

Technical Specification of SIVG4800/360 HV Lightning Test System

1. Brief Introduction

SIVG series HV lightning test system can be used to perform lightning direct effect test according to SAE-ARP-5416A, RTCA-DO-160G (Section 23) and Mil-Std-464 on the aircraft structural.

- a) Initial Leader Attachment Test
- b) High Voltage Strike Attachment Test on Models.

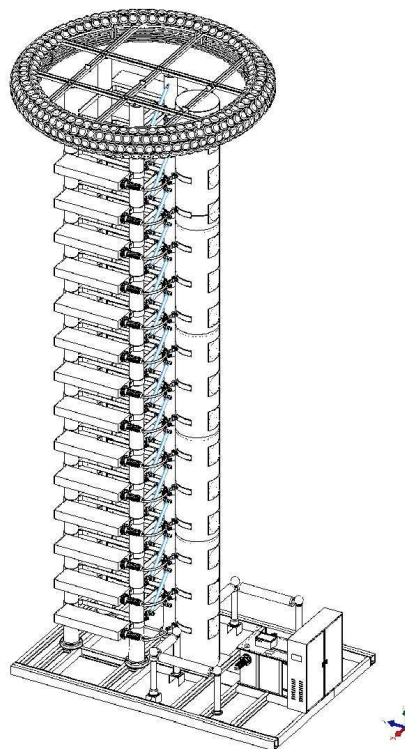
The HV impulse voltage generator is designed for indoor operation.

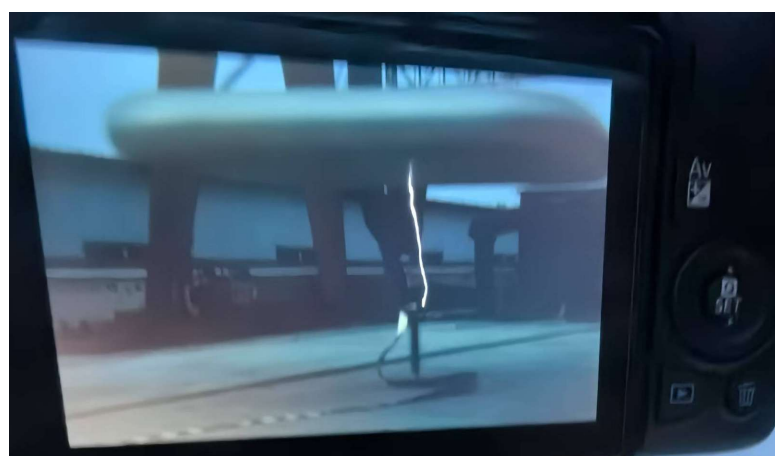


3000kV HV impulse generator



4MV 400kJ HV Generator





2. Advantages and Features

- 1) Reliable and precise triggering unit by pulse amplifier
- 2) Automatic polarity change
- 3) Liquid insulation in the impulse capacitors offers optimal environmental compatibility (no PCBs). The impulse capacitors have very low inductance, high quality and long service life.
- 4) Over-voltage protection, over current protection and fast voltage transients protection
- 5) Protective earthing system, earthing rod and emergency button, gate interlock for personnel and equipment safety;
- 6) Wave shaping resistors are designed for low inductance and connected with handy plug;
- 7) Stable and precise communication between the measuring system and control system;
- 8) The impulse generator is designed for indoor operation.
- 9) The automatic control system is very user-friendly with touch panel.
- 10) The measuring system can measure the test data, analysis and generate waveforms in the LCD screen.

3. Operation Conditions

Altitude: $\leq 1000\text{m}$

Temperature: $-10^{\circ}\text{C} \sim +40^{\circ}\text{C}$

Temperature day difference: 25°C

Relatively humanity: $<85\%$ (20°C)

Indoor operation without conduction dirt or corrode metal and insulation material gas

Earthing system: earth resistance $<0.5\Omega$ with an independent earthing system

4. Main Technical Parameters

- 1) Input power supply: single phase, L-N, 220~240V, 3kVA, 50Hz for control desk;
380V single phase 35kVA for the impulse generator.
- 2) Total rated lightning impulse voltage: $\pm 4800\text{ kV}$
- 3) Total impulse energy: 360kJ

- 4) Stage voltage: ± 200 kV
- 5) Number of stages:24
- 6) Stage energy:15kJ
- 7) Output waveform:

