HTWJF-5/50 Partial Discharge Detector System Solution

I.Overview:

HTWJF-10/50 Partial Discharge Detector System can meet the AC withstand voltage test and partial discharge test for transformers . It is an ideal partial discharge detection equipment for high voltage test department of electric equipment manufacturing enterprises and electric power installation and repair engineering units.

The device is mainly composed of power frequency voltage withstand device without partial discharge, partial discharge measuring instrument, coupling capacitor, protective resistance and isolated power supply.

II.Power Frequency Partial Discharge Detector System

No.	Item	Specification	Unit	QTY	Remark
1	(PD free) Gas Type AC Hipot Tester	YDQ-5kVA/50kV	pc	1	
2	(PD free)Control Box	XC-5KVA	pc	1	
3	(PD free)Coupling Capacitor	HTCW-50	pc	1	
4	(PD free)Separated Transformer	5KVA	pc	1	
5	Protection Impedance	HT-R50KV	pc	1	
6	Partial Discharge Detector	JDF-2000	pc	1	

Ⅲ.Equipment Configuration and Technical Parameters：

1.YDQ-10kVA/50kV (PD free) Gas Type AC Hipot Tester

a)Rated power：5KVA；

b)Input voltage：380V 50Hz

c)AC Output voltage： 0～50kV adjustable

DC Output voltage： 0～70kV adjustable

d)Output voltage Frequency：50Hz

e)Phase：Singe Phase

f)Short circuit impedance：≤5 %

g)No-load current：≤10 %

h)System noise level：≤65dB 。

i)At rated voltage, its local discharge≤3pC。

j)Transformer insulation level

Winding	Rated SHORT-time operating frequency withstand voltage kV (square value)
High Voltage Winding	Power Frequency 150（5min）
Low Voltage Winding	3（1 min）

2.XC-5KVA (PD free)Control Box：

（1）Parameters:

a)Input voltage：380V 50Hz

b)Output voltage；0—400V

c)Capacity：1.5KVA—10KVA

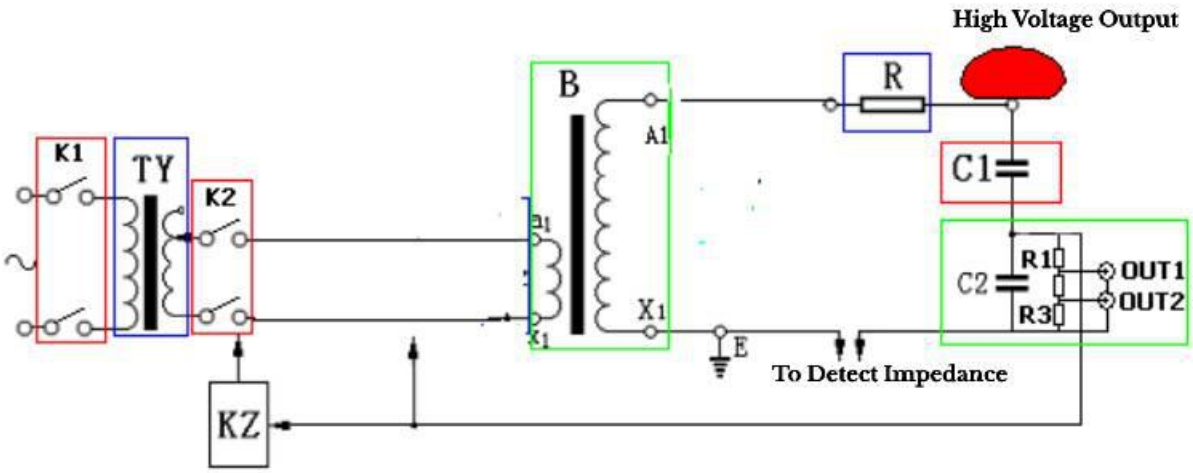
d)voltage distortion：<3%

e)Output Display：Digital voltage, ammeter

f)Display Accuracy：1％

g)Protection：Overvoltage protection, overcurrent protection

h)control mode：Voltage regulator manual i)Digital timer：Alarm when the time is up



3. (PD free)Coupling Capacitor

a) Rated voltage: 50kV

b) Nominal capacitance: 500pF

c) Nominal partial pressure ratio: 1000:1

d) Dielectric loss: < 0.3%

e) Measurement accuracy: < 1%

f) Operation time: same as transformer

4. (PD free)Separated Transformer

a) Rated power: 5KVA;

b) Input voltage: 220 V, 50 Hz

c) Output voltage: 250V

d) Output voltage frequency: 50 Hz

5. Protection Impedance

a) Rated frequency: 50 Hz

b) Rated voltage: 50kV

c) Rated current: 1A

d) Nominal resistance: 4K Ω

e) Operation time: same as transformer

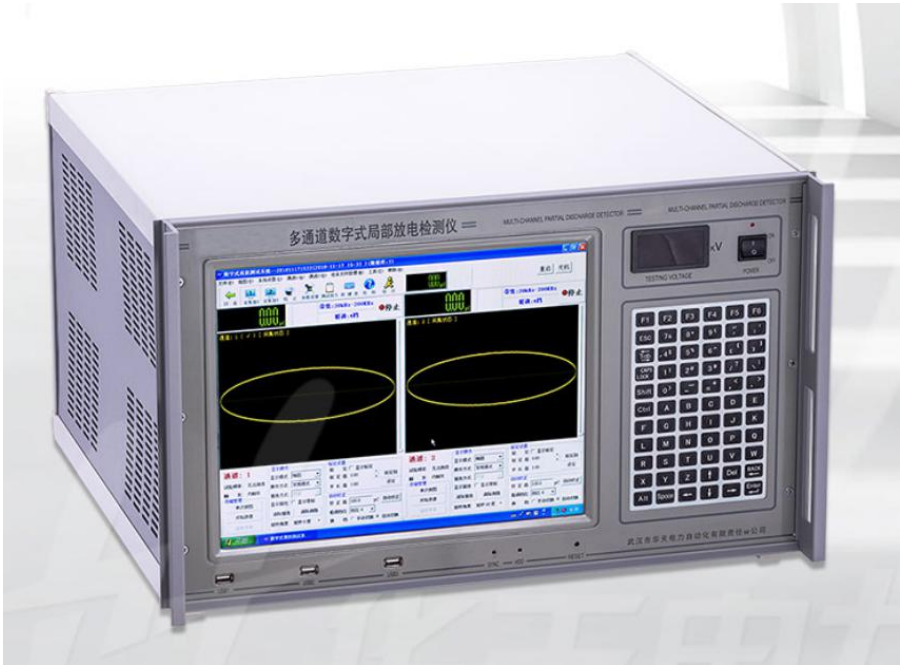
6. Partial Discharge Detector：

6.1 Basic Instrument Overview

（1）Model：JFD-2000A

（2）Product Application Scope：Be suitable to measure and monitor the partial discharge of transformer of any voltage grade, generator, arrester, tube, GIS, capacitor, cable, switch, and other electrical–equipment which work in high-voltage

6.2 Product Pictures



6.3 Product standards

- GB / T16927 -----《high voltage test technology》
- IEC60270 -----《partial discharge measurement》
- GB / T7354-----《partial discharge measurement》
- GB 1094-----《Power transformer》
- IEC6067.11-----《dry type transformer》
- GB 1207 -----《Voltage transformer》
- GB 1208 -----《Current transformer》
- DL417:----- 《Guide for on site partial discharge measurement of power equipment》
- GB 12706.4----- 《test requirements for power cable accessories》
- IEC60885-3 ----- 《partial discharge test of whole extruded cable》
- GB / T3048.12 ----- 《test methods for electrical properties of wires and cables - partial discharge test》
- DL / T 846.4-2004 ----- 《General specification for high voltage test equipment Part IV partial discharge measuring instrument》

6.4 Product Structure

(1) Display: 15 inch true color TFT LCD, high brightness in industry level; display resolution: 1024 × 768; 4-digit digital tube display voltage value.

(2) External interface: USB interface; power interface; 2-way signal input port; grounding terminal; external synchronous signal input terminal; RJ45 interface; RS232 interface.

(3) Overall dimension: length × width × height (540 × 460 × 320) mm.

(4) Weight: 18kg.

6.5 Main specification

1.1 Measuring channel: 2 Independent channels

1.2 The capacitor range of test sample: 6pF~250μF

1.3 Test precision: 0.1pC

1.4 Sample precision: 12bit; Sample Rate: 20M/S

1.5 Display Mode

(1) Display Mode: Ellipse —— Sine —— Line

(2) Tigger mode: Inner trigger mode and outer trigger mode;Inner trigger mode is triggered by power, 50Hz;Outer trigger mode is to synchronize the power frequency, can be any value between 50 ~ 400 Hz.

(3) The voltage range of outer trigger signal: 10~200V, Input power <1VA

(4) Distinguish the signal phase: Ellipse displays signal with the method of polar, Sine displays as the sine wave, it's start is the zero position of phase of test power, it's length is a circle of the test power, the system exactly displays the circle, phase of the test power in the outer trigger mode.

1.6 Time Base: you can select the phase dynamically, amplify the time base dynamically

1.7 Filter frequency band

(1) On high frequency 3dB, f_H: 80, 200, 300 kHz optional

(2) f_L and f_H can be freely combined to form any filter band

1.8 Amplifier

(1) Gain adjust: gross adjustment and fine adjustment, 5 grade in gross adjustment, Gain difference between grades is 20±1dB, fine adjusting range >20dB

(2) The Asymmetry of positive, negative polar response of amp: <1dB

1.9 Partial discharge measurement

it can measure in the continous and amplified mode, the deviation: ±5% . (measured in full scale)

1.10 Data store and display。It can print and generate standard test report

1.11 Work temperature: -10～45℃, Relative humidity: ≤*95%*

1.12 AC220V; Frequency 50Hz; 300W

6.6 Product Features

- 4 partial discharge measurement channels sample, process, display independently;
- Inner, Outer trigger mode for options. Have zero mark indicator and can distinguish phase;
- Display mode: Ellipse, Line, Sine;
- Single partial discharge pulse wave analysis, to analyze it's character;
- Support to store test wave and data, playback and analyze the stored test record;
- Gain: Adjust each channel independently, it doesn't interfere other channels, and doesn't change the measurement result of other channels;
- Support capture some special or random wave and to have specific analysis;
- Anti-noise, can get rid of the interfere noise which fixed in phase;
- Anti-noise with filter, can filter out the random noise which is not synchronized with power;
- Bandpass filter adopts analog and digital filter methods, the band can be freely combined to restrain any interferes;
- Freely select within 360º with single window mode, double window mode;
- Display test voltage while measuring the partial discharge;
- Support measure, time and wave analysis with the partial discharge record;
- Display partial discharge figure in 2D, 3D

- Freely store, print partial discharge picture, data, and automatically generate test report;

6.7 Attention:

(1) First, ground the grounding terminal of the instrument, and then carry out the operation described below; when removing the wiring, finally disconnect the grounding terminal.

