HAEFELY
HIGH VOLTAGE TEST

Impulse Voltage Test System SGVA

200 - 10’000 kV, 10 - 1’500 kJ

Impulse test system with 4000 kV impulse generator & divider and 3600 kV multiple chopping gap at Hyundai Heavy Industries, Ulsan, South Korea

When quality is an issue,
The choice is Haefely Test AG.

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Applications

The sophisticated design of the impulse generators series V considers all requirements in conjunction with impulse voltage tests as imposed by industry and research. The field of applications extends form the industrial test facility to university laboratories and to large-scale research centres for ultra high voltages.

SGVA impulse test systems can be used to generate impulse voltages simulating lightning strokes and switching surges. The total charging voltage range covers from 200 kV to 10'000 kV with a stage energy from 10 to 30 kJ. This wide range permits optimum selection for any test assignment. The system is built on contains all experience acquired in impulse generator production since 1932.

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

in the factory or on-site. For the latter tests, the SGVA system can be mounted in modules on a trailer for on-site tests or installed in an air-conditioned weather-resistant tower for permanent outdoor operation.

Our mechanical design assures withstand to earthquakes and strong winds. Fire and lightning protection is of course ensured as well.

Outdoor test system X kV

User Benefits

Quality

The electronic measurement and control components are designed and manufactured in-house. Our many years of experience in dealing with electromagnetic compatibility of electronic devices in high voltage test bays provide the requisite expertise.
In designing and manufacturing our impulse test systems we take full advantage of our seventy years of experience. As a result, trouble-free operation and a long service life are ensured.

Safety of Operation

The design of the test system and, in particular, the control system comply with VDE 0104. Testing personnel benefit from enhanced protection against accidents. The grounding device with two grounding bands and two grounding switches guarantees safe operation. The controls provide furthermore clear alarm messages and guide the user through the operations.

Motorised safety earthing system

Ease of Operation with Modern Control System

The generator control systems allow very comfortable and flexible control on the SGVA impulse test system. They are 100% our own design and manufacture. Safety features are implemented in the hardware independent of software. All components of the control system are EMC tested.

Controls GC 257 Imp

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Main features of the SGV system are:

- Sophisticated strong and flexible design (experience has proven that a 30 stage generator (6 MV) can withstand strong earthquakes several times).
- Total charging voltage from 200 kV up to 10'000 kV.
- Stage energy range from 10 kJ to 30 kJ.
- Reliable and accurate triggering by improved Marx circuit.
- Easy operation with micro-processor control system.
- Equipped with resistors for performing lightning and switching impulse voltages. Special resistors can be manufactured for any impulse shape or load testing.
- Unique protective grounding device, the fastest available on the market.
- Expandable up to 10'000 kV.
- Ingenious extensions of load range (Glaninger Circuit, Overshoot Compensation, special resistor sets for transformer, cable or GIS testing).
- Short reconfiguration times (internal ladder, internal platforms, handy plug-in resistors and connections, special resistor support and resistor compartments on every stage).
- Series resistors can be interchanged with one another as can the parallel resistors. Different values of a resistor type can be used.
- Encapsulated spark gaps in a filtered air-flow.
- Different kind of base frames available.
- Liquid insulation in the impulse capacitors is made of castor oil which offers optimal environmental compatibility (no PCB's).
- Communication between measuring system and controls allows to determine the efficiency and to work with test voltages instead of charging voltages !
- Top electrodes adjustable according to customers impulse test requirements.
- Special solutions for unique customer problems or test requirements.

