

CDY series

Impulse Voltage/Current Generator



1600kV/160kJ Impulse Generator

CDY series mainly has four types of structure, they are S, voltage from 200kV-500kV, L, voltage from 500kV-1600kV, E, voltage from 600kV-2100kV, H, voltage from 800kV to 4800kV. Energy from 10kJ-720kJ.

impulse voltage generator can be used to generate impulse voltage simulating lightning strokes and switching surges, it also can be used to generate chopping wave, oscillating wave, steeping wave and 4/10us, 8/20us, 10/350us impulse current wave, if property add some extra equipments.

All structures covered include testing to IEC, ANSI/IEEE as well as other national standards.

The basic system can be upgraded in various ways for special tests and or greater ease of operation. A number of additional circuits and components allow optimising the impulse test system for tests on:

- Shunt reactors
- Power transformers
- Distribution transformer
- Instrument transformers

- Cables (type tests)
- Bushings
- Arresters (impulse current tests)
- Insulators
- GIS and air-insulated breakers
- Etc

Feature

- ◆ All the synchronization discharging spheres are set in a sealed insulating barrel; every level of sphere gaps is armed with windows for observing. Filtered clean air is constantly supplied while the equipment is running. The ball is not easily affected by the changing of the environment, and discharging is stable. The whole set forms a sealed ignition discharging system.
- ◆ Every level of loop is equipped with parallel discharging gaps with interstage coupling capacitance and resistor to holding potential, which hugely extends the range of synchronous discharging
- ◆ Automatic grounding device and security grounding system (**L series & H series**): the security grounding system should be started when experiment man climbing the generator to replace the wave resistance or doing some repairing work. All the capacitances should be short and grounded to assure the personal safety.
- ◆ Staircase is set inside the generator (**L series & H series**), every three level has an insulated plate (turnover type) which is for resistance replacing or repairing.
- ◆ You can choose air cushion transportation system for your CDY series impulse voltage generator. It can be moved smoothly and conveniently if needed.
- ◆ Series resistors can be interchanged with one another as can the parallel resistors. Different values of a

- ◆ resistor type can be used.
- ◆ Ingenious extensions of load range (Glaninger Circuit, Overshoot Compensation, special resistor sets for transformer, cable or GIS testing).
- ◆ Unique 8 supports mobile impulse generator design, it can avoid frequent dismantling onsite, save lots of time and human power.
- ◆ Unique DC high frequency 20kHz charging device equip with S and L structure.
- ◆ Automatic PLC control and 12 or 14 bit high accuracy and 100Ms/S high speed impulse analyzer equipped.



1400kV Mobile Impulse Generator

Protection of Test Objects and Test Systems

The test system is shut down in case of over-voltage, over-current and fast voltage transients. The test system is continuously monitored during test operation.

Extension

CDY series impulse generator is a modular system. The impulse generator can be extended for the generation of higher peak values (by adding of some stages) or for the generation of other wave shapes (by adding resistors and or other external circuits). Also the load range can be extended by adding the Glaninger circuit or the Overshoot Compensation.

Function of the Impulse Test System

The test system comprises the following main components:

- ◆ Impulse generator (S,L,E,H)
- ◆ Charging rectifier
- ◆ Impulse voltage divider
- ◆ Control system

Accessories for additional measurements, tests or analyses of the wave shape are:

- ◆ Shunts
- ◆ chopping gap
- ◆ Measuring system
- ◆ Additional circuits for transformer testing or impulse current generation