(2) Before the test, the insulation surface (especially the high voltage end) of the test object should be cleaned.

(3) The connection points should be in good contact, especially the high voltage terminal should not leave sharp contact points, and the high voltage wire should be as thick as possible to prevent corona.

(4) The input unit should be close to the sample as far as possible, and the grounding should be reliable. It is better to use braided copper tape for grounding wire. The host must also be grounded to ensure safe use.

(5) The test circuit should be as compact as possible, that is, the high-voltage wiring should be as short as possible, and the area of the test circuit should be as small as possible.

(6) During the partial discharge test of 110kV and above, the suspended metal objects around the test object shall be properly grounded.
(7) In consideration of the hysteresis effect of partial discharge of oil immersed sample, it is not allowed to apply high voltage exceeding the partial discharge test voltage to the sample several hours before the partial discharge test.

(8) The instrument should be well protected to prevent corrosion, moisture-proof, sunlight, and away from strong magnetic field source. The instrument shall be free from strong vibration and shockproof measures shall be taken during transportation.

(9) If conditions permit, the test object can be placed in the shielding room, which can effectively prevent interference.

(10) Before each test, the instrument should be preheated for at least 5 minutes after the instrument is connected.

(11) It is strictly prohibited to plug and plug the interface with hot line; when inserting and plugging the interface, it is strictly forbidden to keep the instrument in the state of starting up, and the switch should be turned off before the operation of plug-in interface is carried out.

(12) After calibrating the square wave, be sure to take off the wire to avoid being broken down by high voltage during the test, and then turn off the power switch.

6.8 Brief introduction of partial discharge Atlas

Different ways of connecting the measuring piece with the input unit(Fig.3).

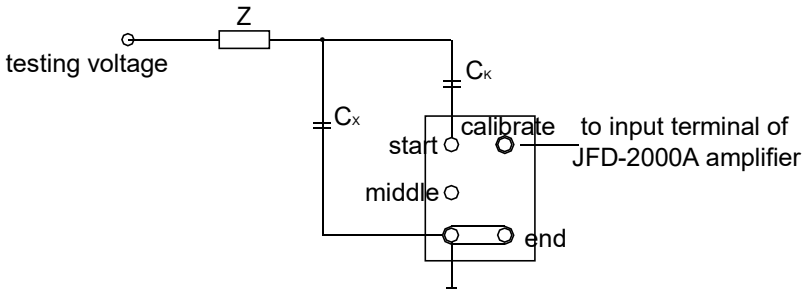


Fig 3a. Parallel connection

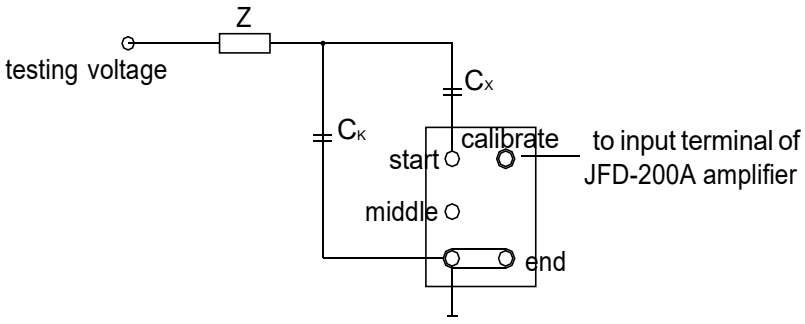


Fig.3b. serial connection

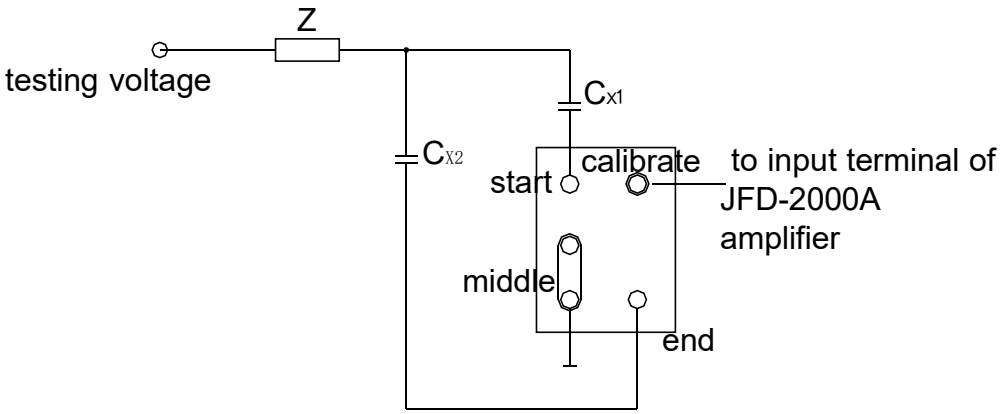


Fig.3c. Balance connection

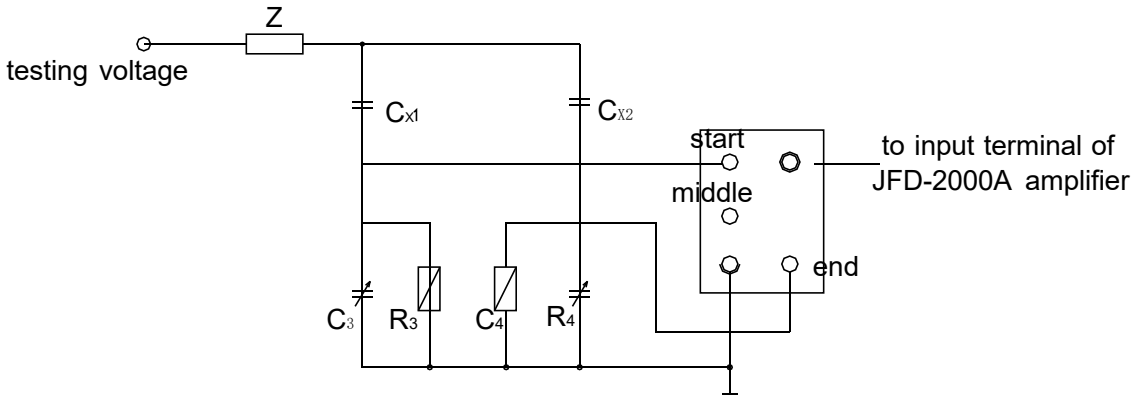


Fig.3d. Bridge connection

In these figures:
Cx--measuring pieces; Ck--coupling capacor; Z--damping impedance;
R3, C3, R4, C4- the balance impedance in bridge connection.

6.1.3 Connect the resistance divider or capacitive divider to testing voltage, then connect the output with “to high voltage resistance” outlet (31) on back panel by the cable.

6.1.4 The partial discharge measuring circuit.（Fig.4）

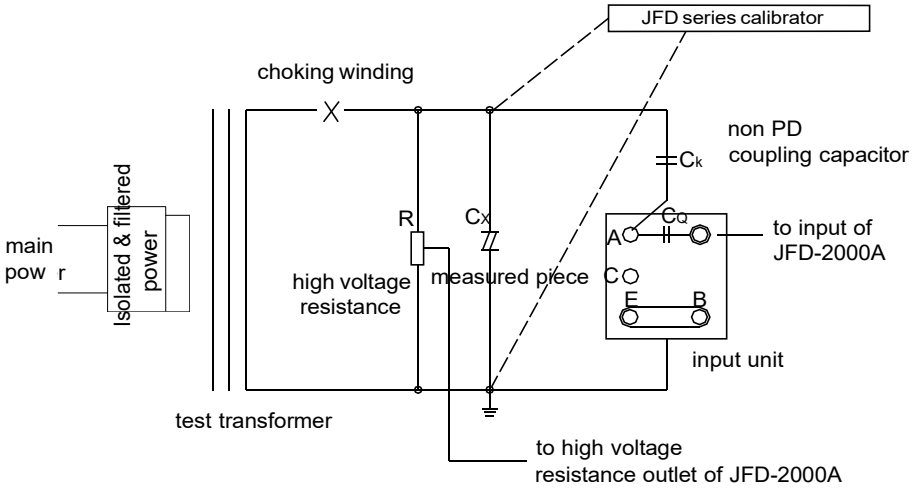


Fig.4, Standard connecting circuit of partial discharge measuring (parallel connection).

A—primary beginning of input unit; B—primary end of input unit;

C—central tap of input unit; E—ground of input unit

IV. Operation

➢ Boot interface

1. Basic function

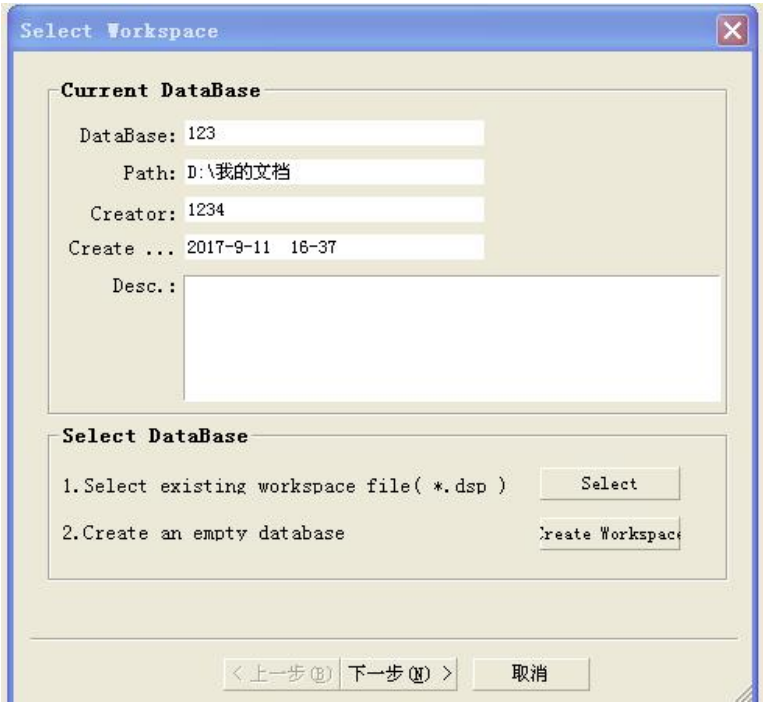
After the software is started, you will see the following interface.

You can choose: creating tasks, data analysis, soft keyboard, and help.

1.1 Creating tasks

When using the digital database management system, users only need to open the directory, and select the appropriate database project files. This method provides convenience for video storage, analysis of more users and test records management of the product.

