HVEX
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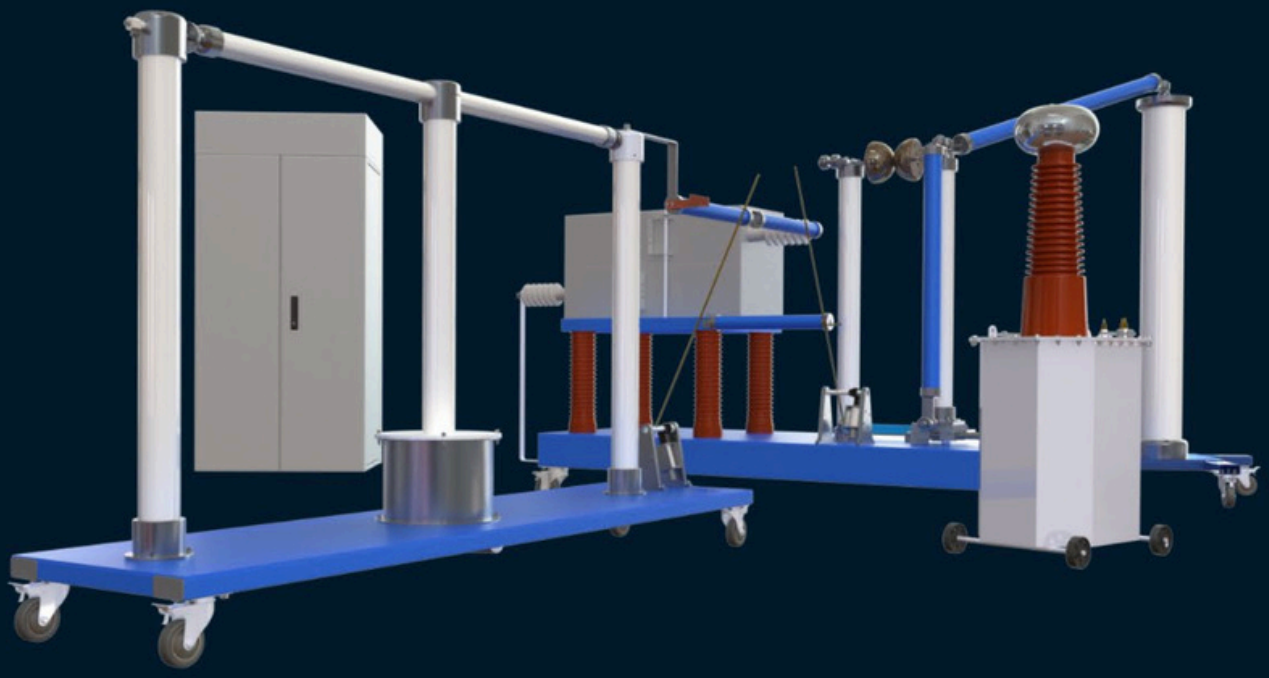
DATASHEET

Surge Generator in Reactor Coils



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Surge Generator in Reactor Coils

Turn-to-turn test

The HVEX Reactor Coil Surge Generator is a high-voltage testing system designed to evaluate the integrity of the longitudinal insulation (between turns) of dry-type air-core reactors. It is a domestically manufactured piece of equipment, customizable to each client's needs, that subjects the coil to a series of impulsive overvoltages to verify the robustness of the dielectric and detect incipient faults before the reactor is connected to the electrical grid.

Complete HVEX surge testing system kit.

1. Application

The integrity of the insulation between turns is one of the most critical factors for the reliability and service life of power reactors. During operation in the electrical system, these devices are subject to severe electrical stresses and rapid transients that can degrade the dielectric and cause irreversible internal short circuits. The turn-to-turn overvoltage test is indispensable during the design and manufacture of these machines to certify the quality of the coil.

- Longitudinal insulation test (between turns) of air-core dry reactors.
- Quality certification and detection of incipient faults, degradation, or short circuits between adjacent turns.
- Applicable to reactors and rotating machines subjected to repetitive impulse stresses.

2. Operating principle

Unlike conventional atmospheric impulse generators—which use multiple stages (Marx multiplier circuit)—this equipment operates by single-stage capacitive discharge. A capacitor bank is charged with direct current by means of a step-up source associated with a high-voltage rectifier diode and a loading resistor. Upon reaching the adjusted breakdown distance between the copper caps of the spark gap, the electric arc forms and energy is injected directly onto the terminals of the reactor under test.

The resulting waveform is a damped oscillatory impulse (exponentially damped sinusoidal wave), with an abrupt front time—similar to that of an atmospheric impulse—to ensure maximum dielectric stress in the first few turns.
The oscillation frequency is defined by the natural resonance (RLC circuit) between the capacitance of the generator and the inductance of the reactor being tested, typically in the range of 1 kHz to 100 kHz. To test the robustness of the insulation, the equipment subjects the reactor to no less than 7200 overvoltages (discharges) of the required magnitude.

