ZXPD-100K Partial Discharge Detector For Switchgear

Content

Safety Precautions

The instrument is used for detecting the partial discharge sources in MV/HV equipment. Even if no electric discharge is detected, it is not indicated that there is no discharge activity in the high-voltage equipment. The discharge sources usually have a latent period, and the insulation property may become ineffective due to other causes than partial discharge. If significant discharge is detected in the equipment connected to a medium/high-voltage electric power system, it is necessary to inform the equipment maintenance department immediately.

Warning

- The product can be used only at the ground potential.
- Before starting the probe during test, it is necessary to ensure that the metal shell of the electric instrument is grounded.
- Please ensure a safety distance between the high-voltage part and the instrument, the probe, the operator involved at any time.
- Please strictly abide by the safety rule of the electric power system.
- Please do not use the product during lightning.
- Please do not use the instrument for measurement immediately after starting it.
- In case of environment change, please press the Left key to eliminate the environment background value.
- Please do not carry out such operations as mechanical impact, vibration and high-temperature heating for the equipment and the probe.
- Please do not operate the product in an explosive environment.
- In case of any abnormality or use query, please do not start the instrument but directly contact the manufacturer or agent.

Implementation of standards

This product performs the following standards:

DL-T 1416-2015 General specification for ultrasonic partial discharge tester

Q/GDW 11059.1-2013 Guidelines for field application of partial discharge live test for gas insulated metal enclosed switchgear

Q/GDW 11060-2013 Guidelines for field application of transient earth voltage partial discharge live test for AC metal enclosed switchgear

Q/GDW 11063-2013 Technical specification for transient earth voltage partial discharge detector

Operation Notices

When using TEV products, it is necessary to abide by the following rules:

1. The strong electromagnetic interference in the frequency range from the DC generated by mobile phones, RF transmitters, video displays and unshielded electronic equipment to 1 GHZ can influence the reading, so the product should be placed in a free space at least 1m away from any conductor surface in order to measure the value of the local electromagnetic field.

2. Please be careful when using the instrument in a narrow space, because the reading accuracy may be influenced when the instrument is near to any other grounding plane. Therefore, it is necessary to use the instrument at the place at least 30cm (vertical distance) away from any metal object.

I. Non-intrusive Partial Discharge Detection

1.1 Introduction

Partial discharge does not cause the electric discharge of a completely short-circuited electrode. Such discharge usually has a very small amplitude value, but it will certainly cause the continuous deterioration of the property of the insulation layer and finally cause electric equipment fault.

The non-intrusive partial discharge detection, as a convenient and simple method, is used for identifying the potential insulation faults which may cause power cutoff or personal injury.

The partial discharge emits energy in following manners:
Electromagnetic energy: radio wave, light and heat;
Sound energy: sound wave and ultrasonic wave;
Gas: ozone and nitric oxide.

The most practical non-intrusive detection technologies

are all based on the detection of the high-frequency signals and the ultrasonic signals in the electromagnetic spectrum. The product is an instrument which has simple operation and is specially developed for detecting the activities of electromagnetic waves and ultrasonic waves.

1.2 Airborne ultrasonic discharge activity

The sound radiation in a partial discharge activity appears in the whole sound spectrum. It is possible to hear, but this depends on the hearing ability of the person involved.

The use of the instrument for detecting the ultrasonic wave in the sound spectrum has following advantages: compared with human ear, the instrument is more sensitive and irrelevant to the operators, and runs at the frequency above voice frequency, and also has stronger directivity.

The most sensitive detection method is to use the ultrasonic sensor with the center frequency of 40 ~200 kHz. By virtue of this method, partial discharge activities can be successfully detected.

1.3 Airborne high-frequency electromagnetic discharge activity

When occurring in the insulation layer of a high-voltage switching cabinet, the partial discharge activity can generate high-frequency electromagnetic wave which can leak from the switching cabinet to the external surface through the openings on the metal shell, and such openings can be the shell gaps or seal washers and the gaps around other insulation components. When propagating to the outside of the switching cabinet, the electromagnetic wave will generate a transient voltage on the grounded metal shell. Such transient earth voltage (TEV) exists in a very short time in the range from several millivolts to several volts, and has a rise time of several nanoseconds.

