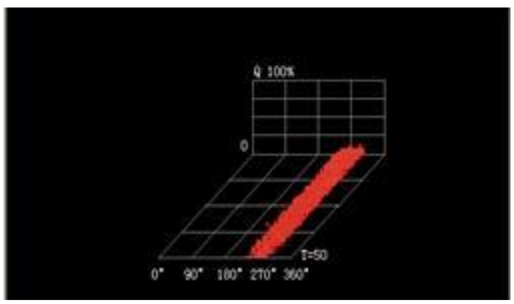
For cable, the UHF sensor testing points are cable terminal, middle terminal, etc.

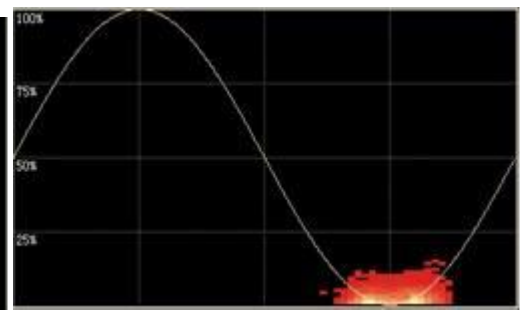
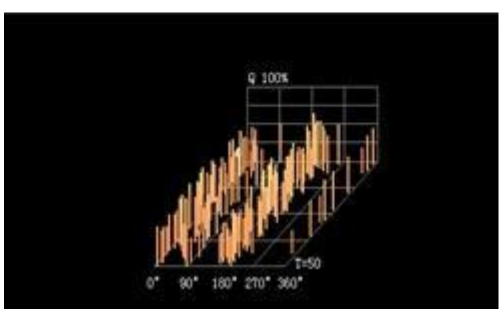
5.3.2. UHF Data Analysis

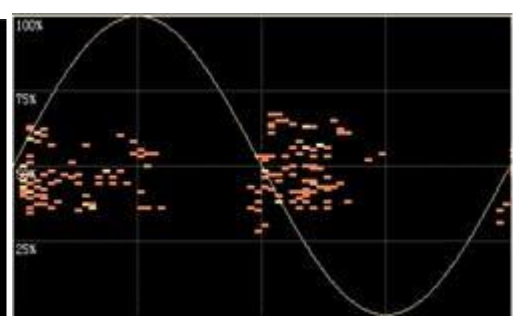
The signal characteristics generated by the Partial Discharge detected by UHF sensor are different within the spectrum. Therefore, in addition to use the signal time-domain distribution characteristic of more conventional methods; we can also identify Partial Discharge type by combining with UHF signals frequency distribution characteristics; this is done to achieve the Diagnostic of the type of insulation defect. According to a large number of experiments and testing experience on-site, draw the following judging data for testing personnel to use:

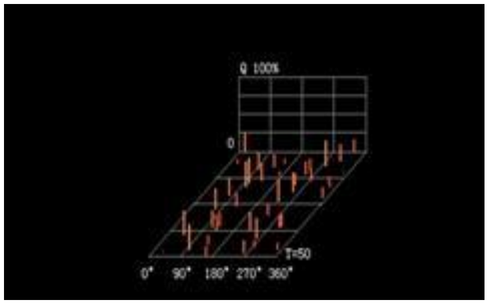
Project	Cycle	Standard	Explanation
UHF Detection	1) 6months to 1 year 2) After put into operation 3) After maintenance 4) When deemed necessary	Table 5.3.2	When detecting, use the same equipment. Localization testing can be carried out when there are unusual circumstances, collecting test data to do comprehensive judgment. 1) The new equipment should be tested once after being put into operation for a week. 2) A more permanent on-line monitoring solution that can be carried out when there are abnormalities within the system.

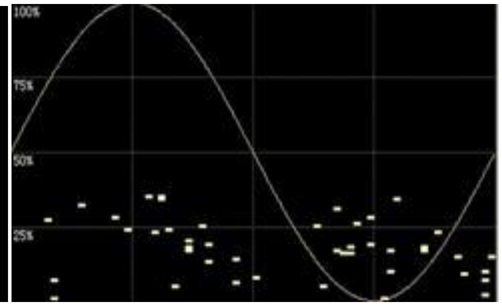
Normally during UHF Partial Discharge measurement, there may be a few possible typical PD signals: Corona discharge, void discharge, freed metal particle discharge and floating electrode discharge. The following table briefly lists the typical spectrums of several of the above listed PD signals, including various types of signal's PRPS and PRPD spectrum.

