HZCJ-1800kV
Impulse voltage generator equipment

Skill

Technique

Open area

Case

1800kV Impulse Voltage Generator Sets of Test Equipment Technical Program

I.The Scope

The generator is suitable for the test of the air gap insulator string, casing, power transformers and transformer standard lightning impulse voltage full wave, standard operating wave and chopped wave impulse voltage test.

II.The General Conditions of Use

Altitude: ≤1000m

Ambient temperature: -5 ℃ ~ +40 ℃

Relative humidity: <90％

Maximum daily temperature difference: 25℃

Use of the environment: indoor

Non-conductive dust

No fire or explosion hazard

There is no gas that corrodes metal and insulates

Supply voltage waveform is the actual sine wave, waveform distortion rate <5%

III.Follow The Standard

GB/T 311.1 Insulation and coordination of high voltage transmission and conversion equipment

GB/T 16927.1 High voltage test Technology Part I General test requirements

GB/T 16927.2 High voltage test technology Part II Measurement System

GB/T 16896.1 High voltage shock test with digital recorder

JB/T 7616 High-voltage line insulator shock resistance test

DL/T 557 High-voltage line insulator steep wave impact test, definition, test method and criterion

ZBF 24001 Implementation details of impact voltage test

IV.The Nominal Parameter Values

1. Nominal voltage: ±1800kV

2. Rated voltage: ±200kV

3、Nominal energy:180 kJ

4、impact the total capacitance: 0.111μF (2.0μF /100 kV single pulse capacitor, a total of 18)

5、Series: level 9

6. Impact voltage waveform parameters:

⑴Standard lightning impulse voltage full wave, ±1.2/50μs voltage utilization factor > 85% (no-load 300PF > 90%);

⑵Truncation wave: truncation time (2-6) ±10%s, zero-crossing coefficient ≤0.3%;

⑶Standard operating impulse voltage wave: 250±20%μs /2500±60%μs,

The parameters and deviations of impulse voltage waveform all meet the requirements of relevant national standards GB311 and GB16927.

7. Minimum output voltage is greater than 10% nominal voltage

8. Service duration: above 70% rated voltage, once charge and discharge every 120

seconds can run continuously ; Under 70% rated voltage, charge and discharge every 60 seconds can run continuously.

V.Technical Description of Main Components

1. DC Charging Part

(1)Constant current charging device is adopted;

(2)using oil-immersed charging transformer, the secondary voltage is 85kV , rated capacity of 30 kvA;

(3)Using 2DL-300 kV / 500 mA high voltage rectifier silicon stack，The reverse withstand voltage ≥ 300kV, the average current ≥ 0.5A, the high-voltage rectifier silicon pile is installed next to the charging transformer, the charging voltage polarity can be reversed automatically by the transmission mechanism. There are polarity switch buttons on the console.

(4)High-voltage rectifier silicon stack protection resistance using enameled resistance wire is tightly wound around the insulation tube；

(5) It adopts bilateral symmetrical constant current charging mode；

(6)During automatic control, the constant current charging device is within 10%~100% of the rated charging voltage range, the actual charging voltage and the setting voltage deviation are not more than ±1%, the charging voltage instability is not more than ±1%, The adjustable accuracy of charging voltage is 1%.

(7)Two DC resistance voltage dividers, using 100kV, 300MΩ oil-immersed metal film resistance. The low-voltage arm resistor is installed in the bottom flange of the voltage divider, and the voltage signal on the low-voltage arm is introduced into the console by shielded cable.

(8)The automatic grounding switch USES the electromagnet to separate the grounding mechanism. When the test stops, the main capacitor can be automatically grounded by protective resistance.

(9)Constant current charging inductance, capacitance in the console, charging transformer, high voltage rectifier silicon reactor, protection resistance, automatic

grounding switch and insulation pillar are installed on a mobile chassis.