6 MV, 450 kJ impulse test system

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

The Haefely Test impulse generator SGV 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
- charging rectifier
- impulse voltage divider
- control system

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

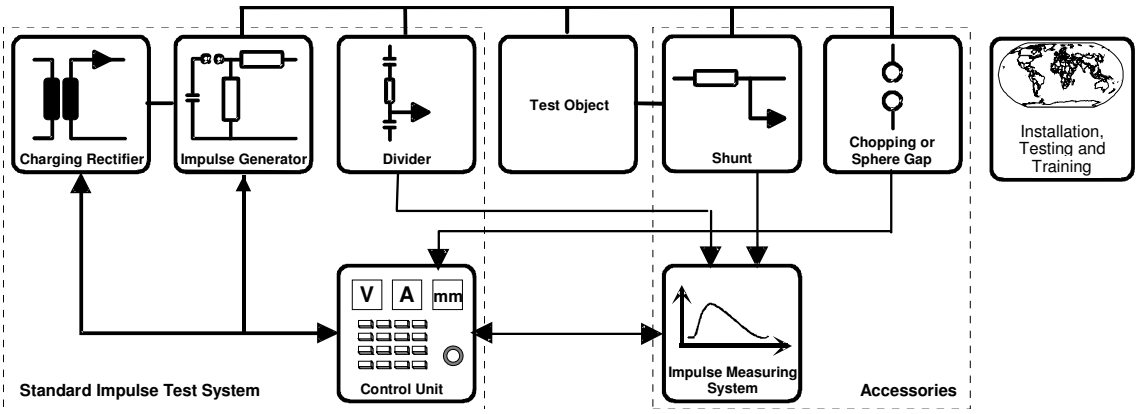
- shunts
- chopping gap
- measuring system
- additional circuits for transformer testing or impulse current generation

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.

An 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

The minimum output voltage is 20 kV positive and negative. This is obtained with only one stage operating. The other stages are shorted or connected in parallel. The maximum output voltage is between 85% and 95% of the total charging voltage, depending on the load and the waveform. Details about the load range and output voltages are given in our quotations.

Ambient conditions

- The impulse generator can be operated at ambient temperatures between -5 °C and 45 °C and relative humidity (R:H.) up to max. 95 % (no condensed moisture).
- The control and measurement equipment is deigned for operation at ambient temperatures of 0 °C to 45 °C and R.H. values between 35 % and 80 %.
- The permissible temperature and R.H. ranges for shipping and storage of all parts are – 20 °C to 60 °C and max. 95 % R.H. (no condensed moisture).

The voltage values stated in the documentation are for standard conditions, that is, T = 20 °C, b = 1013 mbar and f = 80%.
Theses values also apply for operation of the system up to 1000 m above sea level. Above this elevation, the rated charging voltage is to be reduced by 1% for each additional 100 m.

Impulse intervals

At maximum charging voltage, minimum time between impulses is 30 s (2 impulses per minute) for the smaller generators up to 2 MV. This interval is dictated by the maximum charging current, the maximum energy of the impulse capacitors in the impulse generator and the resistor energy absorption capacity.

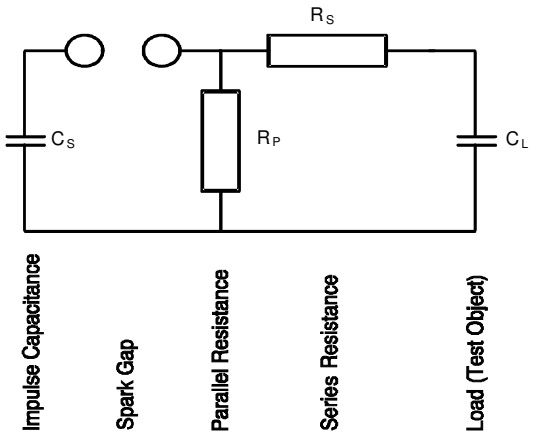
Immunity to Electromagnetic Interference

Electromagnetic interference is unavoidable in impulse testing. The SGVA 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 1'600 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. An impulse voltage generator SGV consists of a number of capacitors charged in parallel up to a maximum voltage of 200 kV for L.I.. 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).

Impulse Voltage Generator
(the simplest equivalent single stage circuit)



Design

Like all Haefely Test impulse generators the SGV 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 being 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.