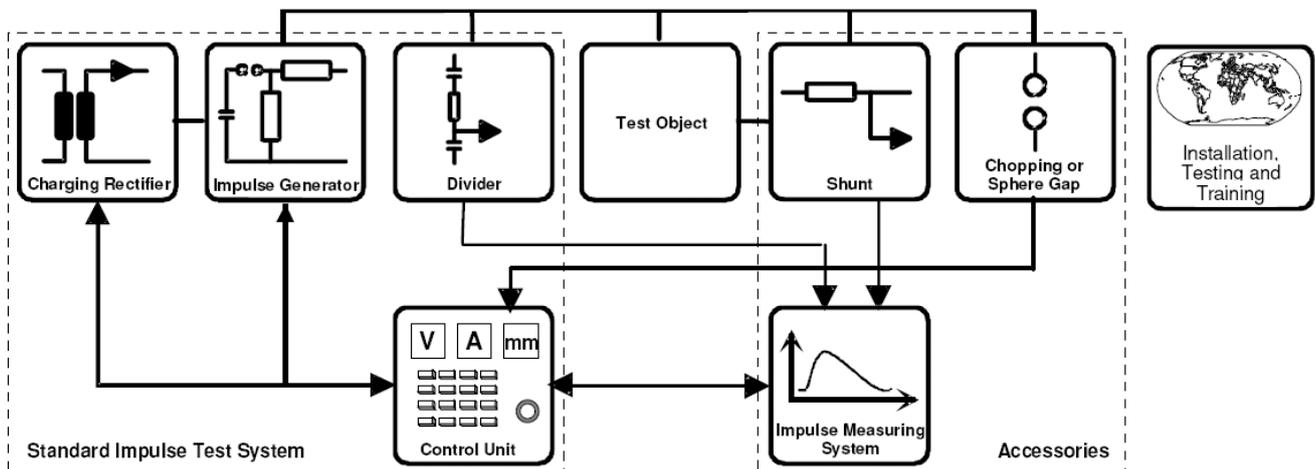
800kV/40kJ L Structure

The block diagram below demonstrates the basic functions of the system. The impulse test system operates under a control system which charges the impulse generator through the charging unit.

This is achieved as the stages in the impulse generator are connected in parallel via the charging resistors. Charging time and charging voltage can be selected.

Once the selected charging voltage has been reached, a trigger pulse initiates firing of the first spark-gap of the impulse generator. The resulting over-voltage triggers the successive stages. As all the spark-gaps fire, the stages which are connected in series, multiply the charging voltage to reach the test voltage. Any impulse voltage divider reduces the impulse voltage to a value that the measuring and recording instruments can use.

Impulse test system line diagram



Operating Range

S, L, E structure impulse generator, the minimum output voltage is 15 kV positive and negative LI, SI. H structure impulse generator, the minimum output voltage is 30kV positive and negative LI, SI. This is obtained with only one stage operating. The other stages are shorted or connected in parallel. The maximum output voltage is between 85% (on load) and 95% (off load) of the total charging voltage.

Ambient conditions

- ◆ Height above sea level: ≤ 1000 m
- ◆ Extreme temperatures for H.V. components: $-5^{\circ}\text{C} \sim +45^{\circ}\text{C}$
- ◆ Relative humidity in main hall under non condensing conditions: $\leq 90\%$ (at 25°C)
- ◆ Use environment: Indoors/Outdoors (Outdoors impulse generator we will use the glass cover)
- ◆ Earthquake intensity: ≤ 8 level
- ◆ Is equipped with a reliable grounding point, earth resistance: $< 0.5\Omega$

Immunity to Electromagnetic Interference

Electromagnetic interference is unavoidable in impulse testing. The CDY series test system is designed especially for minimizing the influence of interference fields for ensure a correct function of the controls and measuring electronic instruments.

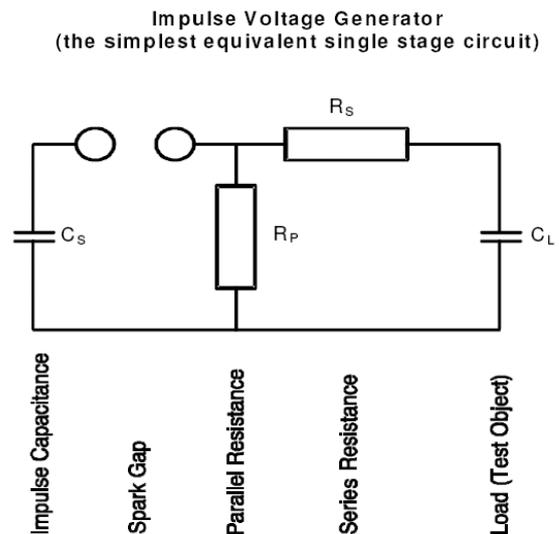
The measurement and control lines are properly shielded and grounded. All inputs and outputs are protected against over-voltages. All system components are grounded with a suitable material such as copper braid or foil to keep the ground potentials at a safe level. The measurement signal from the high voltage divider is in the range of 100 V to 1600 V in order to insure a high signal to noise ratio. All components what Samgor choose all pass strict EMC test.