2. The Ontology Part

(1) The main structure adopts a four-column structure. The steel body bracket consisting of four flanges is connected with two capacitors in parallel, forming a stable structure consisting of 1 level, and the main equipment is 9 stages, forming a combined tower structure. Level stacking, easy to disassemble and test, and stable overall structure;

(2) The main body adopts asymmetric constant current charging mode, constant current voltage regulation, continuously adjustable from zero to set voltage, and the charging power supply is automatically turned off at the instant of ignition and discharge, and the rated voltage of each stage is 200kV;

(3) 9-stage tower structure with body insulation pillars. Each stage includes 2 MWF100-2.0 iron casing oil-immersed pulse capacitors, charging resistors, wave head resistance, wave tail resistance and ignition ball gap, etc.

All synchro discharge balls are housed in a closed insulation, which can be manually adjusted by the console to automatically adjust the ball gap and provide clean air for drying;

(4) a single pulse capacitor is 2 ± 0.05 μF, dc voltage ±100 kV, capacitor inductor ≤0.2 μH, oil-immersed insulation composite membrane, capacitor under normal working condition and working environment, the capacitor for casing to withstand vertical tensile 15 kg, at the same time to ensure no damage and leakage of oil;

(5) Wave head (front) resistance and wave tail resistance are of plate structure and non-inductive winding, with self-inductance ≤ 2.5 μH (the purpose of reducing the inductance is to increase the load capacity. For the load with extra large capacity, an appropriate combination of external regulating capacitor and regulating resistor can be adopted to achieve the purpose of increasing the load.) , the joints are all spring-pressure relay type;

(6) Wave header (formerly), wave tail resistance bracket by four resistors in parallel, wave head (front), equal to the length of the tail resistor can be generic, and each one has stored excess modulated wave resistance the short-circuit the position of the lever; short-circuit rod connectors facilitate the generator series run;

(7) Full set

7.1 lightning wave head resistance; 4 sets

7.2 wave tail resistance 4 sets

7.3 charging resistors (1 pcs reserve) 1 set

Load capacitance (with one moving base, capacitors can be connected in parallel) 200kV/2000pF 2 sets

Cutoff loop damping：Braiding resistance 60Ω（10Ω、20Ω have a tap）1 set

Wave-modulated inductor（200μH、400μH） 1 set

Support resistance 200Ω、300Ω、400Ω（With mobile stand） Each one

(8) The first-stage ball gap adopts bilateral bipolar triggering, and the second- to ninth-level ball gap adopts three-gap ball gap ignition, and the synchronous misoperation rate or rejection rate is not more than 2%; the synchronization range ≥20%. .

(9) The ball gap distance of each level is linearly adjusted by the motor drive, the control system indicates the charging voltage corresponding to the ball pitch, and the transmission structure has upper and lower limit switches;

(10) The ball gap distance can be adjusted manually or automatically on the control system;

(11) The main body can be used in parallel every two or more stages, and the parallel connecting rod adopts a unified connector to facilitate the exchange. The excess modulating resistor can be placed on the device without affecting the electrical performance;

(12) The main body is equipped with an insulating ladder, and its load capacity is designed according to 120kg, so that the staff can replace the wave-modulating components, and each stage of the test stores the tuning resistor and the bracket of the connecting rod;

(13) The two ends of the body are insulated with two ends, and the sealing performance is good;

(14) Anti-corona measures are taken between the

levels, and no obvious corona will appear during

the whole charging process.

(15) Equipped with a safety grounding system, it is convenient for the test personnel to climb the body to replace the resistance or start the grounding system during maintenance, and all the capacitors are shorted and grounded.

(17) Inter-stage insulation and mechanical support can withstand 220kV DC without generating discharge.

(18) The climbing insulation ladder installed on the body, the insulation ladder is convenient and safe and reliable, and the body machinery can fully meet the mechanical and electrical strength.

(19) The top of the impact generator is equipped with a voltage equalizing cover consisting of a turtle-shaped aluminum sheet.