The probe can be placed outside the switching cabinet through a non-intrusive mode to detect partial discharge activities.

II. Technical Parameters

Fig. I Product Appearance

1. Applicable scope: the non-intrusive mode is adopted to detect and locate the partial discharge defects of the high-voltage electric equipment.
2. sensor configuration

   Standard: UA, TEV

   Optional: Sensor network for transformer, high frequency sensor for GIS, sensor for high-voltage cable, or other senors customized according to user's requirements.
3. Detection principle: UHF (Ultra High Frequency) method, UA (Ultrasonic Analysis) method and TEV

(Transient Earth Voltage) method.

4. Detection frequency band:

   UA: 40～200KHz

   TEV: 3~100MHz

   UHF: 300～2000MHz.

5. Measurement range:

   UA: -90～80dB

   TEV: -80～10dBm

   UHF: -80～10dBm.

6. Sensitivity: the minimum sensitivity is 10pC (specifically determined by the distance between the sensor and the discharge source).

7. Sensor:

   a) Ultrasonic sensor: 20～200(kHz);

   b) EV (Transient Earth Voltage) sensor: 5 ~ 100MHz;

   c) UHF sensor: 300～2000(MHz), with directional reception characteristic.

8. Embedded ultrasonic sensor and TEV & UA integrated sensor: such components as transformer dedicated sensor, GIS dedicated sensor and cable dedicated sensor can be selected;

9. Software function:

   a) Continuously detect UHF, TEV and ultrasonic signals to judge whether there is any partial discharge;

   b) Display the variation tendency of the detected

signal in a real-time manner to intuitionally judge the development of the partial discharge signal;

c) Field data storage function;

10. Instrument characteristics:

a) Screen display: high-contrast 3.5”TFT color screen.

b) Data storage: 1000 groups of test data can be stored.

c) Working power supply: embedded 8.4V lithium battery for 8h’s continuous operation.

d) Power supply: input 100-240VAC, output 8.4V/3A, charging time 3～4h.

e) Boundary dimension: 220 * 100 * 40.

f) Instrument weight: 1.5kg.

g) Environment temperature: -25℃～45℃.

h) Storage temperature: -35℃～60℃.

11. Complete configuration: host machine, sensor, AC adapter, connecting cable and transport case.

III. Structural Layout

3.1 Panel arrangement

The product, with portable structure and embedded signal receiving and data processing module, has multiple analysis modes and can conveniently measure the UHF signals and the ultrasonic signals generated by the partial discharge of the electric equipment. Compared with similar products, this product has convenient operation and strong function.

The keyboard layout of the product is as follows:

1) F1 key: during test, "F1" key can be pressed to store present measured data;
2) F2 key: the historical data stored in the host machine can be called through "F2" key;
3) F3 key: in the measuring interface, F3 key is used for switching sensor type; in the data management or setting interface, F3 key is used as an ESC key;
4) Direction key: Up and Down keys are used for gain adjustment in the range of 0～90dB during test, and for time adjustment during function setting, as well as for page turning in historical data browsing;

Fig. II Keyboard Layout

5) OK key: during test, this key can be pressed to enter the setting menu;

6) Power key: the key should be pressed for 3s to turn on or turn off the power supply of the instrument;

The input end of the product is located exactly at the front of the instrument.

Fig. III Front End Layout of Host Machine

Besides the embedded ultrasonic sensor, the host machine of the product is also configured with an external sensor interface for connecting UHF sensor, TEV sensor and external ultrasonic sensor thereto. The uniform

interface is adopted for convenient and simple operation.

Note: The imported connector is adopted for the external sensor interface. Before inserting the external sensor connector, please ensure that the marked direction of the connector is consistent with the marked direction of the socket; if "crack" sound is heard, the successful connection is indicated. Please do not rotate the connector in order not to damage it. When pulling out the sensor connector, it is only necessary to hold and pull out the connector of the metal shell; please do not drag the connecting wires.

