



HV 9000 High Voltage Modular Training Set



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Guarantee & Terms

All overseas deliveries are dispatched in special, made to order wooden crates, extremely sturdy and damage resistant.

The guarantee is valid for 24 months from delivery and covers repair or exchange of parts, defective due to faulty design or workmanship at our factory. Detailed conditions of guarantee are specified in our Terms of Guarantee.

Spare parts for 2-5 years of normal operation can be offered on request.

Regular after-sales service is performed by the worldwide network of Terco representatives, along with the advice and support of our engineers.

Commissioning and training is normally offered separately. Special training can be arranged on request either in Sweden or on site.

Terco is ISO 9001 certified.

Terco reserves the right to make changes in the design and modifications or improvements of the products at any time without incurring any obligations

HIGH VOLTAGE MODULAR TRAINING SET



Energy Conservation

Energy conservation is becoming increasingly important. One method of conserving energy is by reducing losses. An important technique used to reduce losses is to transfer energy through High Voltage Transmission Lines. However, High Voltage is also difficult to handle properly and there are many technical problems to overcome to make handling of High Voltage even more efficient. With TERCO High Voltage Modular Training Set most of these problems can be studied.

Terco High Voltage Construction Kit HV 9000 is based on a system of components made with the highest precision and can be used to build systems both for teaching and research as well as for industrial routine and type tests. The assembly of a test setup is easily done and requires no special tools. The system gives highly accurate values and can even be used for calibration purposes.

General Specifications:

Modular design makes it quick and easy to set up different test circuits, allowing maximum time for experimentation. Parts are easy to handle due to low weight. All components, with the exception of the Test Transformer, can be handled by one person. Specially designed joints facilitate interconnection of components. Designed to minimize partial discharge. All oil filled components are leak proof. Easy to follow equipment manuals and experiment manuals.

Major types of Electrical Power Equipment

- Power and Distribution Transformers (oil insulated and Resin Cast), Reactors
- Rotating Machines
- Power Cables
- Instrument Transformers
- Switch Gears, Isolators
- Power Capacitors
- Insulators
- Surge Arresters
- Bushings etc.

Each type of equipment requires different types of High Voltage Tests depending on their expected operational requirements.

Test Room

It is very important to house the HV 9000 in a specially designed test enclosure. This must be built in accordance with the guidelines below, to a high standard and local safety regulations must be followed.

For a single stage kit a floor space of 4 x 5 m is recommended, with a height of 2.5-3 m.

Since voltages in excess of 1000 V are generated the safety regulations must be carefully followed.

Fencing and grounding of the Test Room are very important.

Safety Equipment

The test area should be enclosed by a metal fence of at least 1.8 m in height and the mesh width not exceeding 50 mm. All doors leading into the test room must be equipped with door contacts, which lock when the door is closed. All contacts shall be connected in series and fed to the appropriate sockets on the control desk.

Red and green warning lamps must be installed on all doors leading into the test room. These lamps should be connected to the control desk.

Earthing (grounding)

Earthing is very important, absolutely necessary for a good test room and a must for impulse voltage test equipment. Connection should be done with low inductance connections (copper bands 100x0.6mm) which connect all components of the high-voltage circuit that must be earthed to ONE earth terminal.

Earthing connections should be done without loops. A modern earthing technique is to cover the lab floor with aluminium sheets (2mm thickness) which are bolted to the floor and connected internally with copper band and to earth. 4 aluminum sheets 2 x 1 m are included in our Safety Cage (HV-CAGE 1).

Any screening surfaces, test objects and/or measuring instruments should be connected to the same earthing point which should be located inside the safety fence and have a lower earthing resistance than the surrounding building. In any case the earthing resistance should not exceed 2 ohm.

Screening

Screening or shielding as it is also called is used to eliminate all external and internal interference and can be achieved by building a Faradays cage. The easiest way to obtain this is to hang a close-meshed metal net on the walls of the laboratory. The unavoidable apertures for power and communication leads must be blocked for high-frequency currents with low-pass filters. Special attention must be paid to careful shielding of doors and windows. The floor should be covered with non-skid sheet metal. The erection of a complete Faradays cage is necessary only when extremely sensitive partial discharge measurements are intended. Experiments in a high-voltage practical course can normally be performed without screening.