3. ±1800KV Weak Damping Capacitor Divider

The high-voltage arm capacitor consists of 2 sections, each rated rated at 900kV/800 pF, and rated lightning impulse withstand voltage of 1800kV.

The voltage divider is equipped with a low voltage arm capacitor with a voltage division ratio of 3000, a partial pressure ratio accuracy of less than ±1%, a partial response time of ≤100ns, and an overshoot β≤20% measurement uncertainty ≤1%

The square wave response characteristics of the weakly damped capacitor divider meet the requirements of GB311

4.1600kV Multi-stage Truncation Gap Device

Including 2400μμf/200kV voltage equalizer capacitor (9 sets), truncated ignition gap (9 pairs), delay trigger device (2 ~ 6s), etc. The truncation time is 2 ~ 6s, the dispersion standard deviation of truncation time is no more than 0.1s, and the gap distance of multi-ball truncation wave is adjusted by the console through the electric transmission mechanism.

VI.Impact Voltage Generator Measurement and Control Integrated System

1.Overview

The impulse voltage generator measurement and control integrated system is a high-voltage equipment automation information platform integrating measurement and control. It consists of ultra-high-speed, large-capacity transient signal acquisition module, program-controlled amplifier, lower-level machine and actuator as the core components. The industrial control computer enables fully automatic control and fast signal analysis and processing of the whole system. Due to the use of a general industrial control computer as an information platform, it provides a broad space for the future upgrade and expansion of the impulse voltage generator measurement and control, and provides a hardware foundation for the construction of the laboratory information center. All of the above components are designed and manufactured in accordance with industrial-grade process standards, providing assurance for system reliability, stability, accuracy, and operating speed.

In view of the operating environment of the high-voltage test room, especially the characteristics of the impact test are adopted, and the anti-strong electromagnetic interference design is adopted. The technical performance index satisfies the requirements of IEC61083 and IEEE1122, GB/T16896.1-1997/200X, IEC61000 and other standards.

The operating software is written in the VC programming environment and runs based on the WINDOWS operating system, which provides guarantee for system compatibility and versatility. The interface is simple and intuitive, and easy to operate.

The weakly damped capacitor divider and the acquisition card shall provide a provincial-level measurement unit calibration test report.

2. Main Feature

- Integrated measurement and control; high integration；
- TDS-3012C High precision measurement oscilloscope
- The system adopts the upper and lower machine mode, and the upper and lower

machines are connected by optical fiber.

- Display waveform and waveform parameters in real time during the test, including peak, wave head time, wave tail (truncation) time, and store data;
- Waveform analysis software detects CD by IEC1083-2；
- Industrial integrated design with high stability, high reliability and excellent electromagnetic compatibility, without any additional shielding device;
- Automatically generate test reports and charts;
- Display the waveform of test voltage and sample current at the same time for easy comparison analysis;
- Remote control and data transmission through the network (LAN), measurement data can be shared in real time;
- Users can save and recall based on the preset parameters of the test content to avoid repetitive work;
- The upper and lower machines are optically isolated to ensure the safety of the console.
- The upper and lower machine communication adopts full-duplex mode and uses a dedicated communication protocol to ensure the reliability of communication.
- Hardware and electrical chain to ensure the correctness and reliability of operation;
- The two-level operation of the software is interlocked. The upper computer (industrial control computer) will block the illegal operation according to the current state. The lower computer must judge the legality according to the current state before performing any operation, and then execute it.
- Closed-loop control of constant current charging and voltage fine-tuning charging mode ensures both charging accuracy and charging time

3. Main Function of The Control System

- Automatic charging mode: set the charging voltage value of each level to be automatically charged and maintained;
- Manual charging mode: manually adjust the voltage and fine-tune;
- Synchronous ball gap automatically adjusts the ball gap distance according to the set charging voltage and displays the actual distance value. When the ball gap limit

switch is actuated, an indication is given; the special ball gap distance is finely adjusted to facilitate adjustment of the ball pitch in a small range.