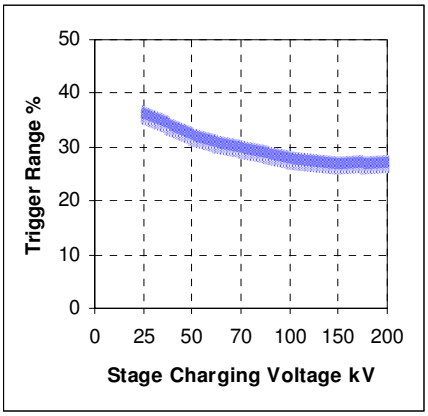
Resistor wiring concept

All resistors are distributed among the stages within the generator. External resistors aren't used for the V type generator anymore. This concept guarantees minimum space requirements and low impulse circuit inductance.

Front and tail resistors are wound with different inner inductances and therefore are not interchangeable. Depending on front times, high or low-resistance front resistors can be plugged in. The tail resistors for lightning and switching impulses generally remain in position. To switch over from the lightning to the switching impulse mode, it is only necessary to remove the short-circuit aluminium bar parallel to the switching resistors and to select a front resistor in accordance with the load capacitance.
The charging resistor has been selected to provide a sufficient efficiency factor, the necessary time to half value and reasonable charging times even for extremely long switching impulse voltages.

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 figure at right shows the trigger range plotted against the charging voltage.
The large trigger range of typically 25% 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.



Support frame

Epoxy resin tubes glued to a welded steel frame and internally tightened are the main part of the support frame. This frame carries sets of two impulse capacitors in a V-shaped configuration as well as the resistor holders and an internal ladder made of insulating material. Fibreglass guys increase stability in generators with more than 22 stages. The design is strong and flexible to support the biggest impulse generators of the world even in earthquake areas. Experience has proven that 30 stage generators (6 MV) can withstand strong earthquakes.

Internal ladder

An internal ladder made of insulating material allows to reach the operating platforms. For normal operating duty, there's no additional external ladder or crane necessary.

Operating platforms

At every third stage a folding platform is mounted. All operations like resistor change, parallel connection of stages, implementation of Glaninger circuit or Overshoot Compensation can be performed from this platform (not only from the internal ladder).

Internal view of ladder and platform

Encapsulated spark gaps

The spark gaps of the generator type SGV consists 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.

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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. Two 100 kV impulse capacitors are positioned in a V-arrangement in each stage.

Years of experience with castor oil guarantee the long capacitor life. Castor oil offers optimal environmental compatibility (no PCB's).

Firing capacitors

Generators with more than 6 stages are equipped with firing capacitors in the lower stages for best triggering. They are built as oil-impregnated paper capacitors cast in a plastic cylinder. These capacitors remain in position in all circuit configurations and for all front resistor values.

Resistors

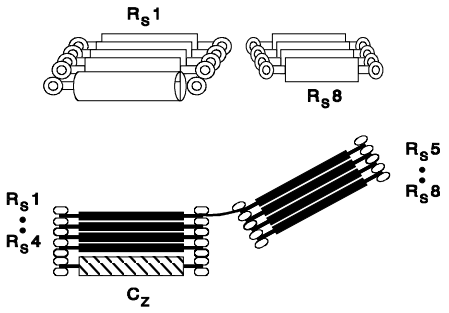
All wave shaping resistors are built into the impulse generator. They are wire-wound resistors of high stability and linearity built in flat epoxy resign-cast resistors for high impulse loads. Each resistor value has a specific colour for easy identification. These resistors have a plug- in connection for quick and easy reconfiguration. The basic system includes a set of resistors for lightning and switching impulse voltages according IEC 60060-1.

Resistor support

Each stage is equipped with resistor holders with corrosion- resistant spring contacts. This holders can support 8 series resistors (also called damping or front resistors) and 4 parallel resistors (also called tail resistors). For the front resistors there are two groups of holders which are connected in series. Each can accommodate up to 4 plug- in elements. Tail resistors holders are also parted in two groups up to 2 plug- in elements. This large number of supports and their special arrangement allows the implementation of a large number of resistor combinations to further increase thermal loading capability and to adjust optimally the wave shape. Every resistor holder is designed for the rated data. So it is possible to use one resistor in one group and to short-circuit the series connected other group.