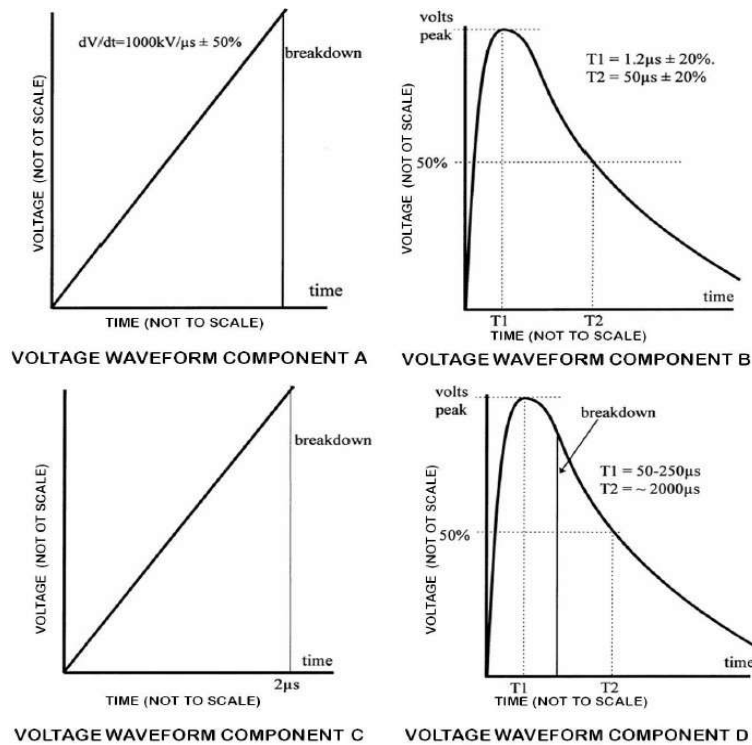


FIGURE 1. Lightning direct effects environment.

➤ Voltage Waveform A

Voltage waveform A is a voltage rising at the rated of $1000\text{kV}/\mu\text{s} \pm 50\%$. The rate of rise shall be measured from 30%~90% of the peak voltage.

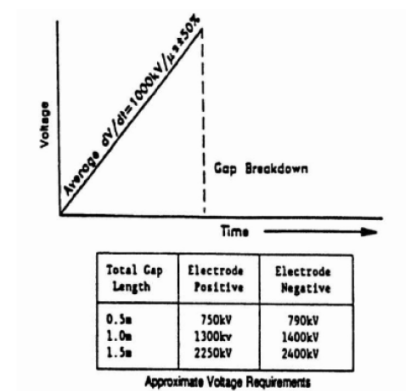
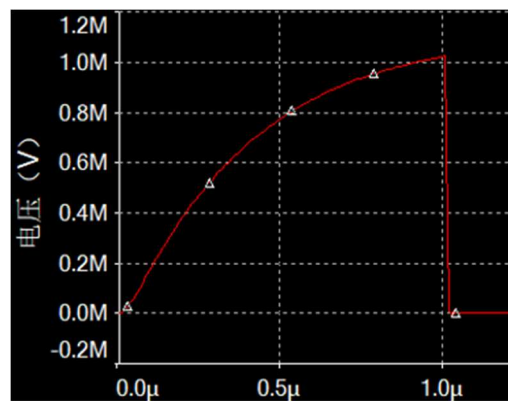
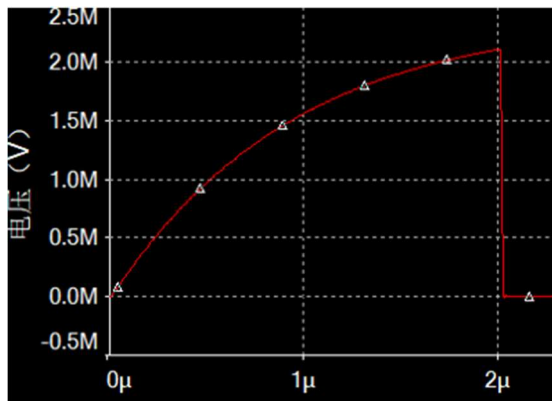


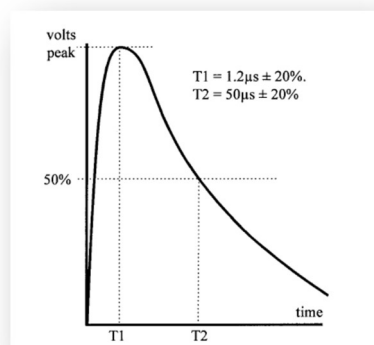
Figure 23-2 – Voltage Waveform A

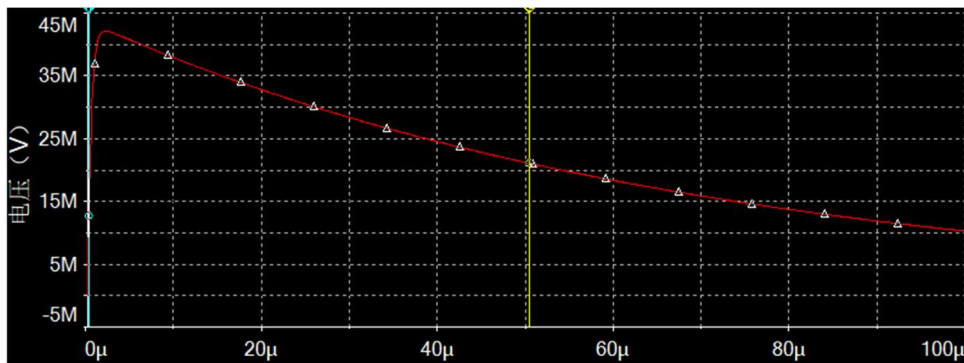


- Max. output voltage: $\pm 4300\text{kV}$ without load (only 4.8MV impulse voltage divider as the load) (charging voltage is 200kV per stage);
- Min output voltage: 200kV ;
- Voltage rise rate: $1000\text{kV}/\mu\text{s} \pm 50\%$ (30~90% of peak voltage);
- T1: adjustable, to meet the voltage rise rate;
- T2: no requirement;
- Efficiency $\geq 90\%$