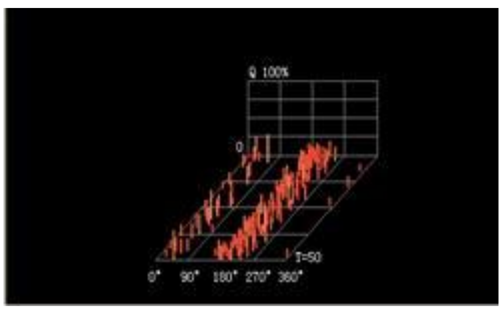
<table>
<tr><th>Type</th><th>Characteristics and Spectrums</th></tr>
<tr><td>Corona Discharge</td><td>Polarity effect of the discharge signal is very obvious, of which usually appears on the negative half-cycle or positive half cycle of power frequency phase. The discharge signal strength is weak and phase distribution is wide, with a multitude of discharges. However, another half cycle may also appear discharge signal at higher voltage levels, the higher amplitude and the narrow phase distribution and less discharge times.


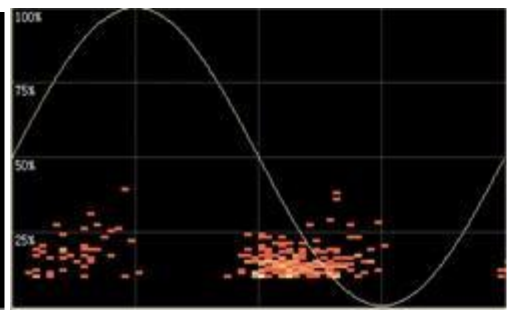

</td></tr>
<tr><td>Floating Electrode Discharge</td><td>This discharge signal usually occurs within both positive and negative half cycles of power frequency phase with certain symmetry. The discharge signal amplitude is large and the adjacent discharge signal time intervals are almost consistent, fewer discharge times and the discharge repetition rate is lower.



</td></tr>
<tr><td>Particle Discharge</td><td>This discharge signal polarity effects are not obvious, well distributed in any phase; few discharge times, discharge signal amplitude without obvious rules or pattern, the discharge signal time interval unstable. Discharge signal amplitude increases when improving the voltage level, but the discharge interval is reduced. (Note:</td></tr>
</table>

<table>
<tr>
<td></td>
<td>When testing the particle discharge, we can assist with AE ultrasonic method to detect and confirm)




</td>
</tr>
<tr>
<td>Void Discharge</td>
<td>Discharge signal usually occurs both at positive and negative half cycle of power frequency phase with certain symmetry. The discharge signal amplitude is distributed with fewer discharge times .




</td>
</tr>
</table>

5.4. HFCT Testing and Data Analysis

5.4.1. HFCT Field Test

A high-frequency current transducer (HFCT) is using a Rogowski coil with high frequency core material, which is a ring-type current transformer with a high frequency core. Sensor bandwidth is 300KHz ~ 10MHz, to obtain high frequency current signal occurred when PD of high-voltage equipment. When detecting, make the sensor fasten at the end shield ground strap, high voltage cable ground strap, transformer core and clamp ground strap to obtain signal. There should be no typical spectrums when normal. When suspecting Partial Discharge, we should compare to other detection methods and analysis comprehensively.

5.4.2. HFCT Data Analysis

Refer to Section 5.3.2

5.5. Precautions to Be Taken During Testing Process

- Transformer substation Partial Discharge test is prohibited to operate high-voltage equipment when testing. For operation, you should promptly notify the testers to stop the test and evacuate.

- Adopt the measure of taking off the wireless communication equipment when testing for a Partial Discharge signal indoor to reduce noise from affecting results.

- In online testing of Partial Discharge, noise should be thoroughly eliminated before making any judgments concerning the abnormal signal found. Taking into consideration the amplitude of the signal, size, waveform, and other factors to comprehensively determine whether the signal has Partial Discharge characteristics.

- Under normal circumstances, turning off lights in the vicinity of the test and then testing is not recommended taking into account safety issues. Only when the area is well-lit can we consider taking the test while having the lights, in the vicinity of the test, off. But in the case of finding an abnormal signal, we should test signals of lights on and off to eliminate the possibility of the signal being noise.

- When test signals are abnormal, we should check whether there is other equipment causing noise around the switchgear, such as the meter screen, air conditioning, fans, etc. When necessary, it might be wise to turn off any such equipment, if that is an option, to eliminate the noise.