3.2 Sensor configuration

Bottom Structure

Fig. IV Bottom Layout

1）Headphone jack: such jack is an international industrial standard interface, and the headphone can be used for monitoring the sound spectrum signal of the partial discharge during test, and the headphone volume

can be adjusted through Left and Right keys.

2）Charging interface: the host machine is charged through the power supply attached to the machine, and it usually takes 4~5h to fully charge the host machine.

2）reset switch: when the instrument is abnormal, click this switch or "■" button to reset the system without worrying about historical data loss.

Sensor Name	Appearance	Application
Ultrasonic wave and TEV integrated sensor (**standard configuration**)		Used for the ultrasonic wave and TEV test of the switching cabinet;
Transformer dedicated ultrasonic sensor **(optional configuration)**		Used for the internal partial discharge test of the transformer;
UHF sensor **(optional configuration)**		Used for measuring the internal partial discharge of GIS;
High frequency transformer （**optional configuration**）		Used for partial discharge test of the high voltage cable

IV. Operation

4.1 Main interface

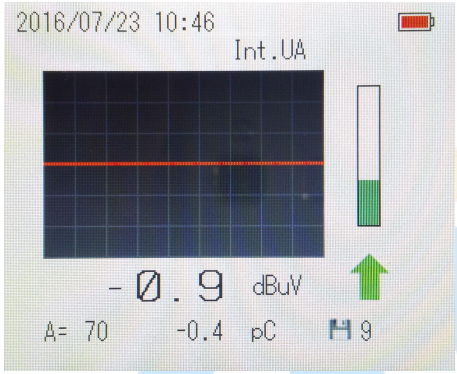

Fig. V Main Interface

After the starting interface is completely displayed, the measurement interface can be directly entered. The test interface is divided into sensor status zone, waveform zone, data zone and histogram zone.

Sensor status zone: the sensor can be selected through "F3" key, and the sensor in the standard configuration includes: embedded ultrasonic sensor (Int.UA), external ultrasonic sensor (Ext.UA), TEV (Ext.TEV) sensor, etc. Plus version has the option for GIS (UHF) sensor. "F3" key can be continuously pressed for sensor selection.

Note: Data can be measured only after the corresponding sensor is connected, and the instrument

can also select the corresponding sensor according to actual connection condition. For example, if the external ultrasonic sensor is selected but not connected, the instrument will automatically switch the signal to the internal ultrasonic sensor to ensure the normal measurement of the signal.

The waveform zone is mainly used for displaying the waveform of the discharge signal collected by the instrument, and such waveform is displayed as a radio-frequency signal under the ultrasonic measurement mode, but as a level under the TEV mode. Specifically, the TEV measurement interface is as shown in Fig. V:

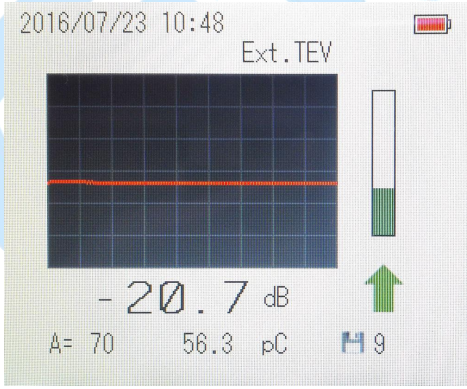

Fig. VI TEV Measurement Interface

Histogram zone: the histogram is used for indicating the severity of present partial discharge through three

colors ---- green, orange and red: green for indicating slight partial discharge, yellow for indicating partial phenomenon and equipment inspection requirement, and red for indicating serious partial discharge and equipment maintenance requirement.

Data display zone: for different sensors, the data zone has different practical significances.

The data is calculated by dBuV (decibel microvolt) and dB (decibel) respectively under ultrasonic measurement mode and TEV measurement mode. The instrument is internally preset with the threshold value data of common electric equipment, so there is no need for the users to separately set relevant data.