The Impulse Voltage Generator

The Impulse Voltage Generator is the main part of an impulse voltage test system.

E, H structure impulse voltage generator consists of two impulse capacitors charged in parallel up to a maximum voltage of 100kV/150kV/200 kV for L.I. S, L structure impulse voltage generator consists only one impulse capacitor charged to maximum 200kV/300kV. When the desired charging voltage has been reached, a set of sphere gaps connect the capacitors in series and the output voltage is delivered via some pulse forming elements.

The figure shows an equivalent circuit diagram for a single stage impulse generator (it is possible to simplify a multi stage impulse generator into this circuit).



Design

CDY series impulse generator is based on the MARX multiplier circuit. The construction of SGV generators is the result of decades of experience in designing impulse test systems. The major impulse circuit elements such as capacitors and resistors are arranged in an optimum manner to simultaneously satisfy the two major requirements for smallest possible internal inductance and operating convenience. The design is strong enough to withstand in earthquake areas. In order to increase the impulse capacitance, generator stages can be connected in parallel and the groups so formed can be further connected in series. The total charging voltage is the product of the stage charging voltage and the number of groups.

The impulse generator can be extended easily for the generation of higher peak values by adding some stages.

Impulse generators are designed for stationary operation as standard. For handy mobility, an air bearing system is available also. Spark-gap drive, gap chimney ventilation, safety ground system, triggering unit and charging rectifier are built into the base frame.



Triggering

High reliability and accuracy of generator triggering, extremely high stage energies and long front times (for switching impulse voltages) is provided with different inner inductances of tail and front resistors and additional firing capacitors in the lower stages. The reciprocal irradiation of the spark gap with the ultraviolet light of the discharge spark is an additional reliability factor. The generator is triggered by a triggering impulse which acts on the triggering electrode in the lowest spark gap via a coupling capacitor. All subsequent stages are then reliably triggered with extremely small delays due to the high natural over-voltages, without the need for a complex electronic triggering system in each individual stage. The encapsulation of the spark gaps and the filtered air flow eliminates the influence of dust and random particles.



Trigger range

The trigger range starts at the lower triggering threshold and ends at the static firing voltage of the switching spark gap. The trigger range is expressed in percentage of the static firing voltage. The larger this value, the more reliable is generator triggering. The large trigger range of typically 20% and more is obtained irrespective of the energy of the generator and practically independently of the resistor configuration. In similar impulse generators without firing capacitors, the trigger range may drop to values below 10% and reliable triggering is no longer guaranteed.

Resistor

All the shaping resistors we used for the impulse voltage generator are the plate shape structure, non inductive winding system, its inductance is $\leq 2.5\mu\text{H}$ (reduce inductance to increase load capacity). Front wave resistor, tail wave resistors support the use of four parallel resistors at the same time. Front wave, tail wave resistors have equal length and can be used together. Each level is equipped with extra storage and short wave resistance pole position; plug can be used to facilitate short circuit to make the generator work in series; All wave shaping resistors are built into the impulse generator. They are wire-wound resistors of high stability and linearity built in flat epoxy resin-cast resistors for high impulse loads. Each resistor value has a specific colour for easy identification. These resistors have a plug-in connection for quick and easy reconfiguration. The basic system includes a set of resistors for lightning and switching impulse voltages according IEC 60060-1.