Click the Creating Task button to open the creating test task and create the dialog box for the current workspace, as the following picture:



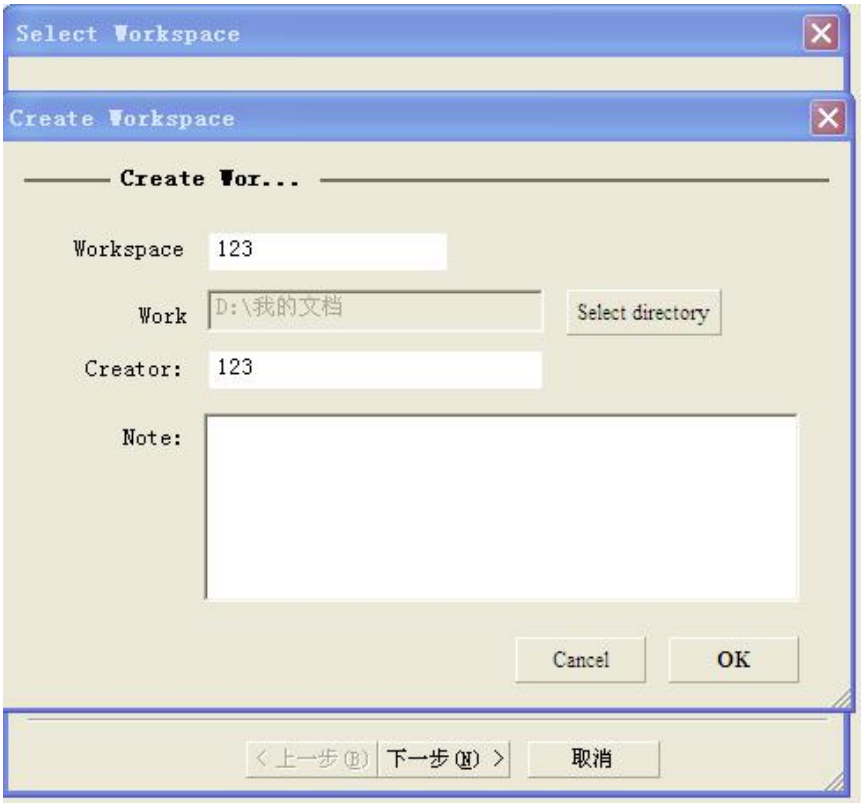
The software will automatically open the database which you selected last time.

If you want to select a new database, you can click [Select existing workspace] button, and the following dialog box will be appeared:

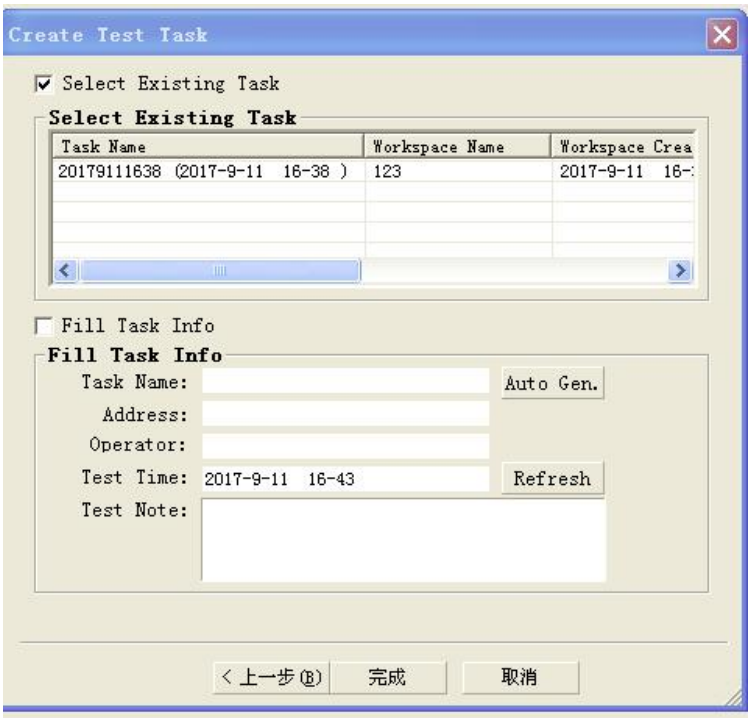
Attention: the name of the selected database must be the one with .Dsp suffix. A database includes the following parts: (1) engineering database files

with .Dsp suffix; (2) database files; (3) Data directory of the test task

Click the [create new workspace] button and the following dialog box appears:



Fill in the name of the corresponding project, and select the directory where the database works, and then click the completion button. After that, click the [next] button to enter the test task interface.



You can either select an existing test task or create a new task. Click the interface to select the existing task button, select a test task from the existing task list and double-click or click the completion button, the system will enter the measurement interface.

You can also choose to create a new task button, and then click the completion button, the system will create a new test task, and enter the measurement interface.

1.2 Data Analysis

1.3 Soft Keyboard

Click the keyboard button, you can open the software's auxiliary keyboard, as the following picture:

1.4 Help

Click the help button and you can open the help document.

➢ Analysis Part

1. Introduction of the Software function

Open the PD measurement interface as follows:

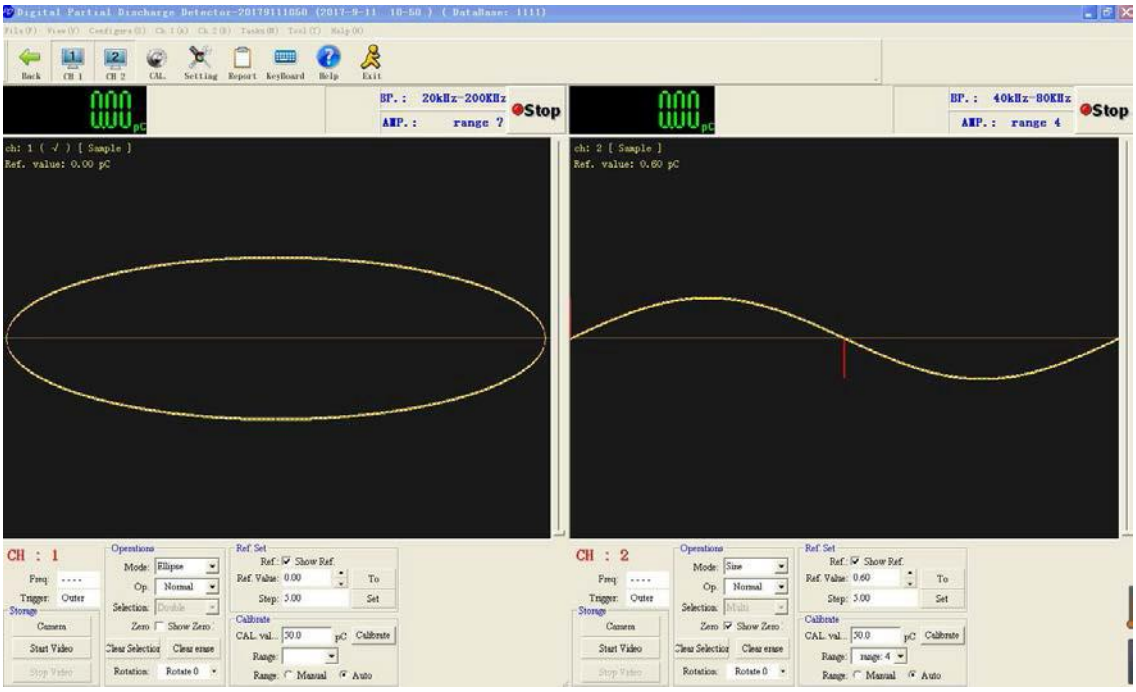


Figure 1 the PD Test interface

The interface includes three parts: (1) discharge status panel; (2) waveform display form; (3) channel control panel.

1.1 discharge status panel

The panel includes: discharge display window, test voltage display window, [run] control button, [coarse] label, [bandwidth] tab, [limit] status button. [Limit] button only will be activated for users to click after the discharge exceeds the set limit threshold.

1.2 waveform display form

The window will display real-time partial discharge waveform. If using the calibration function, [calibration value] to describe the character will also be displayed.

1.3 channel control panel

The panel display modules include: [display mode], [mode of operation], [window selection], [display properties], [clear window selection], [clear blanking], [rotation angle], [calibration settings], [storage management].

[Display mode]: There are three ways to show: elliptic model, sine model, linear model. The real-time current time base frequency will be displayed in the system parameter panel.

[Mode of operation]: There are four modes, namely conventional mode, window selection mode, amplification mode, blanking mode.

[Window selection]: This option is valid only in the windowed mode, and in other modes it is not clickable. You can select a single window, double window, or multiple windows.

[Display properties]: It indicates whether the zero mark on the display. The zero mark represents the display time of 0 degrees; 180 degrees under the zero mark represents the position of time.

[Clear window selection]: If the [Clear window selection] was selected in the current window, the operation will remove it. The window selection operation of the current channel is canceled.

[Clear blanking]: If the [Clear blanking] was selected in the current window, the operation will remove it. The previous blanking settings will be canceled

[Rotation angle]: For rotating the display part of the signal, the signal and the zero mark will rotate clockwise together, as shown in Figure 2.

[Calibration settings]: To set the calibration value, and move the calibration line.

[Storage management]: To grab the video and the current window of the discharge graphics. The graphics is stored in the form of JPG in the current task directory.

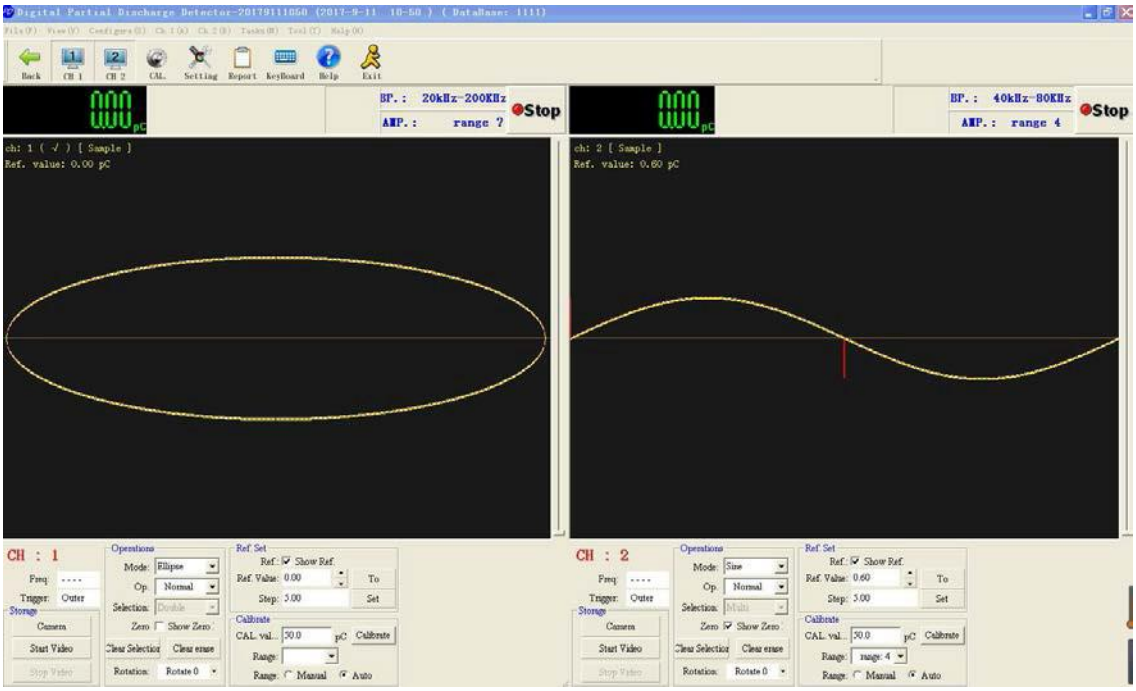


Figure 2

2. Adjustment

When carry on the PD Test measurement, connect the external test circuit and the hardware module correctly,