Installation and Training

The HV-Lab must be installed inside a safety cage to be built on site.

If installation and training is ordered from Terco, the Safety Cage must also be included (compulsory).

Height of the Testroom :

1-Stage : min 2.5 m

2-Stage : min 3.0 m

3-Stage : min 3.5 m



AC Voltage - Test Set-up



Single-stage AC Voltage Test Set-up



3-stage AC Voltage Test Set-up

Technical Specification

Single-stage		Two-stage		Three-stage	
Rated no load voltage	100 kV (rms)	Rated no load voltage	200 kV (rms)	Rated no load voltage	300kV(rms)
Output: Continuous 1 Hr. on	5 kVA 10 kVA	Output : Continuous 1 Hr. on	5 kVA 10 kVA	Output: Continuous 1 Hr. on	5 kVA 10 kVA
Rated current	50 mA 100 mA	Rated current	25 mA 50 mA	Rated current	16 mA 32 mA
Impedance voltage	4 % approx.	Impedance voltage	7 % approx.	Impedance voltage	11 % approx.
Frequency	50/60 Hz	Frequency	50/60 Hz	Frequency	50/60 Hz

Basic Components for Single-stage AC Set-up (no test apparatus)

HV 9103	Control Desk	1 pc
HV 9105	Test Transformer	1 pc
HV 9107	Discharge Rod	1 pc
HV 9108	Connecting Rod	1 pc
HV 9109	Connecting Cup	1 pc
HV 9110	Floor Pedestal	1 pc
HV 9141	Measuring Capacitor	1 pc
HV 9150	AC Peak Voltmeter	1 pc



2-stage AC Voltage Test Set-up

DC Voltage Test Set-up



Single-stage DC Voltage Test Set-up (In the picture above AC-divider + Connecting Rod incl.)

Technical Specification

Single-stage		Two-stage		Three-stage	
Rated no load voltage	140 kV	Rated no load voltage	280 kV	Rated no load voltage	400 kV
Rated current	13 mA	Rated current	10 mA	Rated current	7.5 mA

Basic Components for Single-stage DC Set-up (no test apparatus).

HV 9103	Control Desk	1
HV 9105	Test Transformer	1
HV 9107	Discharge Rod	1
HV 9108	Connecting Rod	2
HV 9109	Connecting Cup	3
HV 9110	Floor Pedestal	3
HV 9111	HV Rectifier	2
HV 9112	Smoothing Capacitor	1
HV 9113	Measuring Resistor	1
HV 9114	Earthing Switch	1
HV 9119	Spacer Tube	2
HV 9124	Insulating Rod	1
HV 9138	Top Electrode	1
HV 9151	DC Voltmeter	1



2-stage DC Voltage Test Set-up



3-stage DC Voltage Test Set-up

Impulse Voltage - Test Set-up



Single stage Impulse Voltage Test Set-up (In the picture above AC-divider + Connecting Rod incl.)

Technical Specification

Single-stage		Two-stage		Three-stage	
Rated DC charging voltage	140 kV	Rated DC charging voltage	280 kV	Rated DC charging voltage	420 kV
Maximum stored energy with:		Maximum stored energy with:		Maximum stored energy with:	
1. HV 9112 (25 nF)	245 J	1. HV 9112 (25 nF)	490 J	1. HV 9112 (25 nF)	735 J
2. HV 9112-50 (50 nF)	490 J	2. HV 9112-50 (50 nF)	980 J	2. HV 9112-50 (50 nF)	1.47 kJ
3. HV 9112-100 (100 nF)	980 J	3. HV 9112-100 (100 nF)	1.96 kJ	3. HV 9112-100 (100 nF)	2.94 kJ
Voltage efficiency (approx)	92 %	Voltage efficiency (approx)	92 %	Voltage efficiency (approx)	92 %