4.2 Ultrasonic measurement program

When the ultrasonic sensor is used for signal measurement, the corresponding sensor should be selected. The product has the function of remembering the previous status setting, automatically calling the sensor status at the previous shutdown, measuring the environment value and preparing for measuring the partial discharge value. Therefore, please do not point the sensor to the measured zone during starting in order to prevent the discharge signal of the measured zone from being wrongly measured as the environment value.

After the instrument is started, “F3” key can be pressed to enter the ultrasonic mode. If the reading is too large, for example, above 15dBuV, large background noise is indicated and the Left key can be pressed to filter the background noise.

After background noise filtering, the instrument runs the measurement program. If the headphone provided thereby is inserted at the moment, the reading will be continuously updated on the display screen. At the beginning, the gain should be adjusted to a large value, and when the reading is too large, the gain should be reduced. Additionally, whether to increase or reduce the

gain can be determined according to the arrow mark at the right lower side. Specifically, the green arrow indicates that the gain at the moment can be increased, and the red arrow indicates that the signal gain is too large and should be reduced.

For detecting the switching cabinet, it is necessary to point the ultrasonic sensor to any air gap on the switching cabinet (especially circuit breaker port, inflatable cable box, voltage transformer and busbar chamber). In any case, it is necessary to ensure the safety distance.

The ultrasonic wave activity above the background value is very important. Real discharge can be identified through the hiss sound (like the hiss sound generated from a frying pan) sent out from the headphone.

The embedded sensor can be used for detecting the remote ultrasonic partial discharge of such electric equipment as cable and porcelain insulator. Additionally, the infrared laser aiming point can assist you to accurately point to the tested sample zone, as shown in Fig. VII.

Fig. VII Infrared Laser Aiming

4.3 TEV measurement program

Background noise:

The electromagnetic signals sent from some signal sources outside the switching cabinet may also generate transient earth voltage at the outside of the switching cabinet. Such signal sources as overhead line insulator, transformer incoming sleeve, radio signal and even nearby expressway vehicle flow can generate transient earth voltage signals on such metal objects as transformer substation door or fence not connected to the switching cabinet. Therefore, before detecting the switching cabinet, it is necessary to measure the background noises on and of such metal objects as metal door and metal fence not connected to the switching cabinet, record the three continuous decibel values and counts related to the metal objects, and take the intermediate amplitude value as the measured

background value.

Fig. VIII TEV Sensor

Implementation of measurement

After starting the instrument, it is necessary to ensure that TEV sensor is located in the free space away from the metal object; or else, the self-inspection will be influenced. After TEV mode is selected, in order to ensure accurate measurement, it is necessary to make TEV probe vertically contact the metal object to be measured thereon (it is better to keep the main body of the instrument away from the metal object). Once TEV probe is dismounted from the metal object, the reading will be no longer displayed on the display screen.

In order to ensure data consistency, you may repeatedly measure for several times. If the displayed value is too large, you can press the Left key to filter the background noise.

The switching cabinet should be measured at the central position of each component on each panel, including cable box, current transformer chamber, busbar chamber, circuit breaker, voltage transformer, etc. The positions of the circuit breaker and other medium/high-voltage switching instruments should be recorded, because some components are not electrified when these devices are disconnected, and there is also no corresponding reading for these components. It is necessary to record the first group of readings at each position, but if the measured amplitude value is more than 20dB and higher than the background interference by 10dB, it is necessary to continuously record three groups of readings.

High frequency transformers can also be used in this mode for partial discharge test of HV cables, as shown in Fig. IX.