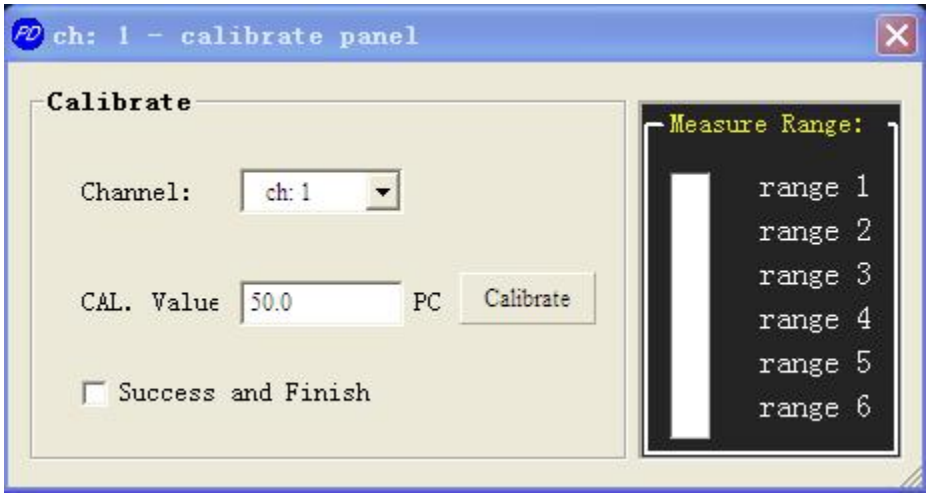


Figure 3 Adjustment panel

The system corrects the correction value automatically. The operation is as following:

2.1 The calibration pulse generator is connected at both ends of the PD test circuit.

2.2 Select the test channel which needs correction. The display window of the selected channel will display the symbol "V" (Note: the correction channel must be the current acquisition correction pulse generator channel).

2.3 Start the selected channel. In the upper panel of the channel display, click the stop button, and if the device is connected properly, the button will

become the run button. The icon on the left will become green, indicating that the channel is in the acquisition state; if the button displays the contents of [wait], indicating that the system is finding the digital substation hardware devices. If the device cannot be collected, you must find the problem, or the next step cannot be carried out.

2.4 Select the correction button from the toolbar and fill in the value in the correction value input box of the correction panel according to the input amount of the external correction pulse generator.

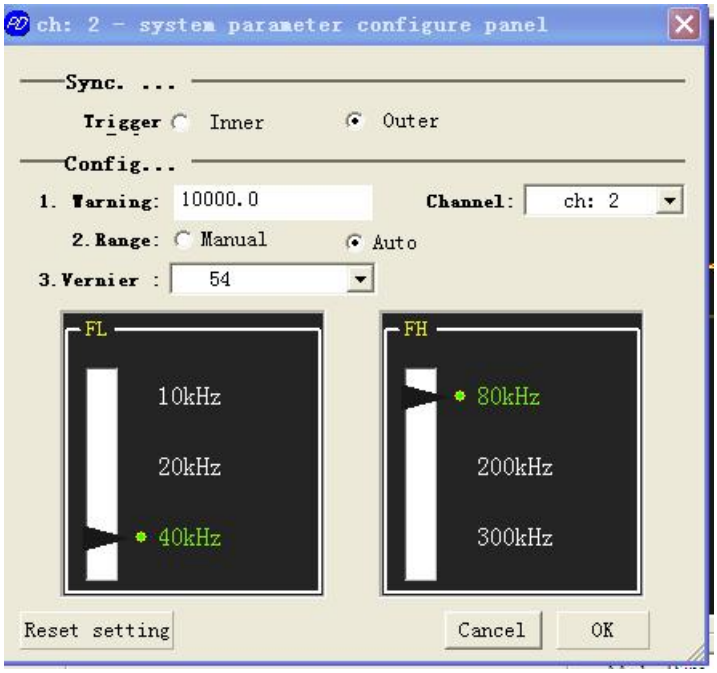
2.5 Press the [auto correction] button to correct automatically. After 3~4 seconds, the correction will be ended. If the communication fails, or the correction timeout occurs, you can click the [auto correction] button again to complete the calibration.

2.6 When calibration is done, be sure to disconnect the calibration pulse generator.

In the correction process, it should be noted that: It needs to take a series of measures to remove interference; at least the signal should be greater than the interference significantly, otherwise it will affect the results of system correction. Select the appropriate filter to filter out the obvious interference signal. Low frequency is 20kHz, high frequency is 200kHz by default. You can also use software windowing, blanking method to get stable, reliable calibration pulse generator signal.

3. Setting system parameter

In the PD test, you sometimes need to set the scope of the filter, the display effect and so on. Click the [parameter settings] button on the toolbar to open the system parameter settings panel as shown below:



3.1 System trigger mode

The system provides two trigger options: internal trigger and external trigger. Selecting here will be valid for each channel of the system. Internal trigger: the trigger frequency is the power frequency of the instrument, usually 50Hz. External trigger: The user access to a frequency of power, to control the system display cycle frequency.

3.2 Threshold of limitation

The amount of discharge displayed by the system is the peak of all discharge values in the whole trigger period. Set a limit of pC. When the discharge peak is bigger than the limit threshold, the limited lights will be flickered on the window of the corresponding channel. When the discharge peak is lower than the limit threshold after 3~5 seconds, the limited lights will stop flickering.

3.3 Range switching

In the PD test, due to the change in the discharge, the current magnification cannot meet the requirements of the measurement, or the signal becomes smaller. It needs to amplify to observe the signal in detail. **Note:** The peak value of the discharge is not directly related to its height. It is different in different ranges; so the amplitude change caused by the range conversion is normal.

Selecting the [auto switch] button, it will make the current choice of the channel into the automatic switch. If the current value is higher than the maximum value of the switching range, the system will automatically be down one step; if the minimum value is lower than the current switch range, then the system will automatically be up one step. If the "manual switch" button is selected, the system will measure all the values in the current range regardless of the amount of pC input.

3.4 Fine location

Fine tuning refers to the current position within the system to enlarge the number. When the automatic correction is completed, the fine location will be updated. The system will automatically adjust the tuning up to the appropriate location, so we do not recommend the user to set the first position here. If the user fails to set the fine position, the fine interface will automatically switch to the last fine position.

3.5 Filter

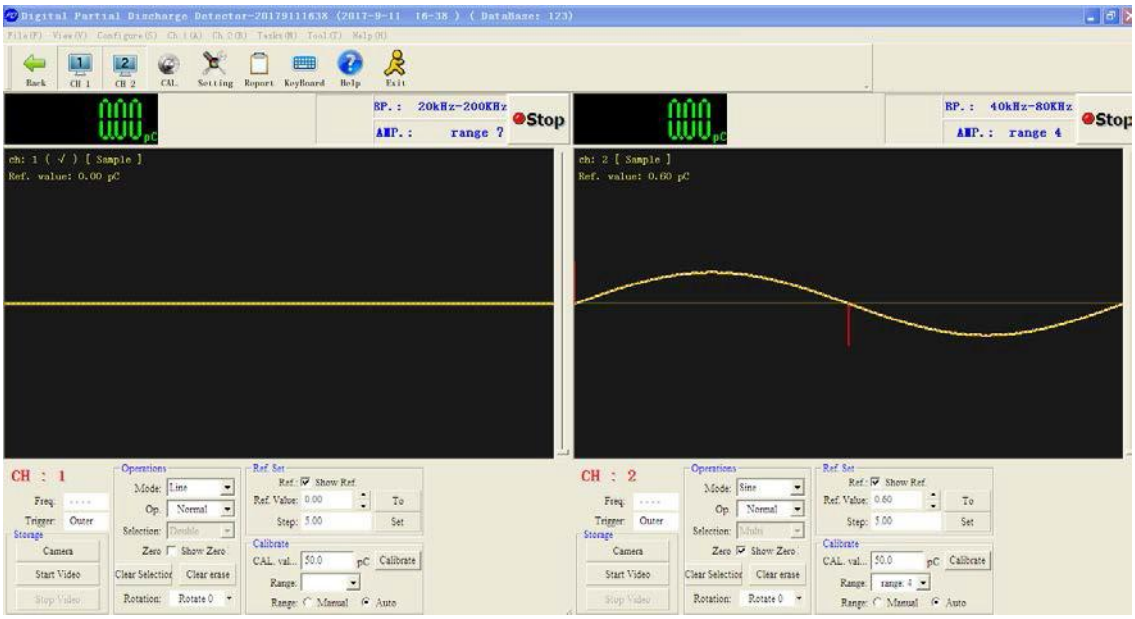
Filtering is mainly used for anti-jamming. Before correcting, we can select the filtering bandwidth to filter the current noise to get a relatively clean discharge signal.

4. System display mode

Three modes: sine mode, ellipse mode, line mode.

Sine mode

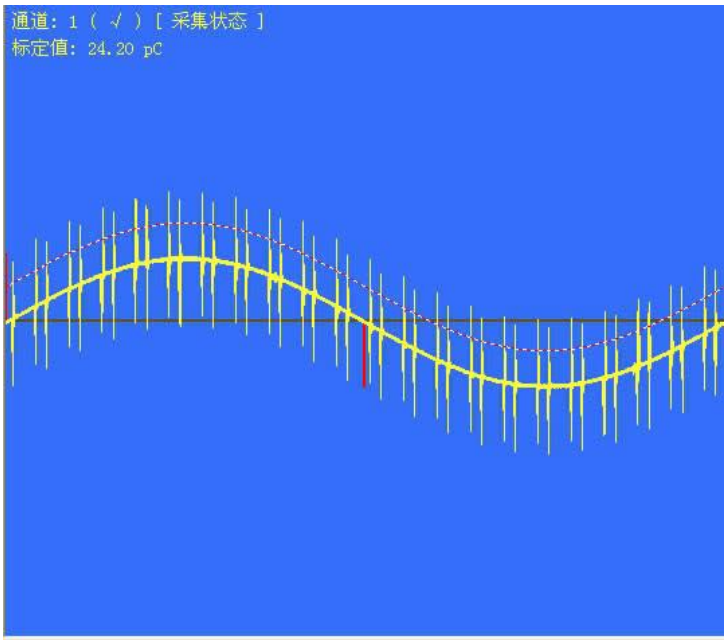
Ellipse mode



Line mode

5. Calibration function

The digital discharge window on the panel shows a discharge waveform. It shows the discharge peak in the period of the current discharge trigger above the panel. If you want to see the detailed discharge value, you can use the calibration function to achieve.