Basic Components for Single-stage Impulse Set-up (no test apparatus)								
HV 9103	Control Desk	1 pc	HV 9122	Wave Front Resistor	1 pc			
HV 9105	Test Transformer	1 pc	HV 9123	Wave Tail Resistor	1 pc			
HV 9107	Discharge Rod	1 pc	HV 9124	Insulating Rod	2 pcs			
HV 9108	Connecting Rod	2 pcs	HV 9125	Sphere Gap	1 pc			
HV 9109	Connecting Cup	7 pcs	HV 9126	Drive for Sphere Gap	1 pc			
HV 9110	Floor Pedestal	7 pcs	HV 9138	Top Electrode	1 pc			
HV 9111	HV Rectifier	2 pcs	Measuring and Control Equipment					
HV 9112	Smoothing Capacitor/Impulse Capacitor	1 pc						
HV 9113	Measuring Resistor	1 pc				HV 9130	Low Voltage Divider	1 pc
HV 9114	Earthing Switch	1 pc				HV 9131	Triggering Device	1 pc
HV 9119	Spacer Tube	5 pcs				HV 9132	Electronic Trigger Sphere	1 pc
HV 9120	Load Capacitor	1 pc				HV 9151	DC Voltmeter	1 pc
HV 9121	Charging Resistor	1 pc				HV 9152	Impulse Volt Meter	1 pc

Impulse Voltage - Typical Configurations



Single-stage Impulse Voltage Test Set-up
Discharger Rod on the Capacitor



2-stage Impulse Voltage Test Set-up



3-stage Impulse Voltage Test Set-up

HV 9103 Control Desk



Technical data

Supply Voltage:	220 - 230 V 50/60 Hz single phase/25 A
Regulating Transformer:	5kVA Continuous rating driven by 24 V DC geared motor drive.
Regulating Voltage:	0-220 V AC
Output:	5kVA Continuous 10 kVA (short time duty 2 min.)
Dimensions:	1220x105x800mm (h,w,d)
Weight:	275 kg

The Control Desk is used to control and operate high voltage AC/DC/Impulse test equipment. The desk contains operating and signal elements for the control circuit of the test equipment for warning and safety. The control desk is made to house the measuring instruments (Peak, Impulse and DC Voltmeters) and also the Trigger Device.

The HV 9103 is fabricated of steel and stands on four wheels.

The above picture of the Control Desk, HV 9103, includes the Measuring Instruments HV 9150, HV 9151 and HV 9152 as well as the Trigger Device HV 9131.

HV 9105 Test Transformer



Technical data

Ratio:	2x220V/100kV/220V
Rated cont. Current:	2x11,4A/50mA/15.2A Continuous.
Output:	5 kVA, 10kVA for 60 min. outputs for AC.
Impedance Voltage:	4% approx.
Frequency:	50Hz or 60 Hz
Partial Discharge Level:	at 100 kV < 3pC.
Height:	770 mm
Diameter:	550 mm
Weight:	215 kg

Application.

Test transformer with coupling winding for cascade connection to produce AC high voltage. The transformer consists of three windings with insulating shell and top and bottom corona free aluminium shielding electrodes. The insulation cylinder is made of epoxy resin with glass fibre reinforcement and coated with anti tracking varnish. The (primary) exciter winding is a double winding: 2x220V for connecting to approx. 220V (parallel connection) or 220 + 220V for connecting to approx. 440V (series connection) The series connection will require 50% of the parallel connection current. Winding No.2 is the HV winding of 100 kV connected in series. The third winding, known as the "Coupler Winding" is provided for cascade connections of transformers. The coil is vacuum impregnated and insulated with high quality grade transformer oil.

MEASURING & CONTROL EQUIPMENT

Measuring Instruments can be supplied as stand-alone modules or as modules to slot into the Control Desk HV9103 which is normal standard. Special covers are available for stand-alone modules (not included)



HV 9150

Technical data

Supply voltage: 220 V 50 Hz
 Measuring Range: 100-1000 $\hat{U} / \sqrt{2}$ kV
 Dimensions: 142x 173 x 245 (W x H x D)
 Weight: 3.4 kg

Peak Voltmeter (Digital Display)

Application

Measurement of AC Voltage Peak. For connection to the Measuring Capacitor, the Compressed Gas Capacitor or the Coupling Capacitor.