Resistor compartment

Each stage has place for the storage of 8 standard plug in resistor elements (also for short circuit bars or other components with standard length).
This resistor compartment allows to reach very short rewiring times, because it is not necessary to move resistors between the stages.
The compartment is easily accessible from the service platforms.



Grounding system

Two earthing switches ground the generator at the first stage.

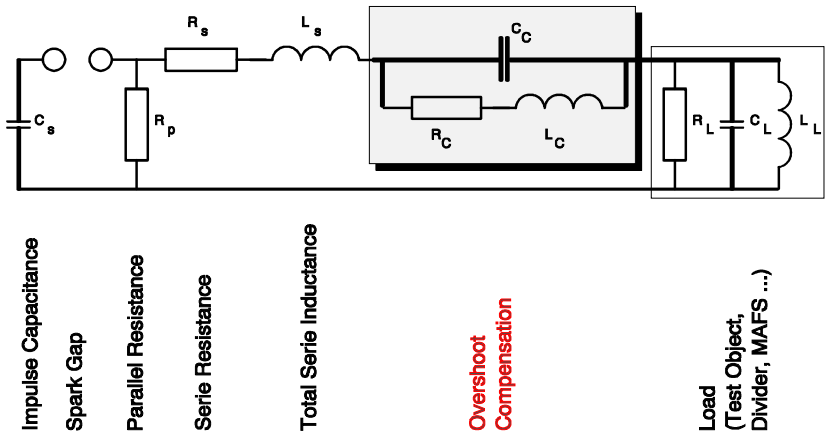
Due to the discharging time constant of the generator a additional high speed earthing band is moved into all stages (for a 15 stage generator in approx. 30 s) and this grounds all capacitors.

Options

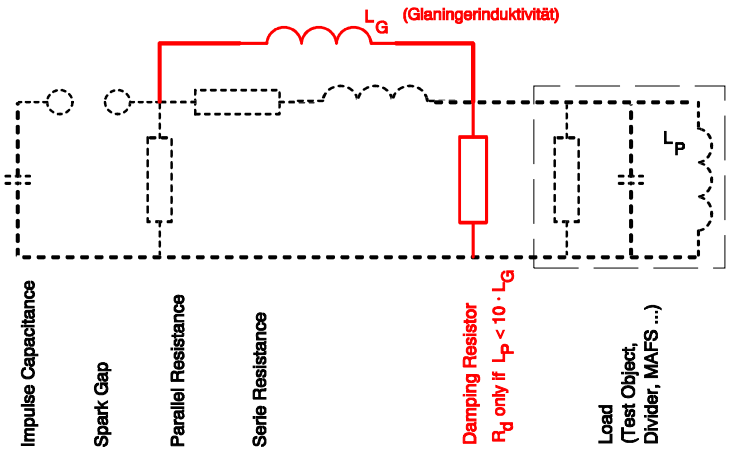
Overshoot Compensation

An overshoot compensation circuit allows to test very high capacitive loads still according to the standard impulse shapes.
The Haefely developed and patented compensation circuit is designed as an add-on circuit which can be integrated in each stage of the impulse voltage generator type V.

Impulse Voltage Generator with HAEFELY patented overshoot compensation (equivalent single stage circuit)



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.
The Glaninger circuit presupposes the existence of the tail resistor set SGV RP.
This circuit is built into the first (respectively ground) and/or second stage of the generator. The stages are connected in parallel (1s2p) or parallel/series (2s2p).

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Options, continuation

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.

Example of a top electrode

Front resistors for transformer tests

Resistor sets are available according IEC 60076-3 and ANSI/IEEE C57.12 for switching impulse for transformer testing. This is recommended to obtain a sufficient operating range for high parallel connections (i.e. secondary voltage windings of transformers)

Tail resistors for testing of small inductances

In order to compensate for the shorter decay time with small inductances, an additional set of tail resistors can be supplied. It consists of three resistors for each stage.