➤ Voltage Waveform B-LI (Lightning impulse)

- Max. output voltage: $\pm 4300\text{kV}$ without load (only 4.8MV impulse voltage divider as the load) (charging voltage is 200kV per stage);
- Waveform: wave front time $1.2\mu\text{s} \pm 20\%$ / Wave tail time $50\mu\text{s} \pm 20\%$;
- Time to crest and decay time refers to the open circuit voltage of a lightning voltage generator and assumes that the waveform is not limited by puncture or flashover of the object under test.
- Efficiency $\geq 90\%$ without load (only 4.8MV impulse voltage divider as the load);





Wave Simulation by 4800kV HV Generator

➤ Voltage Waveform C

Waveform C is a chopped voltage waveform in which breakdown of the gap between an object under test and the test electrodes occurs at $2 \mu s$ ($\pm 50\%$).

The amplitude of the voltage at time of breakdown and the rate of rise of voltage prior to breakdown are not specified.

2 μs wave generated by 4800kV HV Generator

➤ Voltage Waveform D

Voltage Waveform D is a voltage rising to peak in between $50 \mu s$ and $250 \mu s$ with a time to 50% of peak of approximately $2000 \mu s$.

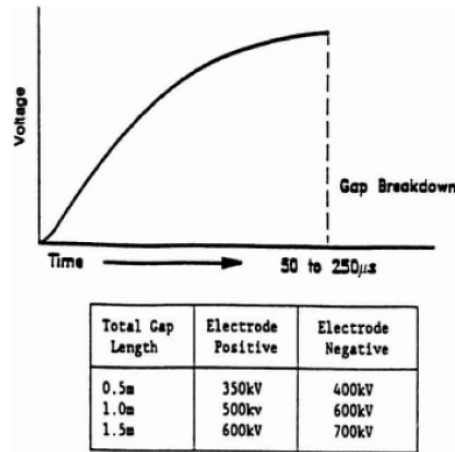
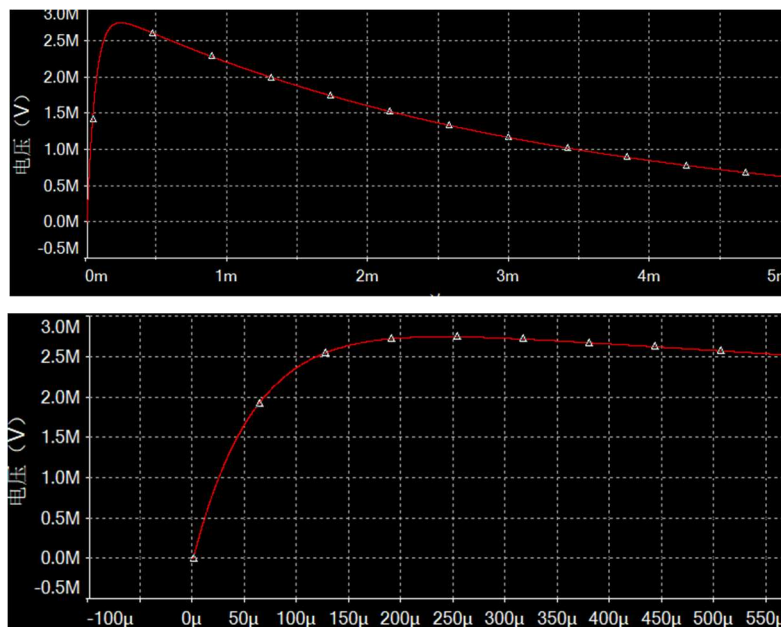


Figure 23-3 – Voltage Waveform D



Wave D Generated by 4800kV HV Generator

- Maximum output voltage without load: $\pm 2400\text{kV}$; (with test specimen, can be charged often at this test voltage)
- Efficiency $\geq 60\%$;
- Remark: Because for the wave D test, it is better to charge @80%~85% rated voltage. The efficiency is about 60%. So $4800\text{kV} \times 84\% \times 60\% = 2419\text{kV}$. In this case, the charging voltage for each stage is 168kV while the rated voltage for each stage is 200kV.

5. Description of Main Items

Scope of Supply

- | | |
|---|---|
| 5.1 SIVG4800/360 | Impulse Voltage Generator |
| 5.2 SXCU-200 | Charging unit for 200kV/30kVA |
| 5.3 SXVD-4800 | Low Damped Capacitive Impulse Voltage Divider |
| 5.4 S XKZ-2014 | Automatic Control and Measurement System |
| 5.5 Electrode | 4m*4m or 3m *3m |
| 5.6 Technical documents | |
| 5.7 Technical Services (In the customer's side) | |

5.1 SIVG4800/360 Impulse Voltage Generator

(1) Base

The impulse voltage generator is mounted on a rectangular steel base frame, which also supports the charging transformer and rectifier.

(2) Support frame

The support frame is made of insulating material and steel. The frame carries resistor holders made out of insulating material and oil immersed impulse capacitors with HV ceramic bushings. The impulse voltage generator has 15 stages totally.