HV 9151

Technical data

Supply voltage: 220 V 50 Hz
 Measuring Range: 140kV/280kV/400kV
 Dimensions: 142x 173 x 245 (W x H x D)
 Weight: 3.0 kg

DC Voltmeter (Digital Display)

Application

Measurement of the DC Voltage. For connection to the Measuring Resistor.



HV 9152

Technical data

Supply voltage: 220 V 50 Hz
 Measuring Range: 100-1000kV
 Dimensions: 142x 173 x 245 (W x H x D)
 Weight: 3.4 kg

Impulse Voltmeter (Digital Display)

Application

Measurement of the Impulse Voltage Peak. For connection to the load capacitor.



HV 9131

Technical data

Supply voltage: 220 V 50 Hz
 Dimensions: 142x 173 x 245 (W x H x D)
 Weight: 3.7 kg

Trigger Device

Application

For triggering the impulse voltage generator, impulse voltage oscilloscope and chopping spark gap. The trigger impulse is transferred to the high voltage sphere by means of a fibreoptic cable. The impulse is amplified in the electronic trigger sphere.



HV 9130

Technical data

Measuring Range 150 kV

Optional 450 kV
 300 kV
 75 kV
 37.5 kV

Weight: 0.4 kg

Low Voltage Divider

Application

Incorporates the Low Voltage Capacitors and the 50 ohm cable adapter. It is plugged in to the UHF socket of the load capacitor and connects the Impulse Voltage Meter by means of co-axial cable.



HV 9132

Technical data

Supply voltage: 220 V 50 Hz
 Measuring Range: 100-1000 $\hat{U} / \sqrt{2}$ kV
 Dimensions: 142x 173 x 245 (W x H x D)
 Weight: 1 kg

Electronic trigger sphere

Application

For controlled stimulation of breakdown conditions. To be used with the impulse equipment.

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BASIC ELEMENTS FOR AC/DC/IMPULSE SET-UPS

Capacitors



HV 9112

Technical data

DC and Impulse voltages:	140 kV
Capacitance:	25nF
Length/Height:	665 mm
Weight:	20 kg

Impulse Capacitor

Application

Impulse capacitor for generation of impulse voltages. It can also be used as smoothing capacitor in DC voltage generation.



HV 9112-50

Technical data

DC and Impulse voltages:	140 kV
Capacitance:	50nF
Length/Height:	665 mm
Weight:	42 kg

Impulse Capacitor

Application

Impulse capacitor for generation of impulse voltages. It can also be used as smoothing capacitor in DC voltage generation.



HV 9112-100

Technical data

DC and Impulse voltages:	140 kV
Capacitance:	100nF
Length/Height:	665 mm
Weight:	50 kg

Impulse Capacitor

Application

Impulse capacitor for generation of impulse voltages. It can also be used as smoothing capacitor in DC voltage generation.



HV 9120

Technical data

DC and Impulse voltages:	140 kV
Capacitance:	1.2nF
Length/Height:	665 mm
Weight:	9 kg

Load Capacitor

Application

Load capacitor and high voltage divider capacitor for measurement of impulse voltages.

The picture shows HV9130 mounted on HV9120.



HV 9141

Technical data

AC voltages:	100 kV
Capacitance:	100 pF
Length/Height:	665 mm
Weight:	9 kg

Measuring Capacitor

Application

High voltage divider capacitor for measurement of AC voltages.



HV 9140

Technical data

Diameter:	800 mm
Height:	300 mm
Weight:	12 kg

Electrode 300

Application

Top electrode to be placed on the top transformer in 3-stage AC-Set-up. Manufactured in polished aluminium.



HV 9142
Technical data
 AC voltages:
 Capacitance:

Measuring Capacitor
 200 kV
 100 pF

Application
 High voltage divider capacitor for measurement of AC voltages.

Height: approx 1.70 m
 Weight: approx 75 kg



HV 9143
Technical data
 AC voltages:
 Capacitance:

Measuring Capacitor
 300 kV
 100 pF

Application
 High voltage divider capacitor for measurement of AC voltages.

Height: 2.30 m
 Weight: approx 125 kg



HV 9146
Technical data
 Rated Voltage:
 Capacitance:
 Partial Discharge:

Coupling Capacitor
 120 kV
 1 nF
 5 pC

Application
 High voltage coupling capacitor to be used mainly for partial discharge measurements in HV testing.