- Charging speed selection, the user can select the charging speed in 5 steps according to the test needs.
- Standardized waveform editing system, the measurement of the waveform can be completed by mouse dragging, and the waveform can be conveniently scaled;
- Automatically convert the charging voltage polarity and display it on the screen;
- Overvoltage, overcurrent protection, automatic grounding;
- Auto-ignition: automatically complete a process of boosting, maintaining and igniting according to the set parameters, including setting voltage value and setting time value;
- It can visually display the status of each discharge, including the discharge voltage value, normal discharge or self-discharge;
- Emergency opening, different from manual opening, emergency opening directly cuts off the main circuit power through the button, used for abnormal conditions, such as power outage in the control room.

4. System Structure

The structure of the system is shown in Figure 2:

The part surrounded by the green line in Figure 2 is an integrated measurement and control system. The lower position machine is directly connected with the impulse voltage generator body, the power supply and the intercepting device. All the bottom operations such as relay opening and closing are controlled by the lower position machine, and the upper computer is connected to the lower position machine through the optical fiber, and sends the command to the lower position machine to drive the body and the power supply. The chopper device continuously collects data and acquires the current state, and simultaneously transmits the collected data to the upper computer without interruption, and the voltage and current signals of the voltage divider are connected to the upper computer through the acquisition module.