The calibration function is located in the right control panel.

Specific operations are as follows:

5.1 Before using the calibration function, select the current channel first. The current channel which is selected in the display window will be with a "√" symbol.

5.2 Select [show] button, calibration value: 27.5pC will be showed at the top of the window to specify the current calibration value. The calibration value is the same as the value shown in the calibration option of the right panel. If the calibration value is too large or too small, it will not be visible beyond the display range of the measurement window, but it is displayed.

5.3 Set the calibration value: users can enter the value directly from the right panel. Then click [calibration] button, the channel display window calibration line will be displayed in the current position of the calibration value.

5.4 Modify the calibration value: Fine calibration value can adjust the display window position calibration, and the calibration value will be changed. The change step of the calibration value is set according to the [step size] button.

5.4.1 Using the mouse wheel to move the display window calibration position.

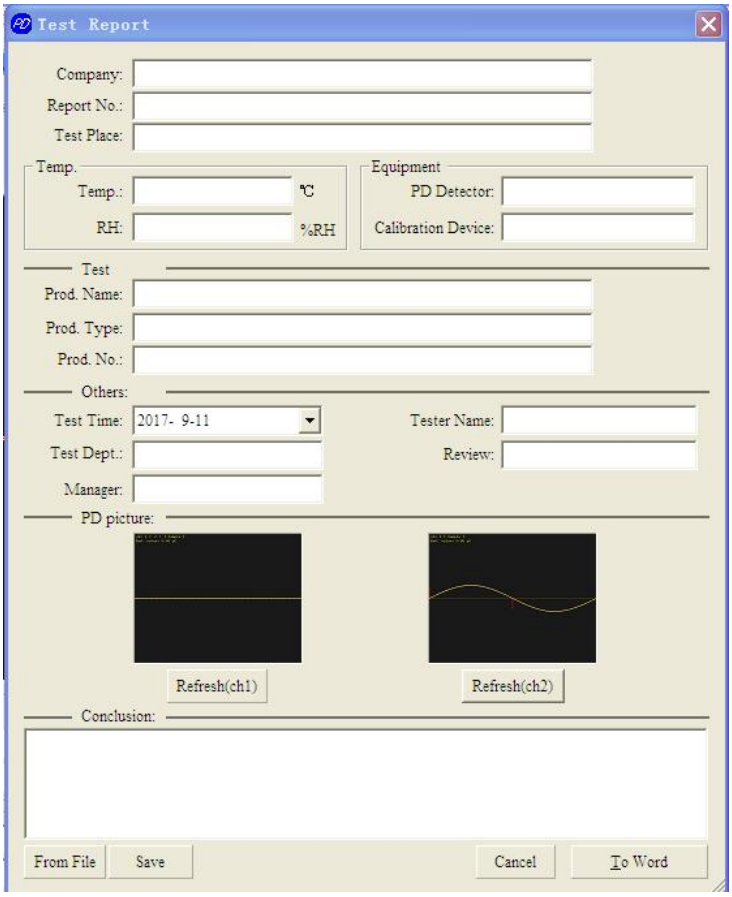
5.4.2 Using the arrow button on the right side of the [calibration value] button in the right panel to change the calibration value.

5.4.3 Using the upper and lower keys on the keyboard to change the calibration position.

Note: When the calibration value shows negative value, it indicates the negative direction of the discharge value.

6. Test report

If you need to print the test report in the PD Test, you can click the toolbar to open the edit window of the test report, as the following picture:



The report will be kept as a Word document.

6.1 Screenshot refreshing function

Users can click [refreshing picture] button to refresh the screenshot of any channel.

6.2 Storage

Users can put some parameters in the form of a file on the hard disk. When fill in the test report, users can choose the previous parameters through the [import parameters] button.

Click the [generate WORD report] button to create the WORD report:

Partial Discharge Test Report

Test No.:

test department:

Test man:		Test Date:	2017-9-11
department:			
review:		manager:	

test object:

product name:		product type:	
product no.:			

test enviroment conditions:

test place:		temp. :	℃
humidity:	%RH		

test enviroment conditions:

pd measure device:		CAL. pulse generator:	

ch 1 test record:

试验电压:	0.00 kV	pd value(pC):	0.00
CAL. pC:	50.00	range:	range -26851
lowpass FL:	20kHz	highpass FH:	200kHz
synchro-type:	Outer	synchro-freq:	----

ch 2 test record:

试验电压:	0.00 kV	pd value(pC):	0.00
CAL. pC:	50.00	range:	range 4
lowpass FL:	40kHz	highpass FH:	80kHz
synchro-type:	Outer	synchro-freq:	----

➢ Analysis of database

1. Test database inquiry

Click the query button on the toolbar to open the database query interface.

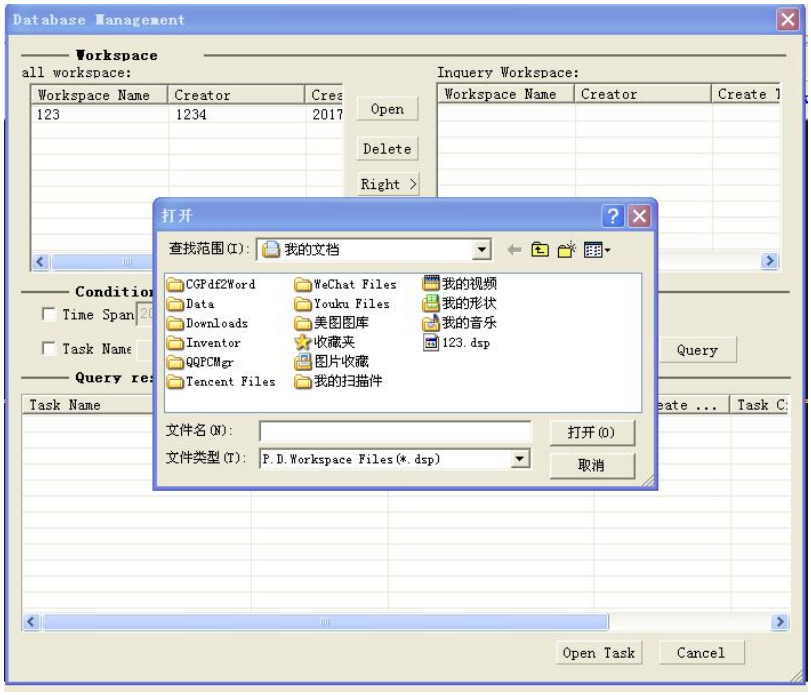


Figure 6 the database query interface

Steps:

1.1 Add database to the database query module.

Select [add] button, it will open dialog box of the DSP database. Then select the correct database files to the left of the database file list, as shown in Figure 6.

1.2 Add the database file which needs to be queried from the database that has already been added.

The conditions of the query database file can be selected: (1) the time of creation; (2) the name of the task; (3) the task executor

1.3 Fill in the database query conditions, and then click the [query], the current selected database files will be queried one by one, the resulting database records will be displayed in the list below.

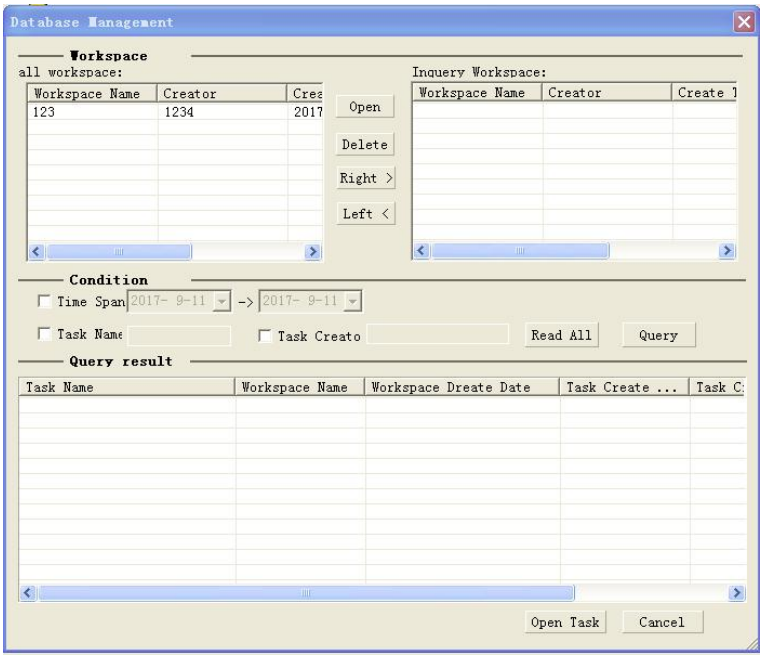


Figure 7 Query results

1.4 Select a test task record from the query's list; then double-click to open the dialog box for the test task to record details.

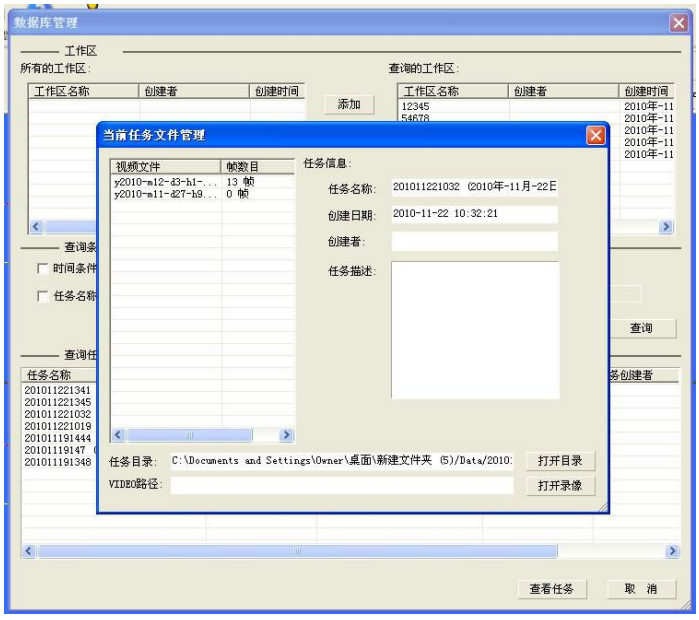


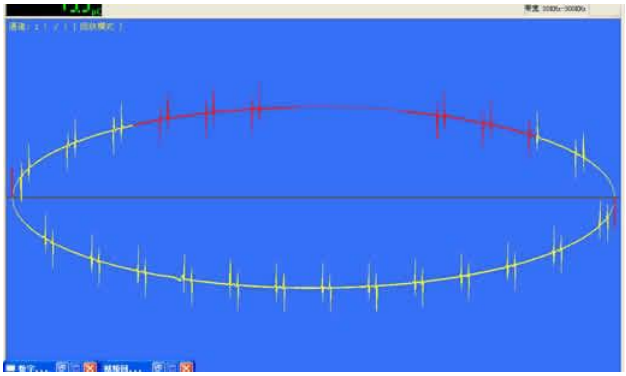
Figure 8 Page of record

The list on the left is a list of stored video files, double click, and the following information will be displayed in the current path of the selected video files. Click on the right of the [Open Video] button, it will be placed in the video playback screen.

