CDY series

Impulse Voltage Generator

4000kV/400kJ H Structure

CDY series impulse voltage generator can be used to generate impulse voltage from 10kV to 7200kV simulating lightning strokes and switching surges, it also can be used to generate chopping wave, oscillating wave and steeping wave if property add some extra equipment. The energies range is from 2.5kJ to 720kJ.

CDY series mainly has four types **S, E, L, and H**.
All structure 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 to optimise 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

Feature

- All the synchronization discharging spheres(S structure doesn't include) 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, all 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 climbs the generator to replace the wave resistance or do 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).

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 of the Glaninger circuit or the Overshoot Compensation.

Appearance

High voltage test bays form an important part of any manufacturing system that maintains the quality of a customers' products.

A well-equipped test bay with appropriate appearance is important. Haefely products are not only technically, but also aesthetically designed to complement the quality image of the customer's facilities.

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

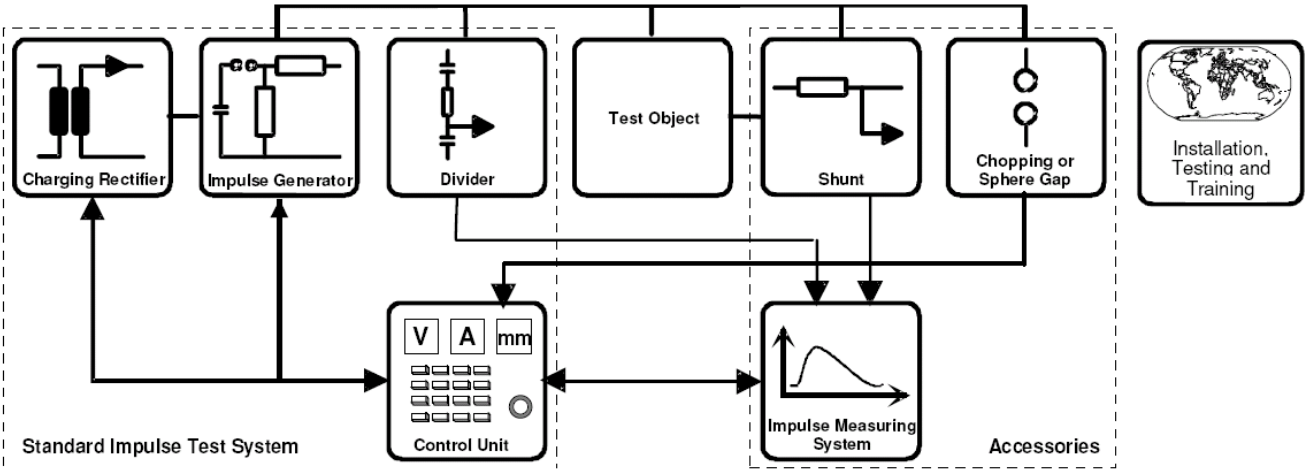
800kV/40kJ L Structure

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 10 kV positive and negative LI, SI.H structure impulse generator, the minimum output voltage is 20kV 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℃~+45℃
- Relative humidity in main hall under non condensing conditions: ≤90% (at 25℃)
- Use environment: Indoors/Outdoors (Outdoos impulse generator we will use the glass cover)
- Earthquake intensity: ≤8 level
- Is equipped with a reliable grounding point, earth resistance: <0.5Ω

Immunity to Electromagnetic Interference

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

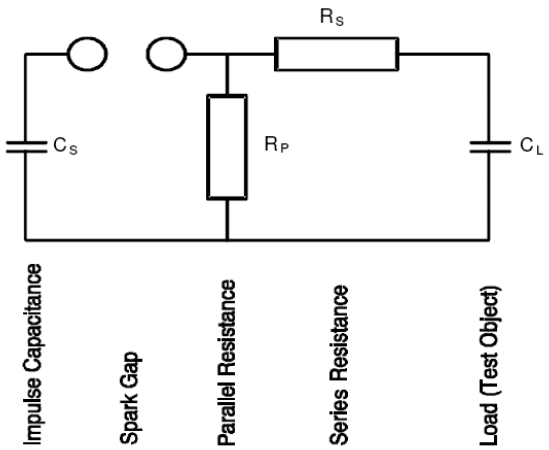
The measurement and control lines are properly shielded and grounded. All inputs and outputs are protected against over-voltages. All system components are grounded with a suitable material such as copper braid or foil to keep the ground potentials at a safe level. The measurement signal from the high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

The Impulse Voltage Generator

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

E, H structure impulse voltage generator consist 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 consist 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 ispossible to simplify a multi stage impulse generator into this circuit).

Impulse Voltage Generator
(the simplest equivalent single stage 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.

1200kV/90kJ E Structure

2100kV/168kJ E Structure

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.

Resistor

All the shaping resisitors we used for the impulse voltage generator are the plate shape structure, non inductive winding system, its inductance is ≤2.5μH (reduce inductance is to increase load capacity). Front wave resistor, tail wave resistor 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 resign-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.

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 per cent 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.

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 capacitors

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 Haefely, Samgor can permit all the technical data is the same what you can get from Haefely.

Grounding system

Two earthing switches ground the generator at the first stage.