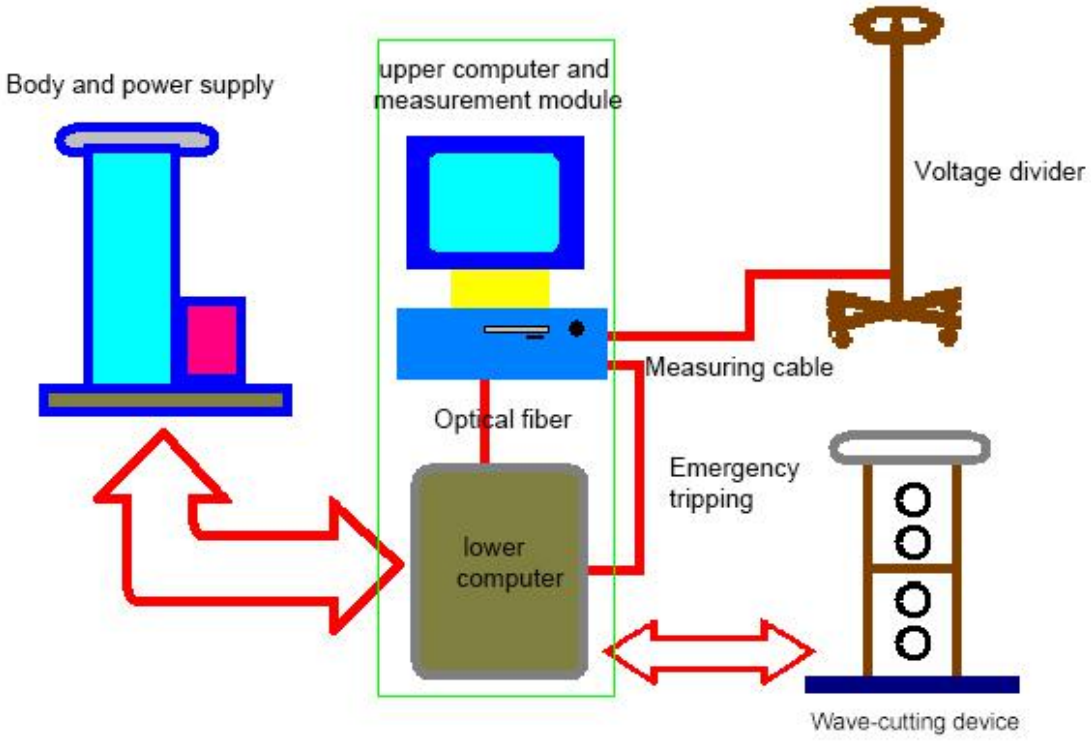


Figure 2 system structure diagram

5. Technical Parameters

Channel number	2 Channel
Sampling rate	100MS/s
Amplitude resolution	9Bits
The amplitude error	<1%
The display screen	15”LCD，1024×768　32-bit true color
Upper machine	The integrated workstation with Intel P4 2.4GHz processor as the core is the platform
Lower computer control unit	MCU processor based on 51 kernel is the main control unit
Intercept ignition control pulse delay	Accuracy of 0.1 us.
Electrical strength of isolation unit	>2500V/RMS ,1min
AD sampling resolution of lower computer	9Bit
AD sampling nonlinear error of lower computer	<1LSB

AD sampling time of lower computer	<10us
AD sampling channel of lower computer	8
Lower computer digital channel	32 input，32 output

VII.Acceptance Requirements

1. The control functions and display functions of the control system reach the expected indicators.

2. All transmission mechanisms and grounding devices work normally.

3. The overall appearance has no obvious defects.

4. Impact test

(1) body air lift test once. The air lift voltage of the main body reaches the required voltage of 220KV transformer test, and the voltage divider works normally (the voltage divider is allowed). During the test, the main body, voltage divider, transmission device, grounding device and control display device work normally.

(2) load test. The main body is empty up to the nominal voltage, and the impact voltage withstand test is carried out on a single transformer. During the test, the main body, voltage divider, transmission device, grounding device and control display device work normally.

(3) intercept impact test. The voltage of the cut-off device shall reach 220KV transformer test voltage value. In the test process, the main body, cut-off device, voltage divider, transmission device, grounding device and control display device work normally. (in consideration of the efficiency of the shock device, if the nominal voltage of the cut-off device cannot be provided, the maximum voltage that can be provided by the ontology shall be taken as the acceptance standard).

(4) the reliable operating range of impulse voltage generator should reach 15%-20%.

(5) waveform acceptance

Waveform parameters of lightning impact test: wave head time 1.2 30%, wave tail time 50 20% (refer to GB/T16927.1)

(6) the intercept time is 2 ~ 6ms, and the standard deviation of the dispersibility of the intercept time is not greater than 0.1ms.

(7) standard operating impulse voltage wave 250 20%ms /2500 60%ms,

The above is the no-load state, and finally take the test products to complete the impact test content stipulated by the relevant national standards.