Fig. IX High Frequency Transformer

The buckle shall be opened before use, and the high frequency transformer will be attached to the cable ground wire. The wiring diagram is shown in Fig.X：

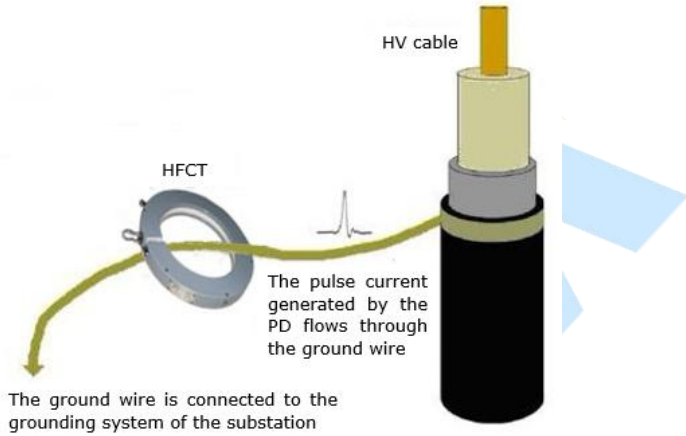

Fig.X Partial Discharge Test of HV cable With HFCT

After the test line is connected,switch to "UA" mode, the partial discharge of HV cable can be tested according to the ultrasonic measurement program.

4.4 UHF measurement program

UHF program is usually used for detecting UHF partial discharge of such equipment as GIS, and the corresponding UHF sensor should be connected under this function mode.

Fig. XI GIS Dedicated Sensor

GIS sensor can be fixed on the insulation basin between GIS pipelines rather than the metal pipeline, and the partial discharge signal will be radiated from the insulation basin to the outside along the pipeline and then received by the sensor. The two ends of the sensor can be fixed by a rubber belt for convenient measurement.

Similarly to other operation modes, it is necessary to filter the background value of the environment before use.

After the sensor is connected, it is necessary to switch the operation mode to “UHF”, namely ultra high

frequency mode, and then press the Left key to filter the background noise as operating in other sensors. The reading will become normal after several seconds.

4.5 Historical data inquiry

In the measurement interface, “F1” key can be pressed for data storage, and the number at the right of the disk icon indicates the group number of currently stored data, and totally 1,000 groups of data can be stored. “F2” key can be pressed for data inquiry, and the Up and Down keys can be pressed for page turning, and “F3” key can be pressed for returning to the test interface.

If you want to clear all data, please right click in the historical data page and select “OK” to confirm, as shown in Fig. XII:

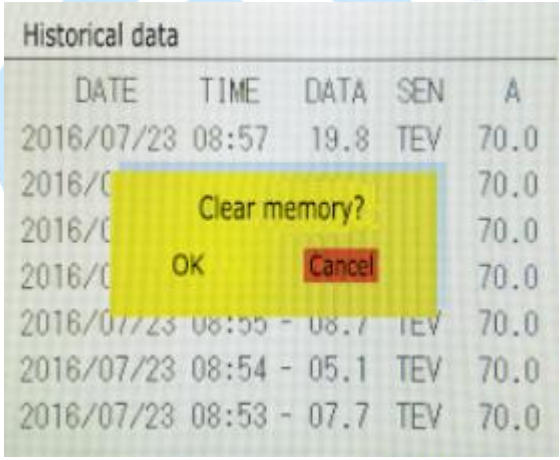

Fig. XII Data Clear

4.6 Alarm threshold adjustment

The user can adjust the alarm value of the status bar according to the actual situation, the discharge degree indicated by the color state of the histogram is as follows, green for indicating slight partial discharge, yellow for indicating partial discharge increased and power-off inspection requirement, and red for indicating serious partial discharge and power-off maintenance requirement.

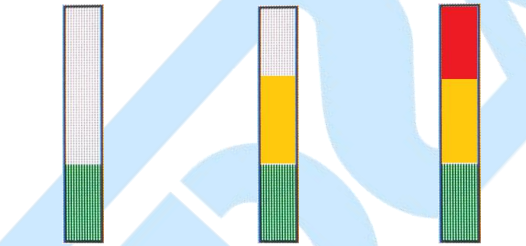

Fig. XIII Discharge level histogram

original factory defaults are as follows:

TEV Red: 29 dB
TEV Yellow: 20 dB
Ultra Red : 6 dB
Ultra Gain: 70 dB

Parameters can be adjusted by up, down, left and right key, left and right key to realize cursor function, up and

down key to adjust value, press F3 key to save and return to the test interface.