Internal Ladder

H structure impulse voltage generator, the main body is equipped with the insulation ladder, every three levels are equipped with an insulation platform, its load-carrying capacity is according to the 250kg design, easy for the staff to replace or adjust the wave part, each level of test the wave resistance adjustment and coupling bar bracket;

Encapsulated Spark Gaps

The spark gaps of the generator consist of copper spheres with 250 mm diameter featuring tungsten sintered metal inserts to reduce burn-off. Precision translatory gears are used to adjust gap distance. The drive motor is automatically controlled from the control unit. The optimum spark gap distance pre-selected for a given trigger voltage is automatically adjusted. A protective fibre-glass reinforced plastic cylinder encloses all spark gaps, keeping dust and random particles away from the spheres. Thus impeccable triggering is guaranteed even in a dusty environment. The lateral service openings are covered with transparent Plexiglas lids. The protective cylinder is supplied with filtered air by a powerful fan. The air blows from the bottom to the top through the spark gaps with a small overpressure. This de-ionises the air between the spheres from one triggering cycle to the next even in fast impulse sequences. Premature firing is therefore practically excluded. The protective epoxy resin cylinder also substantially silences the noise produced during spark discharge.

Impulse Capacitor

Each impulse capacitor consists of flat elements built into a steel housing and impregnated with castor oil. The housing walls are flexible so that the impregnating oil can expand. The inductance of the capacitor is less than 0.2uH. Years of experience with castor oil guarantee 100000 time capacitor life in the full voltage. Castor oil offers optimal environmental compatibility (no PCB's). 50kV/75kV/100kV/150kV/200kV impulse capacitor is using in our impulse generator, the supplier is the same to the Swiss competitor.

Grounding System

Two earthing switches ground the generator at the first stage.

Due to the constant discharging time of the generator, an additional high speed earthing band is moved into all stages (for a 15 stage generator in approx. 30 s) and this grounds all capacitors. We give up to use the earthing steel wire and nylon

wire, and we use steel belt and nylon belt, after long term use, it is more stable than the traditional design.

Top electrodes

The use of top electrodes makes it possible to raise preliminary discharge voltage to very high values. Several models of top electrodes, made of aluminium toroids or of discs (Polycon design) are available. They are chosen according to the lightning and switching ratings and the available clearance to the walls and ceiling.

The normal generator models have a simple tubular electrode at the top. In most cases this is suitable, particularly if the laboratory building is largely dimensioned or if no very high switching impulse voltages must be generated. Basically preliminary discharge will already occur at the top of the impulse generator prior to a spark-over and can be observed as a voltage drop on the measuring unit. This effect is more significant for switching impulse voltages than for lightning impulse voltages and becomes increasingly less important for higher load capacitance.

Base Frames

Different types of base frames are available for instance mobile types with air cushions, with wheels or for rail-bound displacement. The base of impulse generator and the charging rectifier are in the same one or separate. A common base frame for the generator and the charging rectifier allows a displacement of the basic system without any reconnections. Stationary impulse generators are almost exclusively used for routine test systems with standard test objects and test programs.

Below 2400kV, in our experience we suggest to use low resistance wheels, it moves easier and is much economic than air cushion.

Up to 2400kV impulse generator, today most high-voltage laboratories are designed for mobile test systems. The main advantage lies in improved utilisation of available space and in greater flexibility for different types of test configurations. Whenever possible the floor should therefore be designed for air cushion transportation. The modern air cushion devices available today permit effortless displacement of the generator to any desired location.

They are clearly superior to the conventional castor type dollies, particularly when large and heavy generators are involved (friction, drive power). In most cases, a motor drive or a separate tractor can be eliminated with air cushion bases. Two persons can conveniently move even large generators by hand. Many years of operating experience have been gained under various operating conditions.

Charging Unit

SAMGOR ZD-50/100/150/200 uses the silicon controlled current voltage regulation device, the charging method is the bilateral symmetrical constant flow charge method, rated output voltage from 50kV-200kV, rated output DC current from 10-200mA; The current and voltage value are according to different structure and different energy of the impulse generator.

100kV stage structure, the high voltage silicon rectifier is installed outside the charging transformer; it switches automatically the charging voltage polarity. 150kV or 200kV stage structure, the high voltage silicon rectifier is installed

inside the charging transformer. The control panel has the polarity switch converting key.