Impulse Voltage Generator

Control and measurement

Impulse Voltage Generator

1. Impulse Measurement and Control System

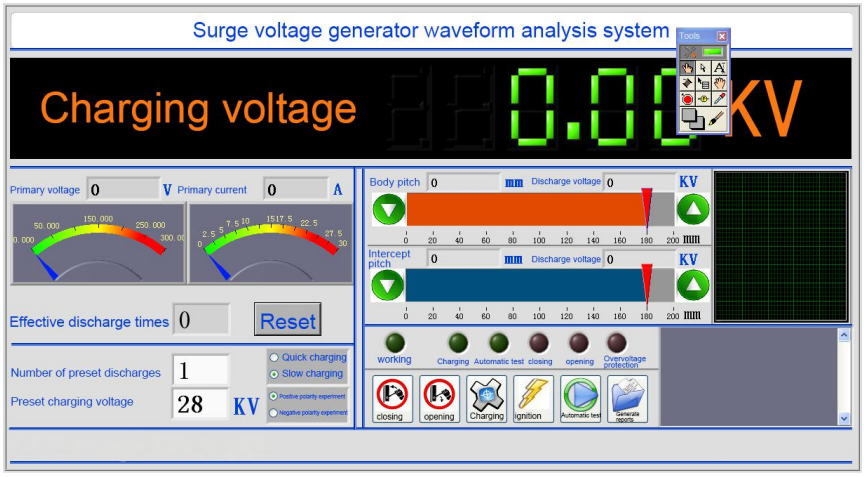
1.1 Outline

HZCJ series of impulse voltage generator intelligent measurement and control system is the latest programmable control system developed by Huazheng Electric Manufacturing (Baoding) Co., Ltd. It includes two parts: automatic control of impulse voltage generator program and automatic analysis of impulse signal measurement.A variety of isolation protection measures, such as photoelectric isolation, phase sequence protection, automatic grounding, over-voltage and over-current protection, etc., truly realize the operation of the equipment in a safe anti-interference environment, effectively improving the reliability and safety of the program-controlled system. At the same time, the system uses constant current charging technology and high-speed, high-resolution, high-precision OMRON conversion module in the analog digital processing process to improve program control accuracy and response. The system control software is developed by LabVIEW 8.5, a professional measurement and control software from National Instrument.The human-machine dialogue interface (HMI) has a simple interface and is easy to operate. The control package is an ACE package.

1.2 Main Indicators

- Charging voltage setting
- Maximum charging voltage 199.9kV
- Voltage regulation accuracy 0.1kV

- Instability ≤ ±1%
- Non-repeatability ≤ ±1%
- Uncertainty ≤ ±1%
- Pulse ignition pulse voltage > 15kV
- Setting of Shock Number
- Range 0~99
- adjustment accuracy 1
- Isolation unit resistance >2500V/RMS /1min
- PLC intelligent control cabinet (lower computer)
- Lower computer AD sampling resolution 12Bit
- Lower machine AD sampling nonlinear error <1LSB
- Lower machine AD sampling time <10us
- Lower computer AD sampling channel 4
- Lower computer DA sampling channel 4
- Lower computer digital channel 24input，16output
- Each unit is isolated and protected, with phase sequence protection, door interlocking, anti-misoperation and strong anti-interference.
- Computer (host computer)
  - One computer is used for control and waveform analysis。
  - 18-inch LCD monitor, strong anti-interference and long life
  - WINDOWS XP, OFFICE 2003, LabVIEW related driver software, ACE measurement and control software package,built in Chinese



ACE measurement and control software package:

Measurement and control main interface

1.3 Main function

This part is mainly to control the operation of the impulse voltage generator, manually or automatically complete the charging and discharging process, and truly realize intelligent operation.

☼Charging control function

The system uses constant current charging and uses the PLC to perform PID algorithm.

According to the test requirements, adjust the charging voltage, charging speed, delay time, and can manually or automatically control the charging process of the voltage generator. When charging by automatic control mode, according to the set value, it automatically charges and stabilizes on the charging voltage value, and delays the alarm for 3 seconds. The repeatability and stability of the charging voltage are very good.

☼Motion control

Charging voltage setting and real-time display; charging current display; real-time display of body ball pitch and intercepting ball pitch.

The body ball size can automatically track the set charging voltage value, or manually adjust the ball size. The body ball pitch value is displayed in the configuration software.

The cutoff ball distance can automatically track the set charging voltage value, or manually adjust the ball size. The cutoff ball pitch value is displayed in the configuration software.

It can control the functions of automatic grounding of the main body, switching of charging polarity and setting of charging times.

Manual / automatic control.

☼Trigger control

The system can trigger the impulse voltage generator ignition manually, automatically or by an alarm. The trigger ignition signal can be independently delayed.

☼Safety interlock control

The system has fuction of alarm system, automatic grounding, overcurrent and overvoltage and phase sequence protection, and emergency stop .

☼Emergency response function

2.Impulse Waveform Measurement and Analysis System

2.1 Outline

The HZCJ impulse voltage waveform analysis software package is specially designed for high-voltage test chambers to measure high-voltage lightning pulse signals and steep wave signals. It first digitizes the input high voltage pulse signal, then stores, displays, and analyzes the waveform. The waveform data can be archived and the output graphic can be printed. The automatic analysis and measurement part uses a high-precision TEK digital storage oscilloscope to collect signals, and automatically analyzes the peak voltage Vp, the head time Tf, the tail time Tt, the cut-off time Td, the zero-crossing coefficient K, the detection current, etc. of the acquired waveform according to the IEC standard. And has the functions of saving waveforms, report preparation and printing.