Ultra Gain represents the amplification of amplifier when tested with ultrasonic, and the actual measured value should be the same regardless of how many magnification is amplified, for dBuV (or dB) is a relative quantity, which indicates the signal level value (no unit) ,the gain value can be set to 50 ~ 90.

V. Data Analysis

UA data analysis

UA Reading	Specification
0dB and below, no discharge sound	No partial discharge
6dB and below, short discharge sound	Slight partial discharge, should be pay attention to
6dB above, discharge sound	obvious discharge, combined with TEV test to determine.

TEV data analysis

TEV Reading	Specification
High background reading, namely above 20dB Note: The background reading refers to the reading when the sensor is not attached to the cabinet.	(a) High noise may cover the discharge in the switching cabinet; (b) Probably due to external influence, it is necessary to maximally eliminate external interference sources and then retest the switching cabinet, or use the partial discharge monitor to identify each partial discharge in the switching cabinet.
If all readings for the switching cabinet and the background benchmark are less than 20dB,	No significant discharge; and the switching cabinet should be detected every year.
The reading is 20 ~ 30dB	Slight partial discharge

The reading is 30 ~40dB	Medium partial discharge, should report to team or specific responsibility, shorten the inspection cycle
The reading is 40 ~50dB	severe partial discharge, should report to team or specific responsibility, shorten the inspection cycle, check the source of partial discharge when has the opportunity to cut off the power
The reading is 50 ~60dB	severe partial discharge, should report to team or specific responsibility, shorten the inspection cycle, power-off repair as soon as possible
If the reading for the switching cabinet is more than 20dB (absolute value) and higher than the background value by 10dB but less than 20dB,	Discharge may probably occur in the switching cabinet. It is suggested to use the partial discharge locator or partial discharge monitor for further inspection.

Relevant Specification

1) Relation between reading (dBuV) and discharge capacity (pC)

The traditional partial discharge detection carried out according to IEC60270 standard aims at measuring the real electric charge generated by high-voltage conductor during the discharging process. Therefore, the discharge amplitude value is usually calculated by picocoulomb (pC), and various high-voltage devices (except long cable) can be equivalently regarded as the lumped capacitors at the detection frequency (usually 10~300 kHz) of the traditional partial discharge detectors.

The UHF sensor is used for the measurement in the frequency range of 3~100MHz, and the high-voltage electric equipment is more approximate to a transmission line rather than a lumped capacitor in above frequency range, and the area of the zone under the voltage/time curve is in direct proportion to the electric charge transfer quantity during the discharging process.

The UHF sensor is used for measuring the voltage in a transient process rather than directly measuring the electric charge, and the measured value is the wave

crest of the external surface of the metal panel, and the wave crest is only a part of the signal in the panel. When the pulse propagates along the armored surface of the metal, it will spread in the time domain and the area of the zone under the curve will not be changed. As a result, the pulse amplitude value will be reduced. Therefore, if the pulse is detected at the place father from the discharge source, the pulse attenuation is larger.

Obviously, the relation between dBuV and pC is determined by various factors most of which cannot be quantified by ultrasonic sensor or UHF sensor, and involves the relation between sound intensity (dBuV) and discharge quantity (pV). Please refer to Tables 1~7 for different objects and the mutual relation thereof.

Table 1 dBuV - pC Reference Guideline for the Place Near to 25kV Cable Terminal

Reading (dBuV)	Traditional Measurement of Partial Discharge (pC)
0	32
5	56
10	100
15	178
20	316
25	560
30	1000
35	1780
40	3160
45	5600
50	10000
55	17800
60	31600

Table 2 shows some experience results obtained according to the ground discharge in the terminal box of 11kV mixture-filled distribution cable.