2. Analysis of two dimensional, three dimensional

Digital PD test system provides the functions of test record database management and analysis

Open the video analysis, as the following picture, and take the detailed method of operation test.



Blanking part cannot be included in the discharge value; the window can be included in the selected part of the discharge value. Open the video analysis panel and you can see there is a corresponding change in each video analysis due to a series of operations in the video playback.

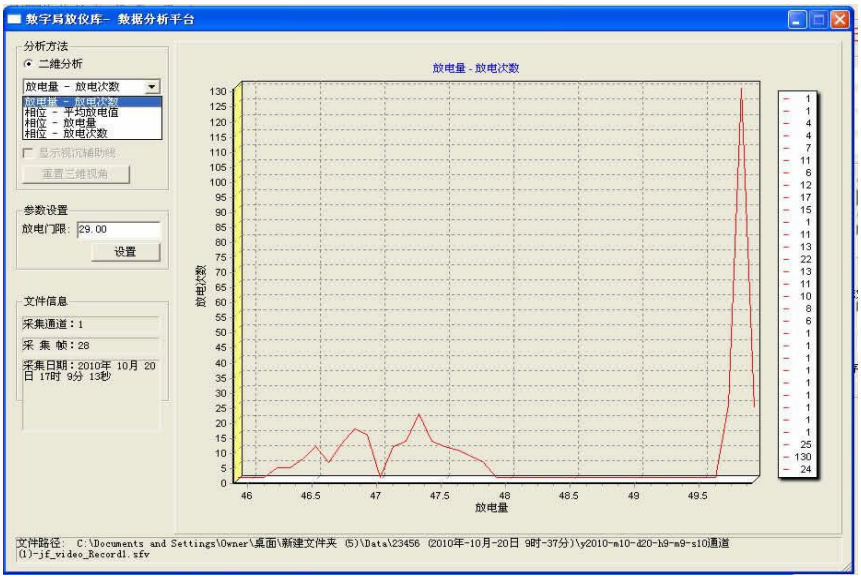


Figure 9 Discharge capacity- Discharge times

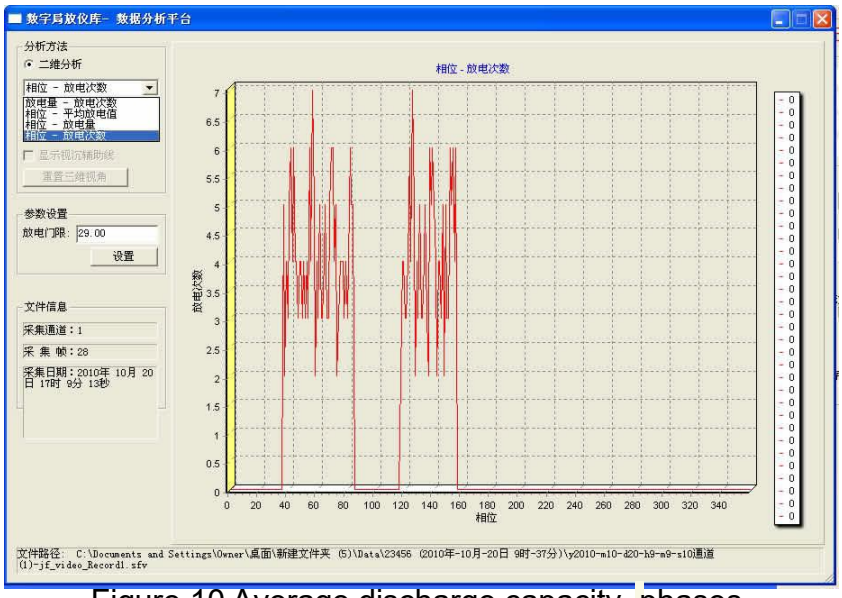


Figure 10 Average discharge capacity- phases

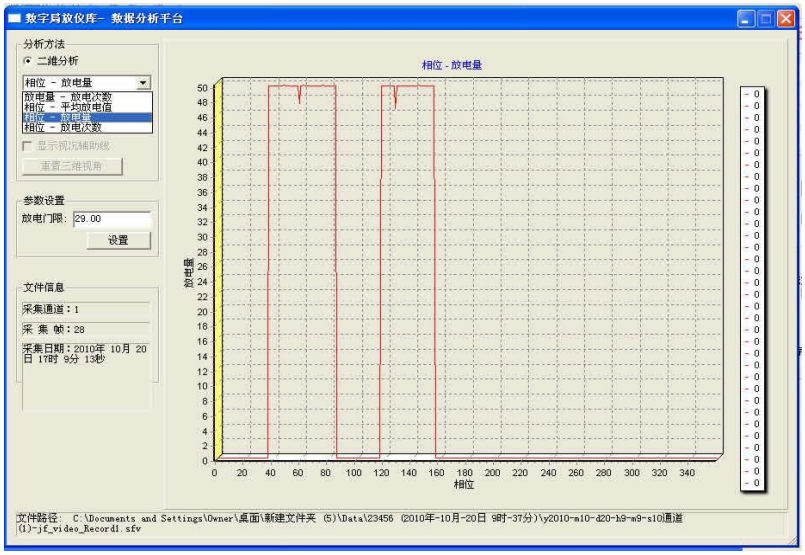


Figure 11Phase discharge

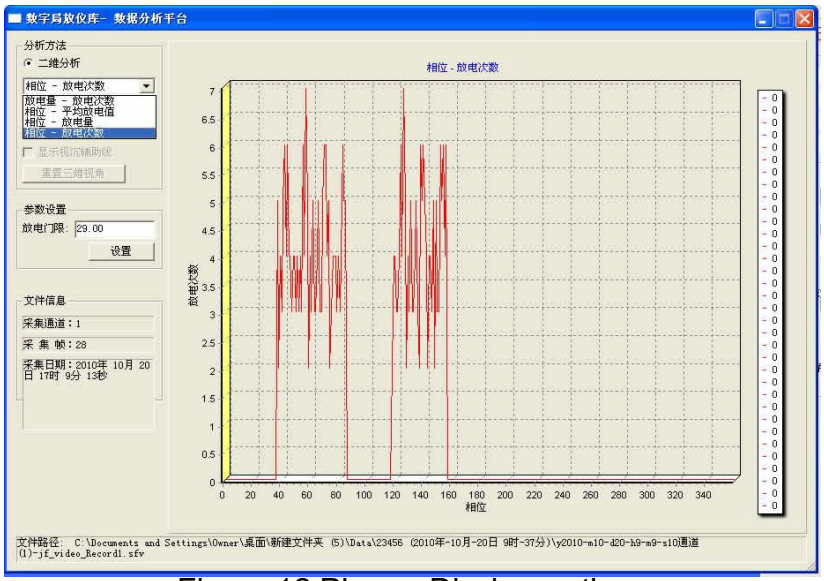


Figure 12 Phase- Discharge times

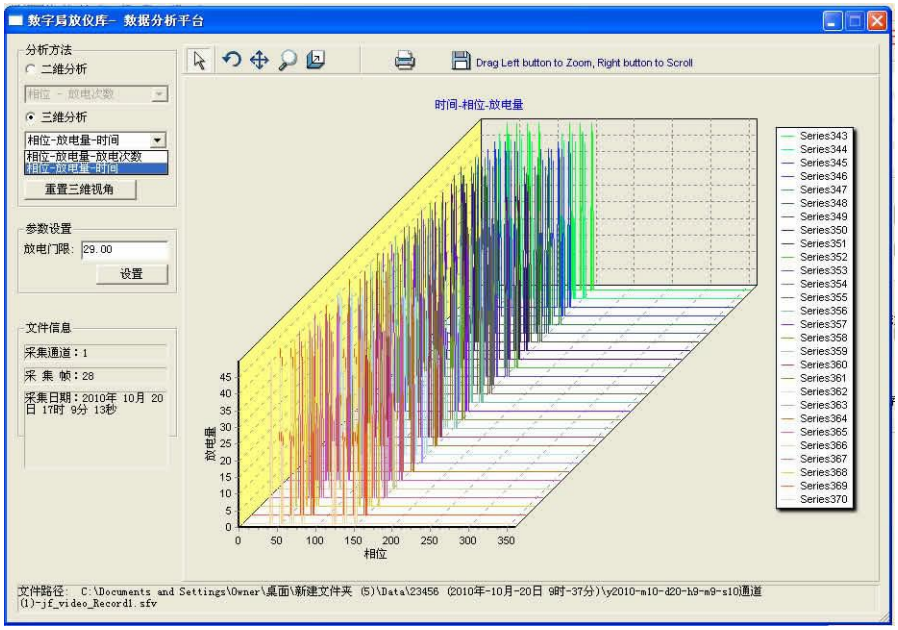


Figure 13 Time-Phase-Discharge capacities

3. Video playback

Click the [video playback] button; the video playback interface will be shown as following:

Functions that can be used: [next frame], [last frame], [fast forward], [rewind], [stop], [pause].

3.1 Fast forward、rewind

Move forward or backward into 10 frames from the currently displayed frame.

3.2 Single step

[Next frame], [last frame]: convert the video playback from the playback state to the suspended state.

3.3 A B Partial Play

A B Partial Play: Select a video of the two frames, and then control the continuous playback between the two frames. Click [>] button and it will trigger the current play into AB playback mode.

3.4 Video analysis

If you want to analyze the video of the two dimensions or the three dimensions, you can click [two-dimensional, three-dimensional analysis] button

to open the analysis panel.

V.Brief introduction of partial discharge map

(1) Identification of discharge type and discharge source

Firstly, the ellipse track on the oscillograph screen is introduced. It rotates clockwise. The positive zero mark pulse indicates that the test voltage begins to change from negative to positive; on the contrary, the midpoint between the two zero standards is the positive and negative peak positions of the test voltage.

It is a highly technical and practical knowledge to identify discharge types and various interferences from discharge patterns on ellipses (it is better to combine with other methods to confirm). CIGRE (International Conference on large power grid) has also compiled a pamphlet for recognizing the discharge pattern. It is judged according to the discharge position and movement in the discharge pattern, the consistent degree of discharge amplitude in positive and negative half cycle, and the variation characteristics of discharge amplitude with test voltage and pressurization time, which can only be roughly introduced here.

Generally speaking, the main characteristic of partial discharge, which is regarded as the formation of real internal bubble, is that most of the partial discharge occurs within two and a half weeks near the rising position of the test voltage peak.

a) Typical internal bubble partial discharge (see Figure 16), waveform characteristics: a discharge is mainly shown in the test voltage from zero to peak within two elliptical phase limits. When the test voltage exceeds UI, the discharge extends to zero. The discharge times and amplitudes of the two opposite half cycles are almost the same (the maximum difference is 3:1). D discharge waveform can be distinguished. There are several situations: 1) if the discharge amplitude increases with the increase of test voltage, and the discharge waveform becomes indistinct, it is often that there are many bubbles in the dielectric or discharge on the surface of the dielectric; 2) in addition to the above conditions, if the discharge amplitude increases rapidly with the pressure time (up to 100 times or more), it is often the bubble in the insulating liquid Discharge, a typical example is the discharge of oil impregnated paper capacitor.