2.2 Performance index

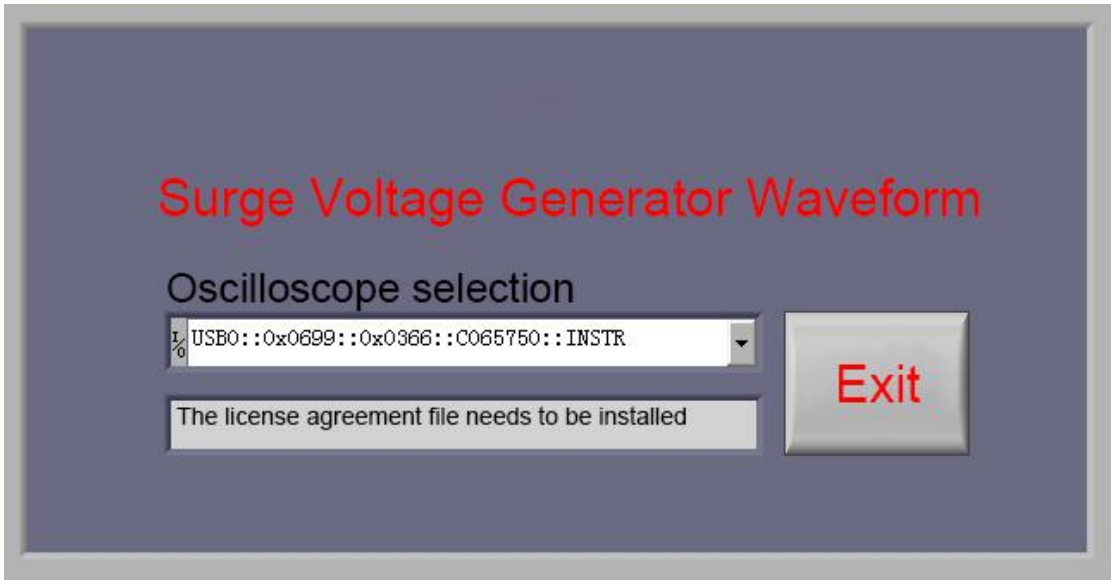
Inlet voltage	＜±1000V
Sampling rate	≥200M S/S
Bandwidth	200 MHz

Number of channels	2/4
Resolution	12 bit
Channel input impedance	2MΩ//20pF

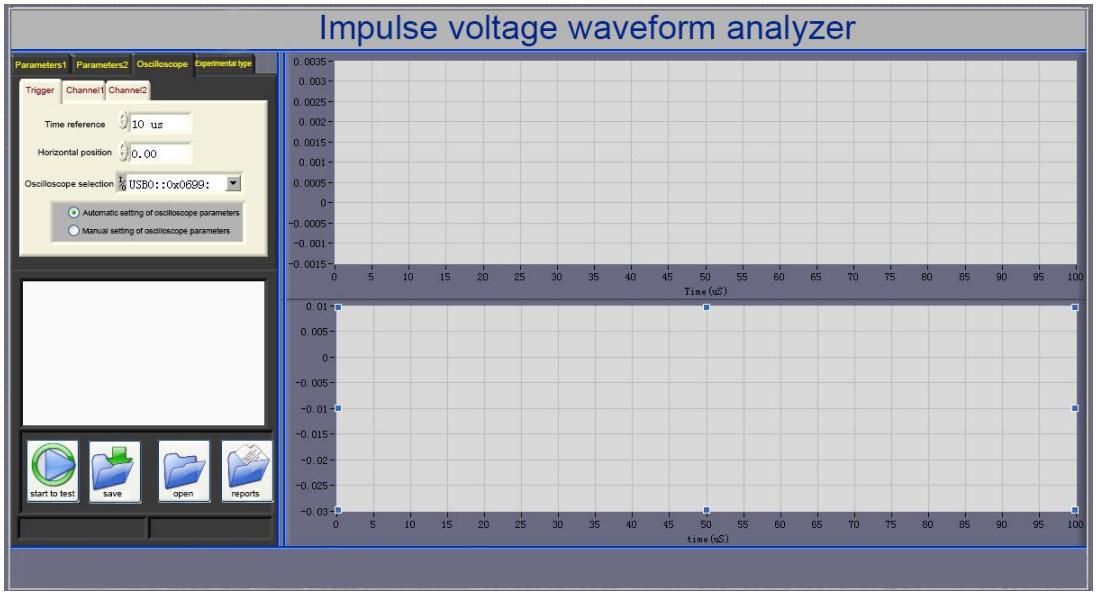
Signal acquisition: Data acquisition card (network port communication)