The diagnosis consists of recording the last full-voltage discharge and superimposing it onto a reference discharge previously performed at reduced voltage. Since the coil acts as the active part of the resonant loop, any fault between turns alters the effective inductance of the machine: the curves no longer overlap, showing a shift in the oscillation frequency and an increase in signal damping—a clear indication of insulation failure.

3. Structure and components

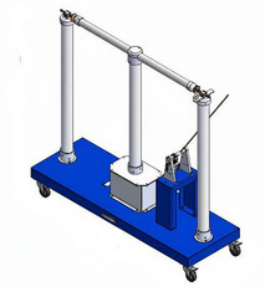
The system is composed of independent modules, designed for the accumulation and rapid transfer of high energy, in full compliance with regulatory safety requirements.

Power panel

Interface between the incoming electrical network and the power supply for testing. It includes isolation transformers between source and load, PLC, optical transmitter for sending the trigger signal, data acquisition hardware, and automation, control, and protection systems.

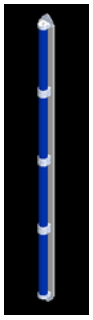
Lifting fountain (Hipot)

Step-up transformer with self-insulating fiberglass tank filled with epoxy resin, which increases the supply voltage to tens of thousands of volts. Responsible for the direct current charging of the capacitor bank.



Diode module

Mounted on a metal base with casters and integrated into the grounding grid. It houses the high-voltage diode and a resistive divider that continuously monitors the rectified output voltage.



Series resistors

A set of four units connected in series that limit the current during the charging phase and distribute the high-voltage stress along the resistive chain, protecting the capacitor tower.

Capacitor tower

Capacitive bank supported by a vertical structure of tubular fiberglass columns, ensuring dielectric spacing and mechanical stability. Base with casters and dedicated connection to the main grounding.

Hubcap movement module (spark gap)

It controls the energy discharge. The copper domes are positioned by a geared motor with millimeter-precise gap adjustment, monitored by a potentiometric ruler, precisely defining the breakdown voltage. It integrates the voltage divider for measurement, shielded against EMI.

Grounding system

Mechanical mechanism for electrical interlocking and controlled discharge of high voltage, maintaining the circuit in a safe, zero-energy state during preparation and immediately after testing.

- **Computer with HVEX LIAS software: communicates via IP with the panel components to configure voltage levels, control triggering, and mathematically analyze the overlap of oscillograms.**

4. Software LIAS

The LIAS (Lightning Impulse Analysis System) is the system for acquiring, controlling, and analyzing the generator. Through its tabs — Test, Analysis, Clients, Laboratory, and Settings — the operator parameters and conducts the entire test. The software performs automated processing of oscillograms, including the calculation of the first peak front time by interpolation (30% to 90% of the crest), eliminating manual calculation and ensuring accuracy and traceability in the validation of normative parameters.

5. Applicable standards

The equipment is designed in strict accordance with current international and national standards for high-voltage testing techniques, with particular emphasis on IEEE C57.16 (dry-type air-core reactors):

IEC 60076-11	**IEEE C57.16**	**NBR 5356-1 IEEE**
IEC 60060-1	**IEC 60060-2**	**Std C57.12.01**

6. Security

RISK OF DEATH — The generator operates at voltages up to 200,000 V. All tests, installations, and calibrations must be performed exclusively by trained and qualified personnel. Even after testing, capacitors may retain residual charge: ground each unit for at least 5 seconds with the grounding rod before any contact.

7. Technical specifications

FOOD	
Voltage Frequency	220 V f-f three-
Maximum current	phase 60 Hz
GENERATION STAGE	180 A
Number of stages,	
Load voltage,	1 (single-stage capacitive discharge) 150
Maximum voltage,	kV ± 200 kV > 10%
Minimum voltage,	10 nF
Capacitance, Energy,	5 kJ
Maximum energy,	5 kJ
Series resistor	80 kΩ
RECTIFIER	
Polarity Source Voltage	Motorized control
Current	45 kVA
MEASUREMENT AND	-200 kVDC to +200 kVDC
CONTROL	Active control
Resistive divider (load)	
Resistive divider (load)	Primary: 1 MΩ Secondary: 25 kΩ Accuracy 1% — ratio 40:1
Resistive divider (measurement)	Primary: 1 MΩ Secondary: 125 kΩ Accuracy 1% — ratio 8:1 Rohde & Schwarz 2,5 GSample/s
Oscilloscope	10 bits
Sampling rate	2
Resolution Channels	
EFFICIENCY	
No-load efficiency	80 %
Minimum efficiency	85 %
ENVIRONMENTAL CONDITIONS	
Relative humidity	≤ 95% non-condensing
Altitude	1000 m
Operating temperature	10 °C a 40 °C

HVEX

Impulsionando a Inovação

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