Samgor also developed high frequency DC charging system, it is a AC-DC-AC power source, use high speed IGBT inside, it can generate 20kHz pulse, then a multiple voltage circuit is be used, it can output 100kV 20mA DC. Below 40kJ 800kV, it is a compact and smart design compare to the any charging unit from any company in the world. It is 1/10 space occupied and efficiency is 2-3 times higher than old design.

Damped Capacitive Impulse Voltage Divider

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. Dividers type DF can be used simultaneously as load capacitance for the impulse generator. Oil-filled insulating cylinders accommodate oil paper capacitor packs. Dividers type DF also can be used as a AC voltage divider.

Main features:

- ◆ Response of system meets requirements of IEC60060-2 (1994)
- ◆ Four arms mobile base frame
- ◆ Indoor and outdoor types available
- ◆ Higher than 3 MV are equipped with fiber glass struts
- ◆ Different top-electrodes available i.e. for measurements of higher voltages in limited space.

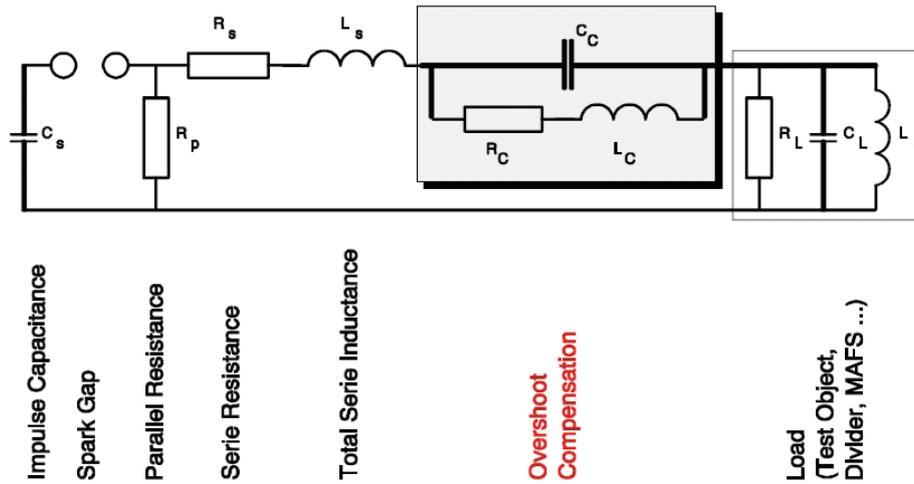


Options

Overshoot Compensation

An overshoot compensation circuit allows to test very high capacitive loads (such as long cable, big transformer and etc.) still according to the standard impulse shapes.

SAMGOR developed and patented compensation circuit designed as an add-on circuit which can be integrated in each stage of the CDY series impulse voltage generator.

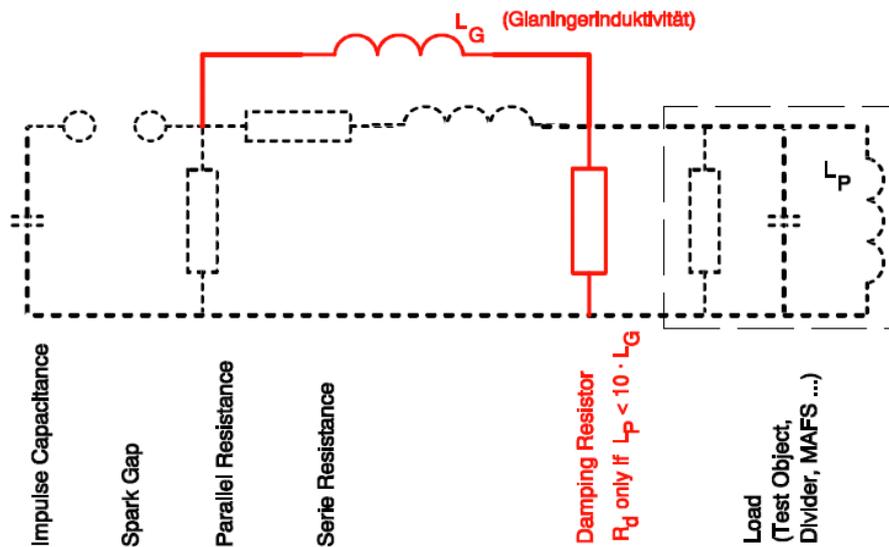


Impulse Capacitance
 Spark Gap
 Parallel Resistance
 Serie Resistance
 Total Serie Inductance
 Overshoot Compensation
 Load (Test Object, Divider, MAFS ...)