- Determine whether the device is working properly before going out to test, especially checking to make sure battery has sufficient charge. Discovery of problems with the device and then impact that might have on the test after arriving at the site should be avoided.

- Partial Discharge test equipment should be verified and calibrated regularly to maintain accuracy of test data.

5.6. Abnormal Signal Diagnostic Procedures and Precautions

- Exclude Noise: Noise in the test may come from all directions. The source may be present inside or outside the electrical equipment. Before starting the test, exclude the presence of noise as much as possible, such as shut off fluorescent lamps and cellphones. Nevertheless, there is still some noise in the on-site environment.

- Record data and give a preliminary conclusion: After filtering measurements taken, if abnormal signal still persists, we need to record data from the current testing point, give a preliminary conclusion, and then detect the adjacent location.

- Attempt to locate: If abnormal signals are not located near the adjacent location, the user can determine that the signal is located internally, and that can be determined directly. If the signal can be found nearby, the signal needs to be positioned as much as possible. Discharge location is an important aspect of health of the equipment. We can probably set the source of the signal by 3D modeling method or means of other instruments. If at the external, we may be able to determine if the noise is from other electrical parts; and if at the inside, the abnormality diagnostic can be made.

- Give the judgment by comparing spectrums: Testers can compare the measured spectrum with typical discharge patterns to determine the type of its Partial Discharge.

- Save data: Accuracy of Partial Discharge type recognition depends on the accumulation of experience and data. After the test results and inspection results are determined, waveform and spectral data should be retained as a future basis for identifying the type of Partial Discharge.

6. System Parameters

Detection bandwidth	**TEV**	3 ~ 100MHz
	Ultrasound	Contact: 20kHz ~ 300kHz Non-contact: center frequency of 40kHz
	UHF	0.3 ~ 1.5GHz
	HFCT	50kHz ~ 50MHZ
Test Range	**TEV**	0 ~ 60dB
	Ultrasound	-10 ~ 60dB
	UHF	0 ~ 70dB
	HFCT	0 ~ 80dB
Accuracy		1dB
Resolution		1dB
Ambient	**Temperature**	5 ℉ ~ 130 ℉ / -15 ~ 55 ℃
	Humidity	0 ~ 90%, non-condensing
Monitor		High definition color TFT LCD
Shell		Plastic protective cover
Appearance	**Size**	7.29 "x 4.33" x 1.38 "/ 185 x 110 x 35mm
	Weight	0.9lbs / 0.4kg
Connector	**Charging and Data Connector**	Mini-USB
	Headphone Connector	3.5 mm audio connector
Charger		Input110 ~ 220V AC,50Hz/60Hz, output 5VDC/1A
Power supply		Built-in rechargeable Li-Ion battery, the battery voltage is low or automatically off when the operation is inactive.

7. Maintenance

Keeping the instrument clean and dry is very important. The instrument was not designed to be waterproof. Do not store the instrument in a humid environment. Do not exceed the temperature limit use. Don't shock and impact instrument excessively. Do not over-squeeze the instrument. Do not open the instrument and its accessories. If you have any questions about the features and operations of the equipment, consult the manufacturer or dealer. Instrument can be wiped clean with a damp cloth. If seriously contaminated, it can be cleaned with foam detergent. Take care and do not let the liquid flow into the instrument when cleaning. The instrument must be wiped with a soft cloth. Be careful not to scratch the surface of the instrument, especially a liquid crystal display.

8. Warranty

The Seller warrants that the Goods shall comply with the Seller's technical specifications, and shall be free of substantive defects in material and workmanship. Warranty period of the AE contact sensor is three months after the date of shipment. Warranty period of all the other parts is one year after the date of shipment. The seller reserves the right of providing final interpretations to the technical specifications of the supplied goods. The Seller is not liable for damage caused by shipping. The Seller shall in no event be liable for any incidental, special, or consequential damages of any nature, even if The Seller has been advised of the possibility of such damages. The Seller will repair/replace defective instruments at no cost to the customer. The Seller will not cover the shipping cost for any repair or replacement.

Attention:

The operation manual above is the manual of all PDetector functions. Since the PDetector that you have selected to buy may not come with all the configurations enabled based on the "Kit" purchased, so some functions listed above may not be available in the PDetector you purchased.

PMDT Company's development strategy is to research and develop the products continuously and keep enhancing the products performance. We have made a very great effort to ensure the accuracy of the descriptions in the above manual. However, there might still be some small inevitable differences between the details of the manual above and the actual product.

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