Termination resistors for power transformers

To obtain the specified time to half value the non-tested windings may be grounded through termination resistors. Values ranging from 20 to 400 Ω are suitable in series or parallel circuits. Used in this applications are band type resistors.

Spare parts

Recommended is a set of spares consists of following:

- one 100 kV impulse capacitor
- one plug-in resistor for each resistance value
- one charging and one potential resistor
- two 250 mm diameter spark spheres

Protective cylinder for outdoor operation

For outdoor operation, the standard indoor generator is enclosed in an air-conditioned weather-resistant tower. Further modifications aren't necessary. As a rule, this solution is only suitable for very large generators with total charging voltages of 4 MV or more. Internal lighting and fire protection system are provided. Our design is also resistant to natural lightning !

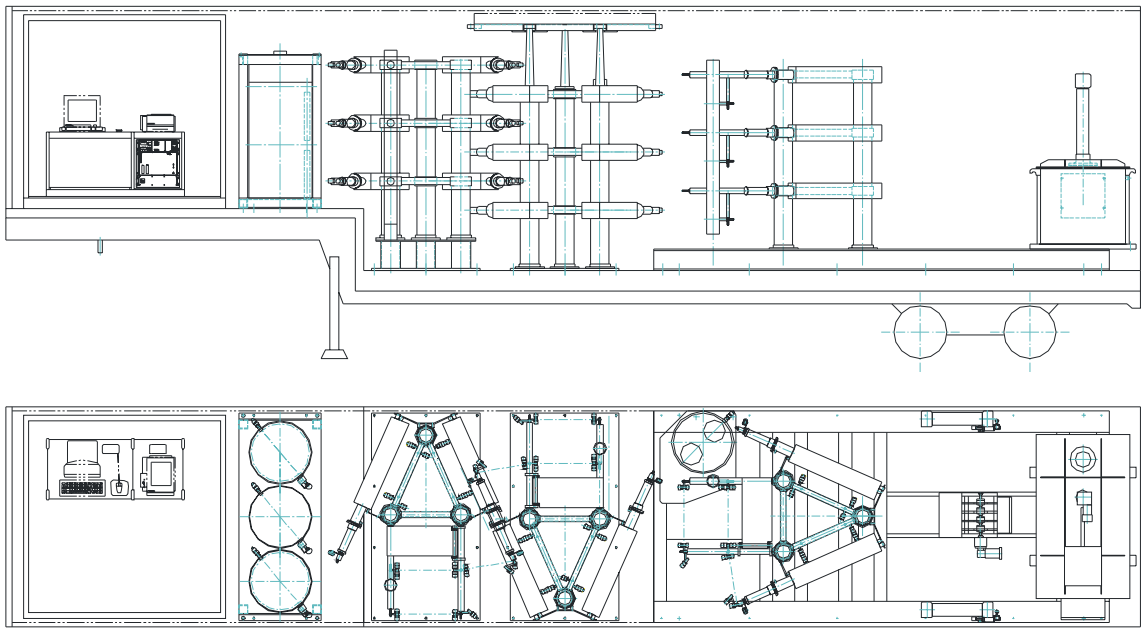
Outdoor impulse generator & multiple chopping gap 2400 kV

Bases frames

Different types of base frames are available, for instance mobile types with air cushions, with wheels or for rail-bound displacement. 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.
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.
The most frequently used air cushion frame is type LLK which also accommodates the charging unit.

On-site & OLI and OSI testing

The impulse voltage on-site test system type SGV is designed for high output voltages. The test system can be stored on a low bed trailer, see below drawing of such a realization.