(3) Spark gap

All the spark gaps are made of copper. The gap distance can be adjusted by the precision motor. The drive motor permits automatic control via our control system. For a selected trigger voltage, the gap distance is automatically adjusted.

The vertical tube where the spark spheres are installed is hermetic and that there is supplied

filtered clean air inside the tube when the generator is in operation.



(4) Impulse capacitors

The impulse capacitors have no PCB's. It is in the shape of welded steel can with capacitive bushing. The impulse capacitors have very low inductance, high quality and long service life.



(5) Wave shaping resistors

The wave shaping resistors including the wave front resistors and wave tail resistors are of slab structure, epoxy resin casting, non inductive winding. They are equipped with plug in end contacts, which is easy for the operator to plug and unplug.

(6) Protective grounding / earthing device

There are four types of earthing device.

First, solenoid for automatic earthing is installed in the charging circuit of the impulse generator, when it stops charging or the emergency button is pressed, the earthing device will be activated automatically, the first stage impulse capacitor will be connected to earth through the earth resistor.

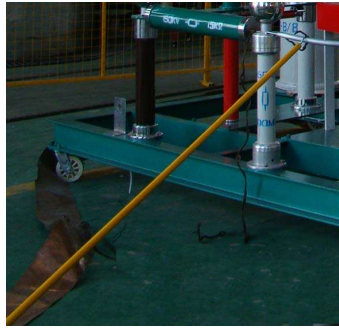
Second, a movable yellow color earthing stick is provided. Each time after firing, please hold the earthing stick in hand and touch the impulse capacitors, HV output terminals before approaching the impulse voltage generator.

Third, we also use wide earth sheet to connect the impulse generator, chopping gap and voltage divider to earth.

Forth, there is safety earthing system (air cylinder type). It can ground all the impulse capacitors.



Automatic Earthing

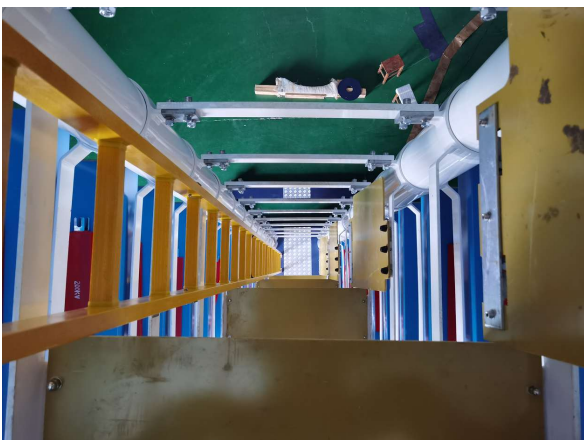


Yellow color Earthing Stick & Copper Earth Sheet



Air cylinder grounding

(7) There is an insulation ladder for easy replacement of impulse resistors and other components.



(8) There is an operating platform at every third stage. (It can hold weight max.100kgs) All operations like resistor change, parallel connection of stages, installation of overshoot compensation can be done from this platform.

5.2 SXCU-200 Charging Unit for 200kV/30kVA

The charging unit is comprised of a HV charging transformer, polarity unit, SCR, protective resistor and DC voltage divider, which are mounted on the base frame of the impulse generator, or alternatively as separate stationary unit. It is equipped with a motorized polarity change which can be remote controlled via the control desk

The HV charging transformer with cylinder shape is used to charge the impulse capacitors of an impulse voltage or impulse current generator.

DC voltage divider is used to reduce the signal of the charging voltage to the value that the measurement system can accept. The internal resistor is oil immersed metal film resistor. The low voltage arm resistor is installed in the flange at the bottom of the voltage divider. The signal of the low voltage arm is introduced to the test system by shielded cable.

Technical Data

- ◆ Input voltage and current:400V single phase, 30kVA;
- ◆ Rated power of charging transformer: 30kVA;
- ◆ Rated output voltage of charging transformer: $\pm 100\text{kV}$
- ◆ Polarity change automatically
- ◆ Double electrical-magnetic earthing system



Charging Transformer

5.3 SXVD-4800 Low Damped Capacitive Impulse Voltage Divider

The low damped capacitive impulse voltage dividers are used to measure high voltage full and tail chopped lightning and full switching impulses. Provided with an adequate additional secondary part, it can also be used for alternating voltage measurements.

The voltage divider consists of several stages of capacitors connected in series. The low damped resistors adopt the multi-stage layout, impulse capacitors are of no inductance, low voltage arm consists of non-inductive leaded multilayer ceramic capacitor. The HV arm is installed on the basis of removable metal plate with wheels. The secondary unit includes a capacitor and a damping resistor of low inductance both arranged in a coaxial design. The unit is fixed at the bottom of the voltage divider and can be easily exchanged. There is corona rings on top to avoid abnormal flashover or discharge when the impulse test is being carried out.