Height: 1.30 m
 Weight: 56 kg

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BASIC ELEMENTS FOR AC/DC/IMPULSE SET-UPS



HV 9124

Technical data

AC voltage:	100 kV
DC and impulse voltage:	140 kV
Length/ Height:	665 mm
Weight:	1.5 kg

Insulating Rod

Application

Insulating component



HV 9111

Technical data

Inverse Peak voltage:	140 kV
Rated current:	20 mA
Protective Resistor:	100 k Ω
Length/ Height:	665 mm
Weight:	8 kg

Silicon Rectifier

Application

Rectifier for use in impulse voltage and DC voltage generation.



HV 9121

Technical data

Impulse voltage:	140 kV
Resistance:	10 M Ω
Length/ Height:	665 mm
Weight:	5 kg

Charging Resistor

Application

Charging resistor for multistage impulse voltage test equipment and current limiting resistor in DC voltage generation.



HV 9122

Technical data

Impulse voltage:	140 kV
Resistance:	350 Ω
Length/ Height:	665 mm
Weight:	5 kg

Wave Front Resistor

Application

For generation of impulse voltages. The resistors determine the rise time of the impulse voltage in lightning and switching impulse voltage generation.



HV 9123

Technical data

Impulse voltage:	140 kV
Resistance:	2400 Ω
Length/ Height:	665 mm
Weight:	5 kg

Wave Tail Resistor

Application

For generation of impulse voltages. The resistors determine the time to half value of the impulse voltage in lightning and switching impulse voltage generation.



HV 9125

Technical data

Impulse voltage:	140 kV
Sphere Diameter:	100 mm
Max. gap settings:	80 mm
With gap settings indicator	
Length/ Height:	665 mm
Weight:	7 kg

Sphere Gap

Application

For impulse voltage generation, for pre-settings of Impulse voltage peak.



HV 9126

Technical data

Input:	220 V
Frequency:	50/60 Hz
Dimensions:	200x125x140 mm
Weight:	5 kg

Drive for Sphere Gap

Application

Remote control of Sphere Gap size. Mounted underneath the Sphere Gap and connected by drive shaft.



HV 9113

Technical data

DC voltage:	140 kV
Resistance:	280 M Ω
Rated continuous current:	0.5 mA
Length/ Height:	665 mm
Weight:	5 kg

Measuring Resistor

Application

High voltage series resistor for measurement of DC voltages.



HV 9106
Length:

HV Connection
approx 1.5 m

Application

Flexible metal connection with connector for the test transformer and connecting cup. For connection of multi-stage AC voltage test equipment with the test transformer.



HV 9114
Technical data
Impulse voltage:
DC voltage:
Service voltage:
Dimensions:

Earthing Switch, Electrically Operated
Application
For automatic safety earthing of the high voltage construction kit when de-energized.

Weight:

140 kV
140 kV
24 V, 50/60 Hz
230 x 115 x 160 mm
(excl. earthing rod)
8 kg



HV 9138
Technical data
Diameter:
Weight:

Electrode
300 mm
1 kg

Application

Serves as termination in conjunction with grounding switch for safety grounding. Also serves as corona free electrode.



HV 9107
Technical data
Discharge Resistance:
Length:
Weight:

Discharge Rod
100 Ω
2.5 m
2.5 kg

Application

For manual discharging of HV components.



HV 9109
Technical data
Dimension:
Weight:

Connecting Cup, Aluminium
Ø 150 x h 85 mm
2.2 kg

Application

Conductive Element: Four elements can be inserted in horizontal position and two in vertical position.



HV 9110
Technical data
Dimension:
Weight:

Floor Pedestal, Aluminium
200 x 200 x 80 mm
2 kg

Application

Conductive Element: For mounting up to four spacer bars horizontally and supporting one component vertically.



HV 9108
Technical data
Length:
Weight:

Connecting Rod, Aluminium
665 mm
1 kg

Application

Conductive connection element.



HV 9119
Technical data
Length:
Weight:

Spacer Tube, Aluminium
665 mm
1 kg

Application

Mechanical and electrical connection on ground level when inserted into floor pedestal.