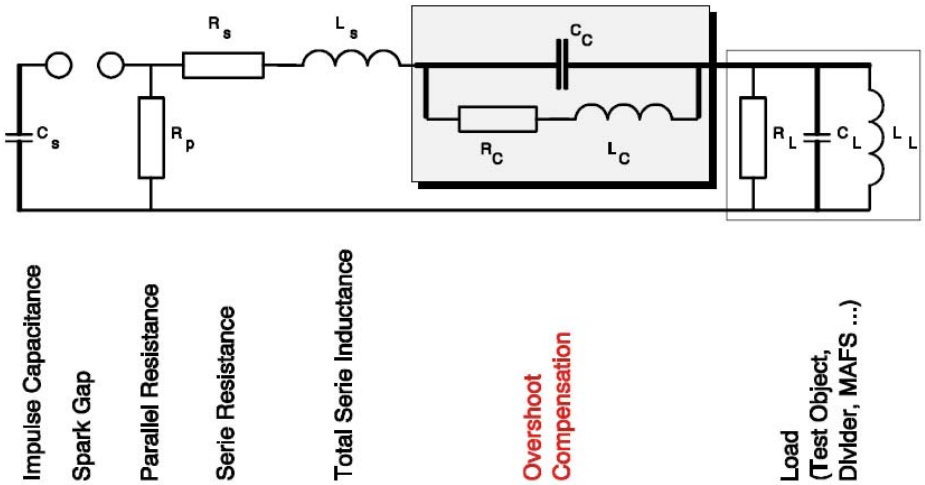
Due to the discharging time constant of the generator a additional high speed earthing band is moved into all stages (for a 15 stage generator in approx. 30 s) and this grounds all capacitors. We give up to use the earthing steel wire and nylon wire, and we use steel belt and nylon belt, after long term use, it is more stable than the traditional design.

Options

Overshoot Compensation

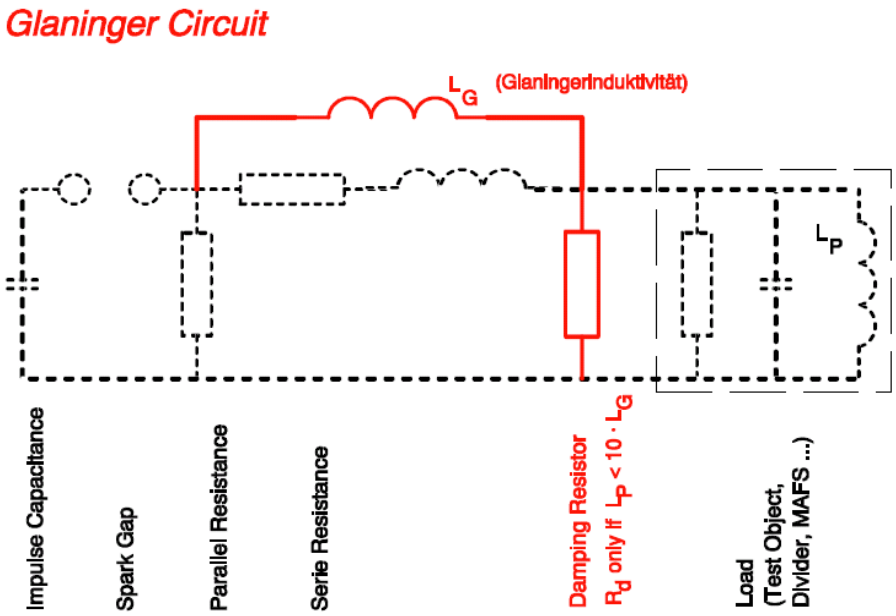
An overshoot compensation circuit allows to test very high capacitive loads (such as long cable, big transformer and etc.) still according to the standard impulse shapes.

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



Glaninger Circuit

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



Normally value we use 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

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 made of discs (Polycon design) are available. They are chosen in function of 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.

Bases 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 sperate. 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 is move easlier and much ecomic 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.

Shunts

SAMGOR shunts 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.

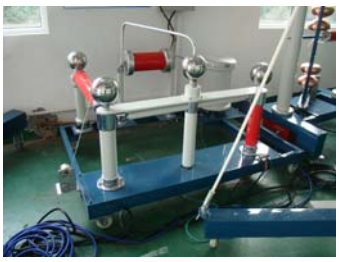
SAMGOR also supply compensation circuit is used to optimise the transient behaviour of the shunt and to avoid distortions at the beginning of the measured impulse current wave shape. This is recommended for fast current impulses with a rise time of 1μs or less. They are equipped with LEMO connectors,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

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

Charging Unit

SAMGOR ZD-50/100/150/200 use the slicon 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 anf voltage value is according to the defferent structure and the difference energy of the impulse generator.

100kV stage structure, the high voltage silicon rectifier is installed outside the charging transformer, automatic switching of the charging voltage polarity. 150kV or 200kV stage structure, the high voltage silicon rectifier is installed inisde the charging transformer. The control panel has the polarity switch converting key.



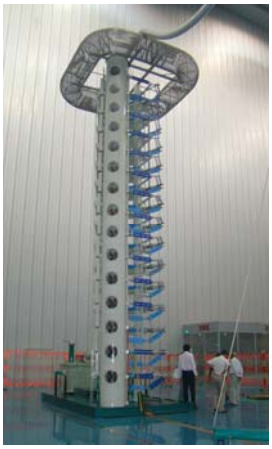
Damped Capacitive Impulse Voltage Divider

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 accommodates 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 withfibreglass struts
- Different top-electrodes available i.e. for measurements of higher voltages in limited space.

Customer Case Overview:



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