Technical Data

Rated voltage: $\pm 4800\text{kV}$

Capacity of high voltage arms: 400pF

Voltage ratio: $4000:1$

Response time: $T_{\alpha} \leq 100\text{nS}$

Step response overshoot: $\beta \leq 20\%$

Stability of scale factor: $K_{\epsilon} \leq \pm 1\%$

With probe 100X

5.4 SXXZ-2014 Automatic Control and Measurement System

The automatic control system and measurement system are integrated in one desk, which comprises of control cabinet, American Tektronix brand MDO32 3-BW-100 oscilloscope (100 MHz analog bandwidth, 2 analog Channels, sample rate up to 2.5 GS/s , 10M points sample record length), touch screen, Dell computer LCD screen, Advantech brand industrial computer with keyboard and mouse and Mitsubishi PLC.



- 1) The control system can carry out the below functions
 - Control the earthing and unearthing of the impulse voltage generator and charging unit.
 - Setup test parameters from the software directly, such as charging voltage, interval time, number of pulses and gap distance etc.
 - Safety: The system has set the maximum charging voltage for 1.2/50 μ s LI and SI respectively. In case the operator sets the charging voltage above this value, the machine will not charge at all. It will give the error tips.
 - Select the positive polarity or negative polarity, the machine will change the polarity automatically;
 - Once the charging voltage is set, the gap distance will be adjusted automatically to the desirable value.
 - There are information tips on the software to show the error information or running condition.
 - Manual trigger or automatic trigger
 - Over voltage protection and over current protection during charging
 - Operating command as start, power on and off, earth, change gap discharge, polarity change etc.

- Show the test situation as power on and off, abnormal, earthing and unearthing, polarity, time, discharge number etc.
- Emergency and safety measures for failure mode

The screenshot displays the 'System Parameter' configuration screen. At the top right, there are fields for 'Date' (ABCD), 'System uptime' (12), and 'Week' (12). The main area contains several input fields and buttons:

- Set voltage:** 12.3457 (Unit: ABCD)
- Test time interval:** 12 (Set 20-999s)
- Test Number:** 12.3457 (Set 0-99 times)
- Impulse settings:**
 - Buttons for 'automatically change the polarity' and 'set the impulse times (second polarity):'.
 - A numeric field for '12.3457'.
 - Radio buttons for 'Set impulse polarity' with options 'Positive impulse' and 'Negative impulse'.
- Navigation buttons:** 'System Parameter', 'Confirm', and 'Return' on the right side.

The screenshot shows the 'SXXZ-0214 Automatic Control System of Impulse Voltage Generator' interface. It includes a top status bar with 'Date' and 'System uptime' fields. The main display area features:

- Charging Voltage:** A numeric field with a 'kV' unit.
- Warning:** A yellow box displays 'No polarity.....'.
- High voltage danger:** A red warning icon and text.
- Progress Bar:** A red bar indicating 50% completion.
- Test Data Table:**

Voltage	0/0	Pulses	0/0
Gap Distance	0/0	Polarity	No polarity
Test time	0/0	Test Num	0/0
- Run State:** A section with status indicators for 'Ready', 'Power', 'Unearth', 'E-STOP', 'Door Interlock', and 'Error'.
- Control Buttons:** 'Ready' (green), 'Start Test' (green), 'Manual Trigger' (green), 'Reset' (green), and 'Test Parameters' (cyan).

control software

Impact test set

Set voltage: 输入框 (Set 5-10kV)

Test time interval: 输入框 (Set 20-999s)

Test Num: 输入框 (Set 0-99 times)

Set impulse poplarity

☐ Positive impulse

☐ Negative impulse

System Parameter

Confirm

Return

Trigger Sphere Gap Distance Set

Min Distance: 816

Max Distance: 270

Max Real Distance: 68

Automatic Sphere Gap Set

Set the voltage and the distance of the sphere gap value and we will caulated the relationship between each other.

1	(kV)	2	(mm)	2
2	(kV)	5	(mm)	3
3	(kV)	10	(mm)	5
4	(kV)	20	(mm)	9.5
5	(kV)	30	(mm)	12
6	(kV)	50	(mm)	23.5
7	(kV)	80	(mm)	37
8	(kV)	100	(mm)	45
9	(kV)	150	(mm)	75
10	(kV)	200	(mm)	100