TEST APPARATUS



HV 9134 Vessel for Vacuum and Pressure.

For the determination of the flashover voltage of electrode arrangements as a function of vacuum and pressure. The vessel consists of a Plexiglass cylinder fixed with top and bottom flanges which are connected to high voltage and ground potential respectively. The bottom cover is equipped with the necessary accessories like inlet valve, outlet valve and measuring gauges for pressure and vacuum. The earthing terminal is provided in the bottom pedestal. The 50 mm sphere electrodes are mounted as shown in the HV 9134 picture.

Technical data

AC Voltage	100kV
DC Impulse Voltage	140 kV
Max. operating pressure (abs):	0-6 bar
Sphere Electrodes	Diam. 50 mm Diam. 20 mm
Height	approx 800 mm
Weight	12 kg

The vessel is delivered with the following different electrodes:

Sphere electrodes 20 and 50 mm
 Needle electrodes
 Rod electrodes
 Flat electrodes



Flat and 20 mm
Sphere Electrodes



Needle and
Rod Electrodes



HV 9134-A1 Vacuum Pump

The Vacuum Pump HV 9134-A1 is designed for pumping of inert gases in the range of rough vacuum, between atmospheric pressure and ultimate pressure of the pump.

Technical Data

		50 Hz	60 Hz
Nominal pumping speed	m3/h	11	13
Ultimate partial pressure without gas ballast	mbar	<1,5	< 1,5
Motor power	kW	0,55	0,65
Dim: 320 x 270 x 220 mm			
Weight with mineral oil	kg	20	20

HV 9134-A2 Compressor

This is a piston type oil-lubricated compressor driven by a single phase electric motor and of fully automatic design. The compressor works silently and vibration-free.

General Data:

Power supply: 220-240V, 50-60Hz 1-ph
 Capacity: 26 l/min at 8 bar
 Max. working pressure: 8 bar

Dimension: 380 x 380 x height 470 mm
 Weight: 22 kg





HV 9133 Measuring Spark Gap

Sphere Gap is a standard measuring device for flash over voltage using various electrode arrangements. It consists of supporting arrangements like remote and hand operated gear, for easy gap setting.

HV 9133 can also be used as chopping spark gap by mounting HV 9132 Electronic Trigger Sphere.

5 m cable for remote spark gap control via the HV 9103 Control Desk included together with 5 different electrodes.

Technical data:

AC Voltage:	100 kV (rms)
DC Impulse Voltages:	140 kV
Power supply:	220-240 V, 50 Hz
Height	approx 800 mm
Weight	18 kg



HV 9133 is delivered with following different electrodes:

Sphere Electrodes: 50 and 100 mm dia.
 Rod Electrode: 20 mm dia.
 Needle Electrode
 Flat Electrode

The 100 mm sphere electrodes are mounted on the HV 9133 above.



HV 9135 Corona Cage

The Corona Cage is inserted into the VVP (Vessel for Vacuum and Pressure) for determination of the partial discharge intensity as a function of the wire diameter and the voltage.

Measurement can be done with or without vacuum or pressure by means of a Micro meter and an Oscilloscope.

Technical data:

AC voltage:	20 kV
Weight:	1.5 kg

Picture "a" shows HV 9135 Corona Cage.

Picture "b" shows HV 9135 mounted in to HV 9134, vessel for vacuum pressure.



**HV 9137 Oil Testing Cup**

The Oil Testing Cup is used to measure breakdown of insulating oils. It has special spherical electrodes with a preset gap setting of 2.5 mm. Measuring Rod is included.

Dimension: 140x100x110 mm
Weight: 0.5 kg

**HV 9127 Load Resistor 2.5 Mohm**

Can be used as charging resistor in impulse generators or loading resistors in HVDC Experiment.

Length/ Height: 665 mm
Weight: 4.5 kg

**HV 9118 Spacer Bar, Aluminium**

For connection of a floor Pedestal with the Measuring Spark Gap HV 9133

Length: 563 mm
Weight: 1 kg

**HV 9144 Compressed Gas Capacitor**

It is a standard capacitor for the loss factor measuring bridge and high voltage capacitor for peak voltage measurement.