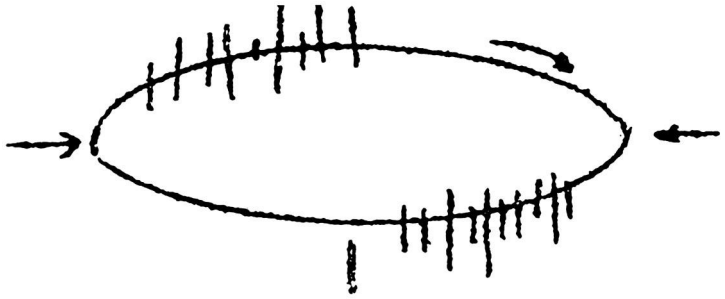


Figure 16

b) For the discharge of bubbles between metal and dielectric (see Fig. 17a), there are many discharges with small amplitude in the positive half cycle and a few with large amplitude in the negative half cycle, and the amplitude difference can reach 10:1. Others are the same as above. A typical example is the discharge of polyethylene cable with poor adhesion between insulation and conductor. If the discharge amplitude increases with the increase of the test voltage, and the discharge waveform becomes fuzzy, it often contains multiple bubbles of different sizes, or the discharge occurs between the exposed metal and the dielectric surface (see Fig. 17b).

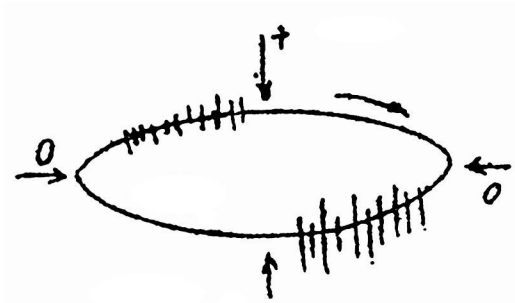


Fig. 17a

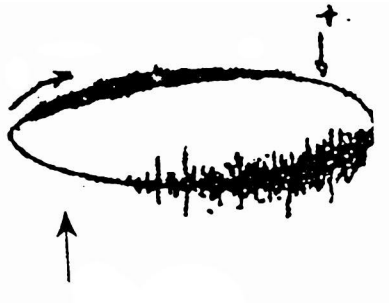


Fig. 17b

Some cases which are mainly considered as interference or abnormal discharge are discussed below.

c) The waveform characteristics of suspended potential object discharge (see Fig. 18a): it appears in two quadrants of positive and negative half cycle before voltage peak, with the same amplitude, pulse number and position, sometimes (as shown in Fig. 18) When the voltage increases, the number of elements increases and the interval decreases, but the amplitude remains unchanged. Sometimes when the voltage rises to a certain value, it will disappear, but it will reappear when it drops to this value. Cause: discharge caused by the gap between metals. The gap may be between two independent metal bodies on the ground or in the sample, such as loose shielding.

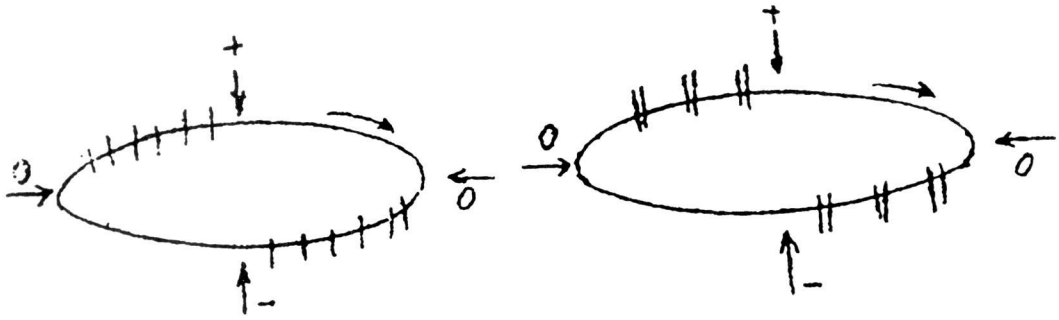


Fig. 18a Fig. 18b

d) External tip corona (see Figure 19a), waveform characteristics: the initial discharge only appears on one and a half cycles of the test voltage, and is symmetrically distributed on both sides of the peak value. When the test voltage increases, the number of discharge pulses increases sharply, but the amplitude remains unchanged and extends to both sides (as shown in Fig. 19b). Cause: high voltage tip or edge discharge in air. If the discharge occurs in the negative half cycle, it indicates that the tip is at high voltage; if the discharge occurs in the positive half cycle, the tip is at the ground potential.

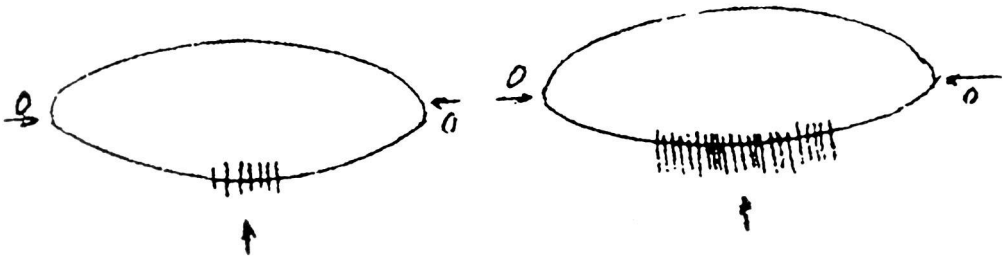


Fig. 19a Fig. 19b

e) Tip corona in liquid medium (Fig. 20a), waveform characteristics: discharge occurs in two and a half cycles, symmetrically distributed in two voltage peaks. Each group of discharge is equal interval, but a group of larger amplitude discharge appears first, and increases with the increase of test voltage, not necessarily equal amplitude: a group of small amplitude discharge amplitude is equal, and does not change with voltage (as shown in Fig. 9b). Cause: the tip or edge discharge in insulating liquid, if a group of large discharge occurs in positive half cycle, the tip is at high voltage; if it appears in negative half cycle, the tip is at ground potential.

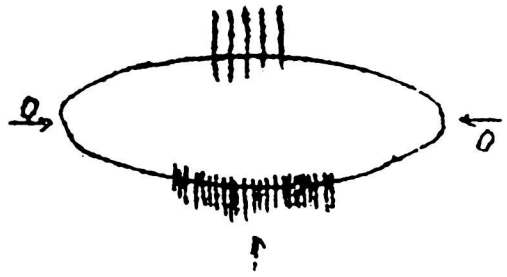


Fig. 20a

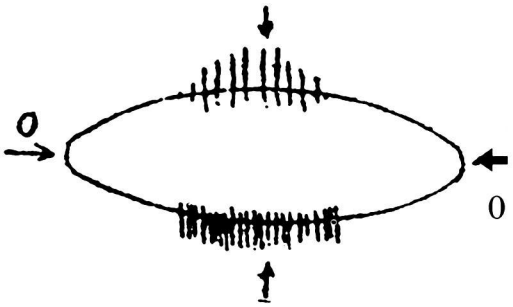


Fig. 20b

f) Poor contact (Fig. 21), waveform characteristics: symmetrically distributed on both sides of the zero point of the test voltage, the amplitude is roughly unchanged, but it drops to zero near the peak value of the test voltage, and the waveform is rough and unclear. When the voltage increases, the amplitude increases slowly, and sometimes it disappears completely when the voltage reaches a certain value. Causes: the connection point of metal to metal poor contact in the test circuit; the poor contact of semiconductor particles in the shielding layer of plastic cable; the plug piece of aluminum foil of capacitor, etc. (the capacitor can be charged and then short circuited to eliminate)

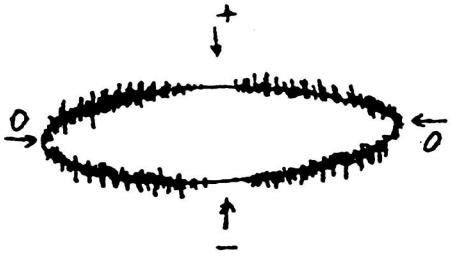


Fig. 21

g) Thyristor elements (Fig. 22a), waveform characteristics: fixed position, each element

generates an independent signal. When the circuit is connected and the electromagnetic coupling effect is enhanced, the signal amplitude increases. During the voltage regulation test, the pulse signal will generate high-frequency waveform broadening, thus increasing the space occupation (Fig. 22b). The reason is that there are silicon controlled elements nearby in operation.

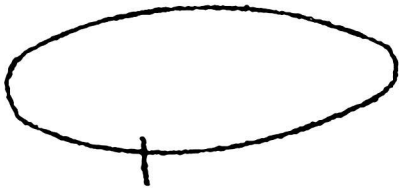


Fig. 22a

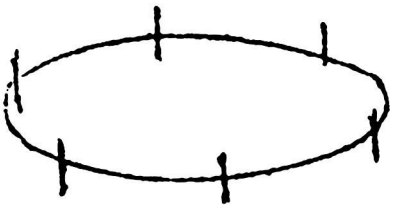


Fig. 22b

h) Relay, contactor, glow tube and other actions (Fig. 23), waveform characteristics: irregular or intermittent waveform,

It has nothing to do with the test voltage. Cause: thermal relay, contactor, spark tester and recorder with spark discharge act.

Fig. 23

m) Asynchronous motor (Fig. 24), waveform characteristics: symmetrical two clusters of signals appear in the positive and negative half cycle, and rotate at a constant speed in reverse direction along the elliptic time base. Cause: asynchronous motor running signal coupled to the detection circuit.

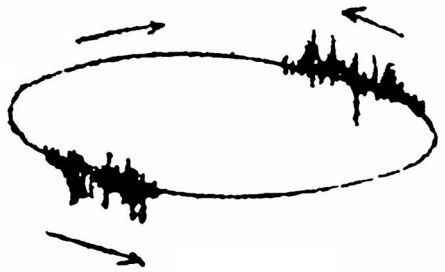


Fig. 24

l) Fluorescent lamp (Fig. 25), waveform characteristics: grid shaped, pulse with approximately the same amplitude, accompanied by two clusters of pulse groups with positive and negative half wave symmetry. Cause: fluorescent lighting.

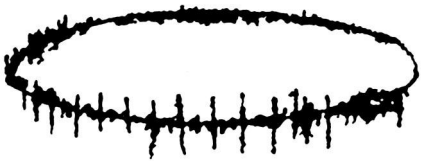


Fig. 25

n) Waveform characteristics of radio interference (Fig. 26a, b): high frequency sine wave with amplitude modulation, independent of test voltage. Reasons: wireless telephone, broadcast telephone, carrier communication, etc.