Save

Cancel

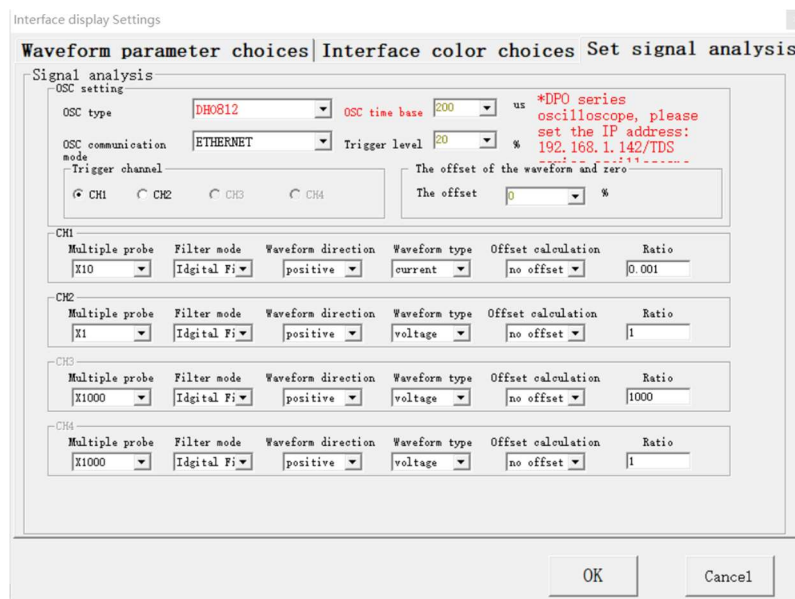
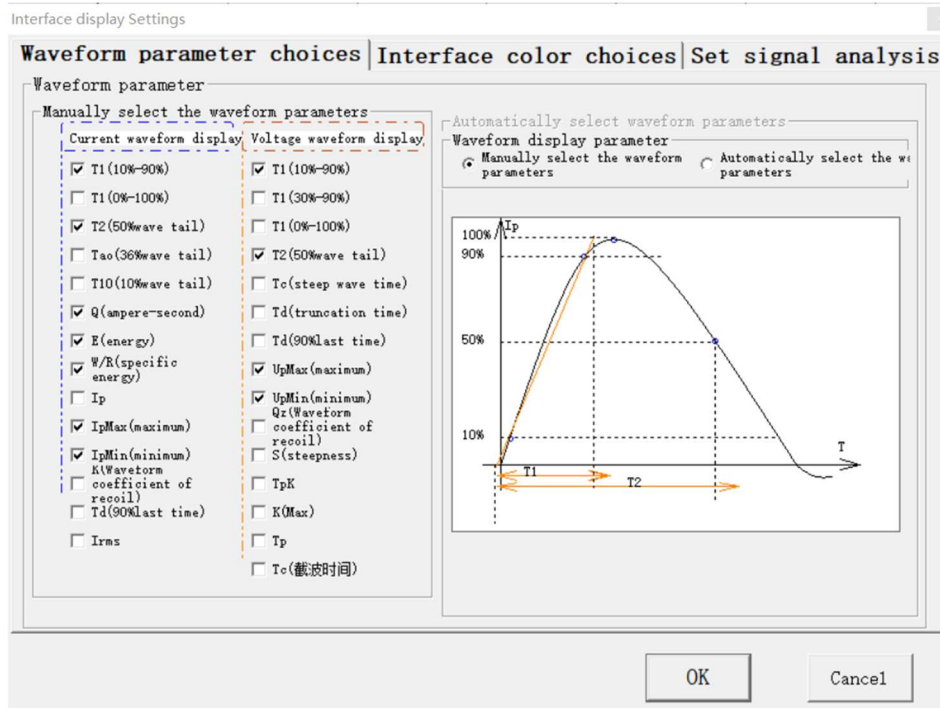
Reset

2) The features of the measurement system are as below:

- The analysis software of wave form can automatically read the data and parameters of wave forms, such as the wave front time, wave tail time, peak voltage, chopped time etc.
- The test result can be saved automatically in jpg format.
- Optical fibre is used to ensure the stable communication.
- English interface is provided;
- Can input the name of the test person, name of the test object, model no of the test object;
- The waveform can be stored in jpg or bmp format according to the customer's requirement. The measurement software will automatically save the waveform after each

discharge.

- Some important remarks can be written on the output waveform.
- The excel file test report can be achieved for convenient edit.
- The waveforms can be copied to USB disk.
- The color of the output waveforms can be changed according to the operator's requirement.



Test parameter setup

Basic Information

product model		test number	
sample model		test person	
sample units			
test note info			