Industrial Control Host: Industrial Grade Computer (configuration above)

Automatic analysis software: Automatic analysis of waveform parameters, smooth waveforms, save waveforms and print functions.



Measurement start interface



Dual channel measurement interface

2.3 Main function

The impact automatic measurement and analysis system is designed for high-pressure environment, laboratory and laboratory, and is used to measure lightning impulse voltage and lightning impulse current. The system first digitizes the input high-voltage pulse signal, and quantizes it by the data acquisition system. After A/D and D/A conversion, the waveform is displayed on the computer screen or on the oscilloscope screen. According to the user's choice, if the automatic analysis specially developed by our company is selected. Software, the computer will automatically analyze the waveform parameters (wave head time Tf, tail time Tt, voltage and current peak Vp / Ip, cutoff time Td, zero-crossing coefficient K, display damage current Ip, etc.) and then store, display and waveform analysis, Waveform data can be archived and printed out. This system complies with the IEC standard. Suitable for transformers, transformers, high voltage switches, power capacitor factories, insulation materials factories and pilot stations.

Reliable trigger performance: the input signal is directly detected, and the trigger level program control is adjustable. There is no need to trigger the antenna and delay line.

Accurate parameter measurement: Automatic analysis of waveform parameters, including peak and time parameters of pulse signals, to avoid human error.

Clear display waveform : the recorded waveform can be continuously displayed on the screen, and the waveform can be enlarged or compressed to adjust the display range of the waveform.

Large storage capacity: 10K (TDS3012C) memory per channel, 100 microseconds can be recorded at 100MHz sampling frequency. One channel can record the pulse head or full wave of pulse voltage or current signal, which is equivalent to ordinary high voltage oscilloscope. The working capacity of the two channels.

Convenient archiving: Waveforms can be permanently saved by disk files and can be reloaded into the computer for waveform display and report printing, eliminating the need for photographing, rinsing, etc.

Easy report production: waveform printout, and can send graphics to OFFICE to prepare test reports.

Strong anti-interference ability: The system adopts a variety of shielding structures and has anti-interference isolation and filtering power supply.

2.4 Main equipment

（1）Data acquisition card

Inlet voltage ＜±1000V

Sampling rate ≥200M S/S

Bandwidth 200 MHz

Number of channels 2/4

Resolution 12 bit

（2）Control computer (configuration is consistent with control part)；

（3）Piano cabinet, drawer keyboard；

（4）Isolation transformer，500W ；

（5）HZCJ impulse voltage waveform automatic analysis software package, including manuals, etc.

3.Main Components

No.	Range	Unit	Quantity
1	1800KV impulse voltage generator body	set	1
2	±200kVCharging device	set	1
3	1800KV Weakly damped capacitor divider	set	1
4	1600KV interceptor	set	1
5	Control and computer analysis system	set	1
6	Printer	set	1
7	Secondary control, measuring line	set	1
8	Spare parts resistance	set	2