The charging voltages of mobile on-site impulse voltage test system is available up to 2400 kV, depending of the testing needs. In general the size of the on-site test equipment is not limited. The modular design allows an easy storage in a low-bed trailer. For assembling and disassembling a crane is required. Such systems are suitable for testing Power Transformers or GIS of the highest voltage classes.
Control and measuring equipment are fitted into a „control container“ which is also mounted on the low bed trailer. This control container is removable and can be placed according the on-site conditions. Additional elements like divider, top electrodes and inductances (for OLI, OSI generation) are stored in a standard container.

For testing GIS with oscillating lightning or switching impulses, the oscillation frequency is determined by inductance in the generator and capacitance of the test specimen. In addition to the voltage divider, a minimum capacitive load of 2 nF is required for operation of the test system acc. to the IEC 60517 standards.

The inductances are made of modules to suit the rated voltage of the generator. Each module consists of a coil wound on an insulating tube. The voltage distribution is capacitively graded. The inductances are arranged horizontally between generator and divider.

Impulse Current generation

Only additional resistors and wave shaping inductances are necessary for generating impulse currents with an impulse voltage generator. Exponential impulse currents acc. IEC 60099-4 can be generated on test objects having very high residual voltages.

Impulse current testing arrangement for MV arresters

Shunts

Haefely shunts can be used for the measurement of impulse currents. They consist of a metal cylinder with coupling flanges and coaxial measuring connector. Different models are available depending of the application.

Charging Unit LGR 200

The charging rectifier type LGR 200 are used to charge the impulse capacitors with stage voltages up to 200 kV such as the type SGV. It is usually located on the base frame of the impulse generator. Connection from the bushing to the generator is done with an aluminium tube. The main components i.e. high voltage transformer, rectifier element and measuring resistor are located in an oil filled tank. Standard charging rectifier type LGR 200 has a rated voltage of 200 kV and a current of 60 mA or 200 mA (type LGR 200-60 or LGR 200-200).

Main features of the LGR 200 are:

- Compact & rugged design.
- Short circuit protected.
- Standard automatic motor-driven polarity reversal.
- Powerful
- Accommodates the connection box, damping & demagnetisation resistors.

Charging rectifier 200 kV, 60 mA

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Controls

Two systems different in sophistication and technical data are in the Haefely scope. The competitive and well established GC 223 and the fully computerised GC 257 Imp, operating under Windows.

The control systems for the SGVA test systems allows to create a fully automatically test sequences. The programming of the control system is user-friendly and easy. A manual mode is also available. Data communication between other Haefely Test equipment (impulse measuring equipment) is fully supported. Also a remote controlling from a host computer is available. The control system can be designed as a desk top, or in a mini rack with table version. Haefely control systems run on a self developed PCI (special computer based on the up-to-date P.C). No additional efforts like optical link or IR communications are necessary.

Impulse Generator Control GC 223

- Comfortable and flexible control of an impulse system
- Safety actions implemented in hardware, independent of any software
- Manual and automatic mode available
- Stand alone desk top unit or 19“ rack insert available
- Dust and dirt protected
- RS 232 Interface optional
- Automatic correction for atmospheric conditions
- EMC shielded and proofed
- Execution of automatic test sequences (optional)
- Remote control for all functions (optional)

Advanced Impulse Generator Control GC 257 IMP

The basic functions are the same as in the GC 223, but the GC 257 Imp offers more operating and upgrade capabilities.

- Windows based operating software
- Sophisticated sequence programs developed together with the industry
- User-friendly software equipped with a flat screen colour monitor. The operator is prompted by the software.
- Easy and clear indication and graphical display of several features, like as: -trip levels, -system status, -failure conditions, -flashovers, etc.
- Free programming and storage of complex test cycles. Any number of test cycles can be stored on floppy disks.
- Interfaces for remote control and for transfer of measured data.
- Fully automatic operation mode for customised test sequences with individual parameters
- Integrated measurement and control functions as required.
- Digital measuring system (like HIAS 743 or DIAS 733) can be easily integrated

Safety and Protection Functions

The control unit has a connection for a safety circuit and is equipped with a connection for warning lights. Actuation complies with VDE 0104. The lockable emergency switch is built into a separate box. The switch can be placed as needed so that it can be operated quickly in case of emergency. All safety functions are directly wired to the input circuit breaker i.e. they do not pass through the microprocessor control system.