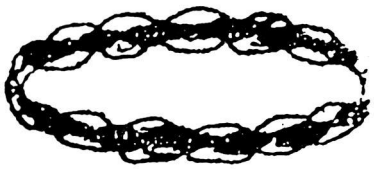


Fig. 22a

Fig. 22b

o) Motor interference (Figure 27), waveform characteristics: discharge waveform is uniformly announced along the elliptic baseline, and each single group number is in the shape of "hill". Cause: motor with commutator, such as fan, hair dryer operation interference.

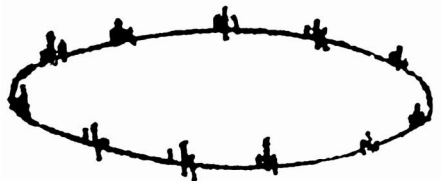


Fig. 27

p) Medium and high frequency industrial equipment (Figure 28), waveform characteristics: continuous occurrence, only within half a cycle of power waveform. Cause: induction heating device and ultrasonic generator with frequency close to detection frequency, etc.

Fig. 28

q) Core magnetic saturation harmonic (Fig. 29), waveform characteristics: lower frequency harmonic oscillation, appeared in two and a half cycles. The amplitude increases with the increase of voltage and disappears without voltage. Cause: resonance caused by magnetic saturation of various iron core equipment (test transformer, filter reactor, isolation transformer, etc.) of the test system.

Fig. 29

r) The electrode moves mechanically in the direction of the electric field (Fig. 30). Waveform characteristics: only two discharge responses symmetrical to the peak value appear on the half cycle (positive or negative) of the test voltage, with the same amplitude but opposite pulse direction. At the initial voltage, the two pulses are close to each other at the peak, and gradually separate when the voltage increases, and a new pulse signal pair may be generated. Reason: part of the electrode (especially the metal foil electrode) moves under the action of an electric field.

Fig. 30

s) The waveform characteristics of leakage trace and branch discharge: the discharge signal waveform does not conform to the general typical image, and the waveform is irregular and uncertain. Cause: electric leakage on contaminated insulation or carbonization trace or branch passage caused by partial overheating of insulation.

In the discharge test, it is necessary to ensure that other components (test transformer, blocking coil, coupling capacitor, high voltage resistance, etc.) in the test circuit will not discharge. The common method is to replace the sample test with a non discharge capacitor or insulation structure of the same order of magnitude as the sample capacitance to see if there is discharge.

After understanding the waveform characteristics and sources of various discharge types and identifying the interference, measures can be taken to eliminate the interference causes and correctly conduct discharge measurement according to the specific situation.

(2) The main formation mode and invasion way of interference

a) The main forms of interference are: ① interference from power supply network; ② interference from grounding system; ③ interference received by other high-voltage tests or electromagnetic radiation field; ④ interference generated by test circuit itself; ⑤ interference caused by poor contact in test circuit or sample.

b) There are usually several ways of interference invasion: ① capacitance coupling: if there is interference voltage on the conductor (such as feeder), the stray capacitance of the conductor to the test circuit can be coupled to the test circuit. Capacitive coupling is

most likely to occur when the capacitance of the sample is small; ② inductive coupling: if the conductor (such as the feeder) carries interference current, it is coupled to the test circuit through the magnetic induction between it and the test circuit. In the measurement of large capacitance test object, as long as there is a small mutual inductance m, the inductive coupling effect is very strong; ③ grounding coupling: This is mainly caused by multi-point grounding, and the current flows through two grounding points in the grounding system, thus establishing an interference voltage in the test circuit; ④ coupling through high-voltage power supply: the interference voltage from the power grid main line passes through the primary and secondary windings of the test transformer The capacitance coupling between them enters the test circuit.

c) Main measures to eliminate or restrain interference

1) A filter control power supply (such as LB-5) with voltage regulator, isolation transformer and filter is adopted. The primary winding of the isolation transformer is shielded to the ground of the power grid system; the secondary winding is shielded to the ground of the test circuit (or the ground of the fully shielded system).

2) Set up shielding room. Only the test circuit part can be shielded, while the high voltage transformer is outside, and the high voltage is introduced by bushing (but filter must be used). High voltage power supply can also be placed in the shielding room, while the partial discharge detector is outside. It is better to put the detector in the shielding room. The purpose and function of shielding room is to prevent capacitive coupling and inductive coupling. For the design of shielding room, please refer to relevant information.

3) For reliable single point grounding, the test loop system or the whole shield body shall be designed as single point grounding structure, and the grounding resistance shall be small. The grounding point shall be separated from the ground grid and power grid neutral line of general laboratory. As shown in Fig. 31a, it is a single point grounding, while the grounding mode in Fig. 20b is easy to form loop ground current and cause interference.

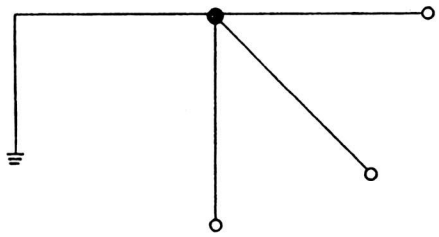


Fig.31a

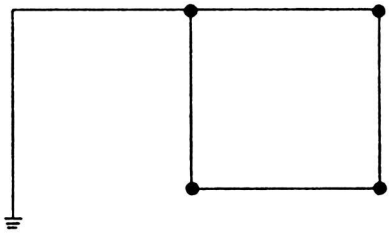


Fig. 31b

4) High voltage filter is used. Adding a high-voltage filter to the high-voltage side of the secondary of the test transformer can further suppress the interference of the power grid

system and improve the detection sensitivity. As shown in Fig. 21, the two-stage T-shaped filter can attenuate the 30kHz signal by 60dB if l = 0.5h and C = 0.004f. Of course, the high voltage filter must also have no discharge under the test voltage. Domestic units have used the tuned frequency selective filter in series in the high voltage lead, and the effect is also very good.

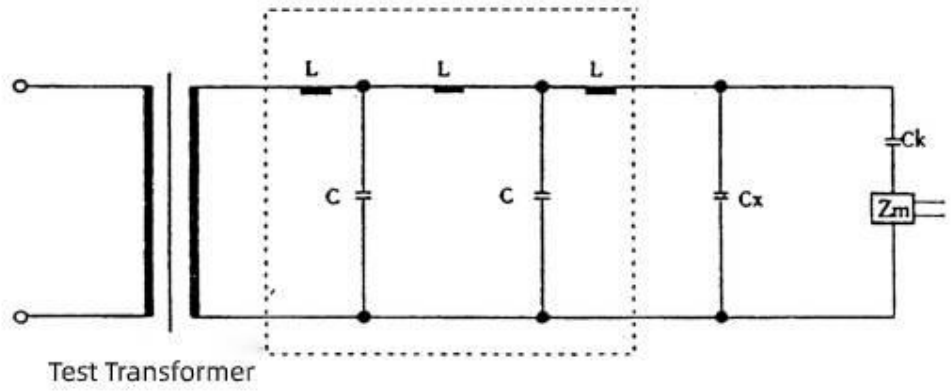


Fig.32

High voltage filter connected to test circuit

In the figure, C_X is the sample; C_K is the coupling capacitance; Z_M is the input unit.

5) Balance method or bridge test circuit is used.

6) By using the time window of the gate unit, the interference of the fixed phase does not fall into the "window".

7) The amplifier uses a narrow frequency band, such as (40-80) kHz. Or use frequency band to avoid the frequency range with large interference.

8) Install high voltage shield or semi conductive rubber tire cap at high voltage end to prevent external corona interference.

9) The test circuit is far away from surrounding objects, especially suspended metal objects.

VI. Anti interference measures

(1) In general partial discharge test, the interference mainly comes from power grid and space. According to the form of expression, it can be divided into fixed and mobile. The main interference sources are as follows:

1.1) suspended potential objects discharge through stray capacitance to ground

1.2) external tip corona

1.3) the thyristor element operates nearby

1.4) relays, contactors, glow tubes, etc

1.5) poor contact

1.6) radio interference

1.7) fluorescent lamp interference

1.8) motor interference

1.9) medium and high frequency industrial equipment

(2) General anti-interference methods:

2.1) adopt voltage regulator to isolate the control power supply of transformer and filter.

2.2) the shielding room can only shield the test circuit part.

2.3) reliable single point grounding: the test loop system shall be designed as a single point grounding structure, the grounding resistance shall be small, and the grounding point shall be separated from the general test grounding grid and power grid.

2.4) high voltage filter is used.

2.5) balance method or bridge test circuit.

2.6) the fixed phase interference is outside the bright window by using time window.

2.7) adopt narrow frequency band or use frequency band to avoid the frequency range with large interference.

2.8) install high voltage shield or semiconductor rubber cap at high voltage end to prevent corona interference.

2.9). The test circuit is far away from surrounding objects, especially suspended metal solids.

VII. Accessory list

1) special measuring cables (8m)	2pcs
2) 1 high frequency power feeder	1pcs
3) 1 power cord	1pcs
4) 4 fuses	4pcs
5) 1 copy of operation manual	1pcs
6) 1 Certificate	1pcs

Partial discharge system configuration:

(1) Hardware system:

A. Industrial computer:

a. Amplifier, filter

b. Zero standard circuit

c. A / D converter

d. RAM memory

B. LCD Display

C. Printer: laser printer

D. Detection Impedance: 2pcs

E. HTJF-301 calibration pulse generator

F. Measuring shielded cable (50m, 20m coaxial signal cable)

G. 101 keyboard

H. Aluminum alloy packing box

(2) Software system configuration:

1. Data acquisition and network communication software

J. Graphic display and processing software

K. System working mode control software

L. Partial discharge signal analysis software

(3) Measurement channels: 2 pcs

(4) Working environment:

Temperature: - 5 ℃ ~ 45 ℃

Humidity: ≤ 90%

Altitude: < 1000M

Earthquake intensity: ≤ 7

Suitable for indoor and outdoor use

Detection Impedance:

No.	Tuned capacity			Flow capacity limits valid values	Zero standard voltage sampling capacitance and AC limiter	
	minimum	neutral value	maximum			
1	6 pF	25 pF	100 pF	30 mA	2μF	10V
2	25 pF	100 pF	400 pF	60 mA	2μF	10V
3	100 pF	400 pF	1500 pF	120 mA	10μF	10V
4	400 pF	1500 pF	6000 pF	250 mA	20μF	10V
5	1500 pF	6000 pF	25 nF	500 mA	30μF	10V
6	6000 pF	25 nF	100 nF	1A	30μF	10V
7	25nF	100 nF	400 nF	2A	30μF	10V
8	100 nF	400 nF	1.5μF	4A	30μF	10V
9	400 nF	1.5μF	6μF	8A	30μF	10V
10	1.5μF	5μF	25μF	15A	30μF	10V
11	6μF	15μF	60μF	25A	30μF	10V
12	15μF	60μF	250μF	50A	30μF	10V

It has the function of over-flow pressure protection

Software graphics introduction