Glaninger Circuit

For testing low voltage windings of transformers, an optional additional set is available. This external circuit permits to test very low inductive loads.

Glaninger Circuit



Impulse Capacitance
 Spark Gap
 Parallel Resistance
 Serie Resistance
 Damping Resistor
 R_d only if $L_p < 10 \cdot L_G$
 Load (Test Object, Divider, MAFS ...)

- Normal value used in the Glaninger circuit:
- Inductance (LG) 100 mH, 100 kV (2 pieces)
 - Resistor (Rd) 25 W
 - Resistor (Rd) 50 W
 - Resistor (Rd) 100 W
 - Resistor (Rd) 200 W
 - Resistor (Rd) 400 W

Shunts

The shunts from Samgor can be used for the measurement of impulse currents. Most shunts have two types, one is a metal cylinder with coupling flanges and coaxial measuring connector, the other type is cylinder insulation with the resistor. Different models are available depending of the application.

SAMGOR also supplies compensation circuit used to optimise the transient behaviour of the shunt and avoid distortions at the beginning of the measured impulse current wave shape. This is recommended for fast current impulses with a rise time of 1µs or less. They are equipped with LEMO connectors, one on each side.

Dimensions: 130 x 80 x 60 mm, weight 2kg.



Rogowski Coil

The Rogowski coil, named after Walter Rogowski, is an electrical device for measuring alternating current (AC) or high speed current pulses like 8/20µs impulse current and others up to 100kA. It consists of a helical coil of wire with the lead from one end returning through the centre of the coil to the other end, so that both terminals are at the same end of the coil. The whole assembly is then wrapped around the straight conductor whose current is to be measured. Since the voltage that is induced in the coil is proportional to the rate of change (derivative) of current in the straight conductor, the output of the Rogowski coil is usually connected to an electrical (or electronic) integrator circuit to provide an output signal that is proportional to the current.

Advantage:

- ◆ It is not a closed loop, because the second terminal is passed back through the center of the toroid core (commonly a plastic or rubber tube) and connected along the first terminal. This allows the coil to be open-ended and flexible, allowing it to be wrapped around a live conductor without disturbing it. No grounding disturbing the measuring system like shunt.
- ◆ It has an air core rather than an iron core, it has a low inductance and can respond to fast-changing currents.
- ◆ Because it has no iron core to saturate, it is highly linear even when subjected to large currents, such as those used in electric power transmission, welding, or pulsed power applications.



Impulse current adjust inductor

The inductor is used as a adjust waveform device to make a impulse voltage generator to not only impulse voltage, also generate impulse current, several taps include for the inductor and difference resistors combination, they system can generate 4/10us, 8/20us, even 10/350us and etc.

Use together with high voltage impulse voltage generator, it can generate the impulse current with high voltage impulse voltage up to 1200kV at more than 10kA.

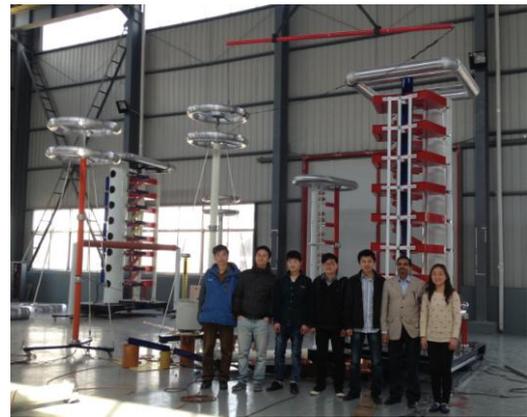


Chopping Gap, Sphere Gap, Resistive Divider, Please Check itself detail PDF catalog in www.samgor.com; For other impulse parts, you also can contact our local sale term.

Part Customer Case Overview:







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