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 CR can be used simultaneously as load capacitance for the impulse generator.

Oil-filled insulating cylinders accommodates oil paper capacitor packs. Dividers type CR have an inserted damping resistance, but need an additional external damping resistor above 1000 kV.

Main features:

- Response of system meets requirements of IEC 60060-2 (1994)
- Four arms mobile base frame
- Indoor and outdoor types available
- CR dividers higher than 3 MV are equipped with fibreglass struts

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

2400 kV impulse voltage divider

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Technical Services

A high level of customer service is essential in view of the complexity of high voltage test systems and the high reliability demanded by the customer.

The full warranty of the impulse voltage test system is conditional on the performance of the following Haefely services:

- Expert installation and on-site testing of the system
- Training of the operating personnel
- Maintenance of the test system throughout its service life, but for a period of at least 10 years
- Availability of spare parts

Installation and Testing on Site

The user is responsible for the preparation of the test station and the power supply. The installation and the connections for the voltage transformers must be prepared.

The warranty of a impulse test system requires that the system must be installed and tested on site under the supervision of Haefely Test specialists. Haefely Test performs the fine tuning on the control and measurement electronics. A system test is then performed under no load conditions.
An acceptance testing is performed in co-operation with the purchaser. If possible, the customer furnishes a test object. Haefely Test accepts no liability for the test object.

The standard acceptance test includes the following points:

- Tests of all functions
- Calibration of controls
- Impulse tests

Training of Operating Personnel

After acceptance testing, the personnel assigned to operate the impulse voltage test system will be trained. Installation and operator training are conducted by Haefely customer service personnel and are adapted to suit the particular test facility and test specimen. This is an important contribution to reliable operation of the test system.

10 Years Maintenance Guarantee

Because of the high degree of vertical integration with respect to high-voltage components and electronic equipment, Haefely is virtually independent of the product policies of suppliers. A large stock of replacement parts is held for maintenance purposes. This makes it possible for Haefely to ensure the maintenance for 10 years.

On-site Calibration Service

Simple and unified calibration methods which apply to complete measuring systems give high-voltage test equipment manufacturers, users and customers the assurance of comparable quality requirements and tests involving such equipment.

Haefely Test performs following services on-site or in our works:

- Calibration of divider
- Calibration of measuring unit
- Calibration of entire system

Other Services

Haefely Test offers a maintenance agreement tailored to the customer's special needs. In this way, the value of the test system can be preserved over a long period of time.
Further services are offered for support in integration tasks or during operation.

Order text

Description	**Code**
- Complete system, including:	SGVA ... kV, ... kJ
- Impulse generator	SGV ... kV, ... kJ
- Charging rectifier	LGR ... kV, ... mA
- Control unit with set of control and measuring cables, 20 m	GC 223
- Impulse voltage divider with 20 m LEMO measuring cable	CR ... kV
- Impulse current shunt with 20 m LEMO measuring cable	SH ... Ohm
- Two sets of operating instructions and test reports	
Options	
- Computerised control unit with set of control and measuring cables, 20 m	GC 257 IMP
- Impulse current peak meter	DMI 551 IMP
- Impulse Analysing System	DIAS 733-2
- High Resolution Impulse Analysing System	HIAS 743-2
- Technical services	DEL
- Other possibilities	please contact us

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List of leaflets

Controls type GC 257 IMP
Controls type GC 223
Impulse voltage divider type CR
Impulse voltage test systems up to 800 kV, 40 kJ, type SGSA
Impulse voltage test systems up to 2600 kV, 260 kJ, type SGΔA
Digital Measuring Instrument type DMI 551
Digital Impulse Analysing System type DIAS
High Resolution Digital Impulse Analysing System type HIAS

4800 kV impulse generator at CESI, Milano

HUBBELL High Voltage Test Business

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12.2003