Save the waveform data

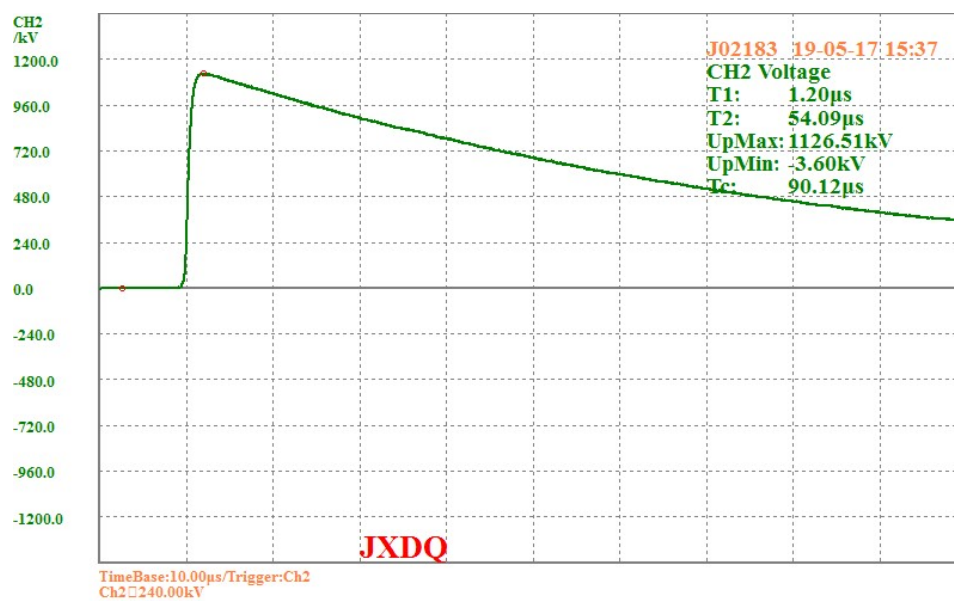
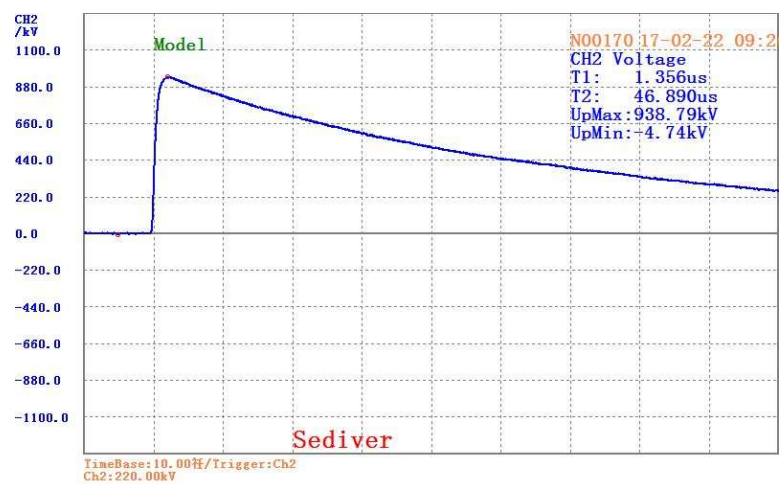
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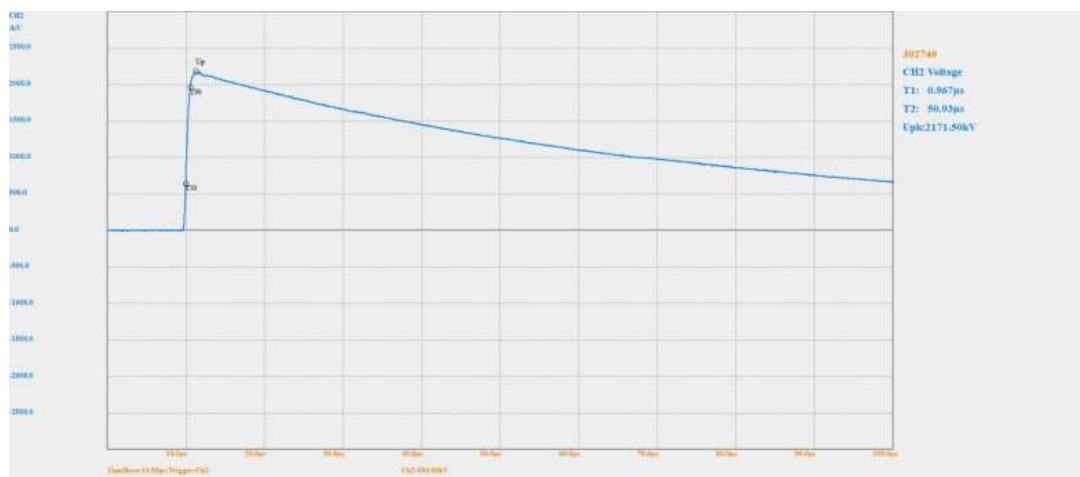
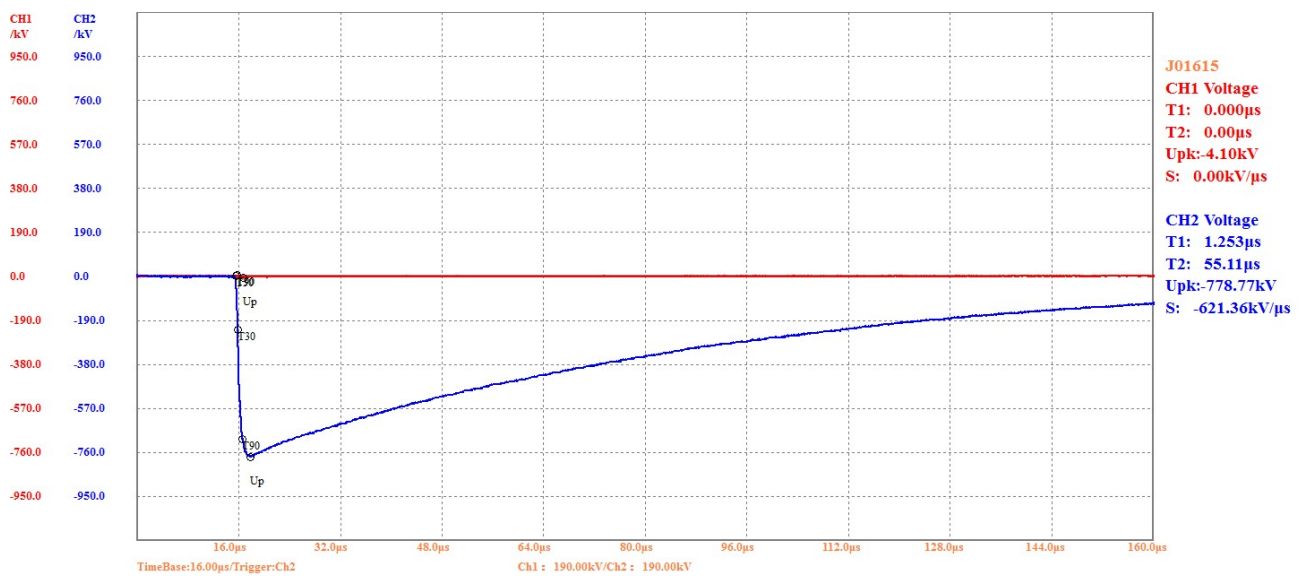
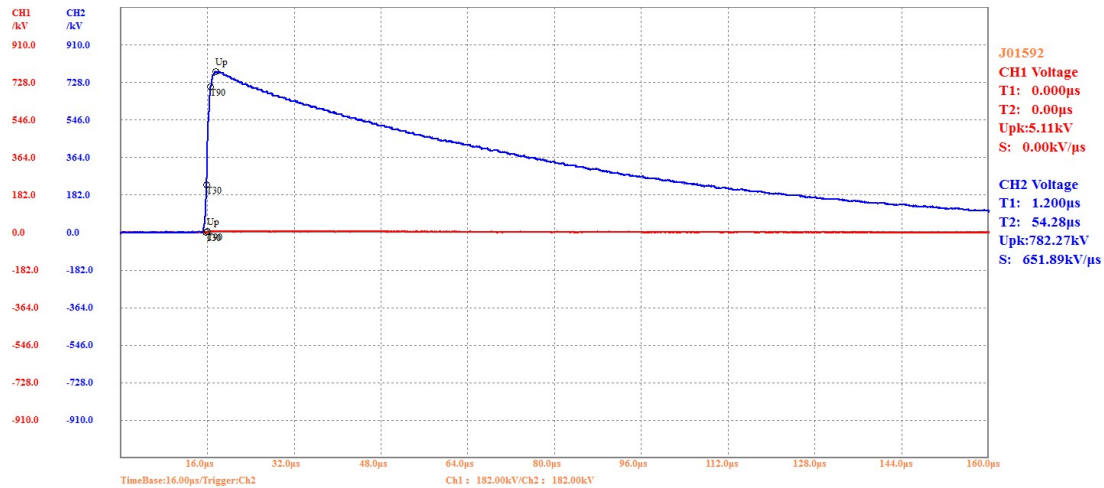
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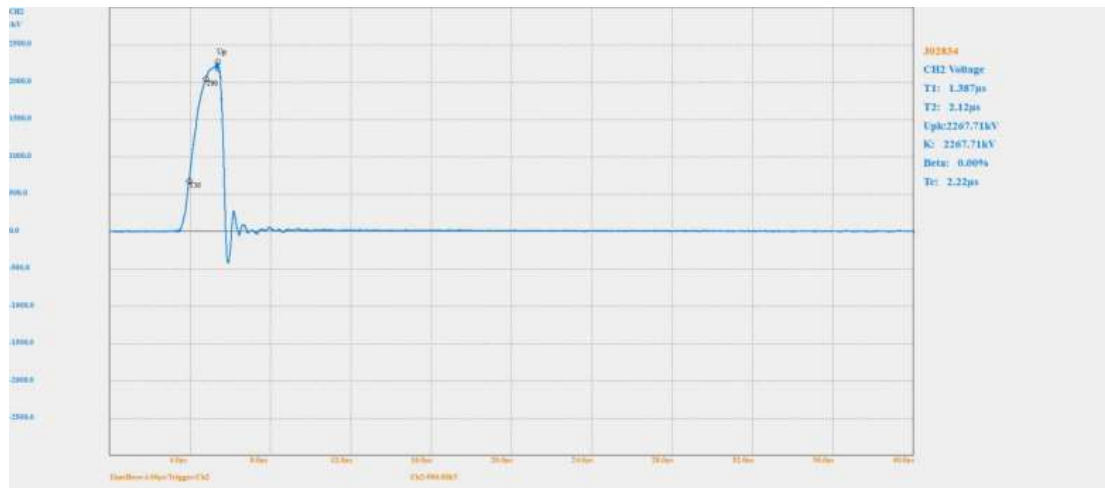
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Image type ☐ JPG ☒ bmp

Save and Cancel







Chopped @2.2 μs @2267kV

5.5 Electrode

An electrode with a dimension of 4m*4m will be provided.



5.6 Technical documents

- 1) User manual in English 1 copy in paper document and 1 copy in pdf
- 2) Electrical drawing in English 1 copy in paper document and 1 copy in pdf

5.7 Technical Services (In the customer's side)

Installation, System tests and training of operating personal, Acceptance tests on the test objects provided by the customer (4 staff, approx. 30 days on-site, 2~3 people are needed from your side to help us for installation)

6 After Sales Services

We provide one year guarantee. During one year after the installation in the customer's side, we will replace the broken parts (if it breaks due to poor quality), or send our technician on our own account to the customer's side (under the situation that the problem is caused by poor quality instead of improper operation and in case you can't solve the problem under our advice.). Otherwise, all the charge should be paid by the buyer.

After one year guarantee, we can provide spare parts at low cost to the buyer, and if necessary, we can send our technician to do some maintenance work and the buyer should pay all the fee including air tickets, accommodation and dining fee.