Table 2 dBuV - pC Reference Guideline for Terminal Box of 11kV Mixture-filled Distribution Cable

Reading (dBuV)	Traditional Measurement of Partial Discharge (pC)
0	100
5	178
10	316
15	562
20	1000
25	1780
30	3160
35	5620
40	10000
45	17800
50	31600
55	56200
60	100000

Table 3 shows some experience results obtained according to the ground discharge in the SRBP sleeve of oil circuit breaker.

Table 3 dBuV – pC Reference Guideline for SRBP Sleeve of Oil Circuit Breaker

Reading (dBuV)	Traditional Measurement of Partial Discharge (pC)
0	134
5	239
10	423
15	753
20	1340
25	2390
30	4230
35	7530
40	13400
45	23900
50	42300
55	75300
60	134000

Table 4 shows some results obtained according to the discharge in 11kV resin-cast current transformer.

Table 4 dBuV - pC Reference Guideline for 11kV Resin-cast Current Transformer

Reading (dBuV)	Traditional Measurement of Partial Discharge (pC)
0	224
5	399
10	708
15	1260
20	2240
25	3990
30	7080
35	12600
40	22400
45	39990
50	70800
55	126000

Table 5 shows some results obtained according to the discharge in 11kV resin-cast voltage transformer.

Table 5 dBuV - pC Reference Guideline for 11kV Voltage Transformer

Reading (dBuV)	Traditional Measurement of Partial Discharge (pC)
0	224
5	399
10	708
15	1260
20	2240
25	3990
30	7080
35	12600
40	22400
45	39990
50	70800
55	126000
60	161050

Table 6 shows some results obtained according to the discharge in 35kV/12500kVA transformer.

Table 6 dBuV - pC Reference Guideline for 35kV/12,500kVA Transformer

Reading (dBuV)	Traditional Measurement of Partial Discharge (pC)
0	67
5	119
10	211
15	376
20	670
25	1195
30	2115
35	3765
40	6700
45	11950
50	21150
55	37650

Table 7 shows some results obtained according to the discharge in 10kV switching cabinet.

Table 7 dBuV - pC Reference Guideline for 10kV Switching Cabinet

Reading (dBuV)	Traditional Measurement of Partial Discharge (pC)
0	22
5	40
10	70
15	125
20	223
25	398
30	705
35	1255
40	2233
45	3983
50	7050
55	12550
60	22333

Emphatically, the above tables are only taken as the general reference guideline. Although pC level increase is usually equal to dB level increase, such factors as discharge source and attenuation path can also seriously influence the calibration result. Therefore, it is necessary to judge the insulation degree of the measured object according to historical data.

VI. Service Conditions

Environment temperature: -35℃ ~ 65℃

Elevation: below 3,000m

Maximum relative humidity, no condensation: 95%

Pollution grade: grade III

Maximum wind speed: 35m/s

VII. Conformance Statement

The product conforms to the following applicable regulations:

IEC Standard EN61010-1 for Measurement of Electric Equipment

EMC Electromagnetic Compatibility Regulation 2004/108/CE

Low-voltage Regulation 2006/95/CE

In order to conform to the specified operating rules, the equipment design includes the following principle:

The product does not emit electromagnetic wave (electromagnetic compatibility).

The product is not influenced by external electromagnetic interference (EMI).

The product is provided with electrostatic discharge (ESD) protection.

VIII. Warranty

8.1 Warranty Policy

The host of this product provides a one-year maintenance guarantee. But the warranty period for batteries and accessories (chargers, headsets, sensors, etc.) is 6 months. The warranty includes free replacement of materials for all components that are defective, provided that they are not damaged by human beings. The warranty does not include transportation, loading and unloading.

The warranty does not cover damage or contingent damage caused by misuse, abuse, or any modification. The warranty does not cover the product which is repaired or opened without authorization.

8.2 Extent of Warranty

In any case, the agents or any related company will not be held liable to your or any other party for any damages, including but not limited to loss of business, business interruption, loss of information, defects in this product component or its accessories,personal injury, loss of time, money or material or any other direct or indirect loss caused by user, or the inability to use the product,

even if the product has been warned that it may have been damaged.