Full instructions "how to fill SF6" are included.
The Capacitor will be delivered without gas.
Gas is not included.

Technical data:

AC voltage	100 kV rms
Capacitance	37pF approx.
Loss Factor	0.0002
Dielectric gas	SF6
Filling pressure	3.5 bar

Height	approx 800 mm
Weight	15 kg

PARTIAL DISCHARGE



In the picture Measuring Spark Gap is arranged as a test object.
The configuration above shows the HV 9105 Test Transformer with the HV 9141 Measuring Capacitor.
HV 9133 Measuring Spark Gap is arranged as test object.

GENERAL

The measurement of partial discharges is a non-destructive test on electrical apparatus or equipment. The measured quantities are valuable data to determine the quality of an insulation. In high-voltage test technique, special importance is therefore attached to measurement of partial discharges.

Partial discharge intensity is read in pico Coulombs (pC), radio interference voltage (RIV), in micro-volt (μV).

THE PARTIAL DISCHARGE MEASURING SYSTEM

- Partial discharge meter: The basic measuring unit with built-in oscilloscope to display PD pulses on elliptical time base and window gating facility to mask unwanted noise. It has provisions for direct measurement as well as bridge measurement.
- Filter insert Narrow band Selective filter (HV 9155) or as option Broad Band filter (HV 9157).
- Measuring impedance (HV 9154) and coaxial connecting cable.
- Pulse generator (HV 9156).

MEASURING PRINCIPLE

Partial discharges in or on the test object cause charge transfers in the high-voltage circuit, giving rise to voltage pulse variations on the measuring impedance (quadrupoles). These are evaluated by the partial discharge meter. The filter with adjustable centre frequency allows selection within the high-voltage specter for measurement purposes.

Partial Discharge Meter



HV 9153 Partial Discharge Meter

The measured partial discharge intensity is displayed either in pC or in μV in accordance with IEC 60 270 / IS 6209 or NEMA 107. According to IEC 60 270, the measured quantity shall be multiplied by a correction factor, which considers the circuit characteristics of the complete test arrangement. With the built-in correction circuit it is possible to incorporate the correction factor into the display. The actual partial discharge intensity can then be read directly without the usual calculations. At switch position "CORR", the correction factor is displayed directly. The PC pulses are tapped from the analogue output terminal and displayed on the built-in oscilloscope. The power frequency test voltage can be displayed with the partial discharge pulses in an elliptical time-base and periodically recurrent interference pulse can be blanked in the oscilloscope display, automatically eliminating their evaluation in the partial discharge meter.

Built-in provision is available to conduct the bridge type PD detection, which is useful to suppress external noise with an attenuation level of 40 dB.

Filter inserts

A selective filter for variable center frequency and a broadband filter can be supplied.

Measuring Ranges

2 pC to 50 000 pC (IEC 60 270)
2 V to 25 000 μV (VDE, CISPR)

Dimension and Weight

19" rack (6 units of height), 40 Kgs.

**HV 9155 Narrow Band Selective Filter**

Variable center frequencies from: 600 kHz to 2400 kHz
Band width: 9 kHz

**HV 9157 Broad-band Filter**

Bandwidth: 40 kHz to 220 kHz
The basic noise level of the instrument is less than 0.6 pC in the most sensitive measuring range. The measuring accuracy and linearity correspond to IEC 60 270 and IS 6209

**HV 9154 Coupling Quadripole**

The measuring impedance (quadripole HV 9154) filters the HF voltage portions from the high-voltage test circuit. It can be continuously loaded with 4 A. Built-in surge diverters protect the instrument against over voltages. Two quadripoles are required for bridge measurements.

ACCESSORY

Co-axial cables to connect quadripoles to meter.
Housing, in case the instruments are not intended for rack-mounting.

**HV 9156 Pulse Generator**

The HV 9156 Pulse Generator is connected in parallel with the test object and a fictive partial discharge in a selected range of 5 - 5000 pC, transmitted to the HV 9153 Partial Discharge Meter input, to enable calibration of the PDM before the HV test.

ACCESSORIES



HV 9191 Component Stand

Sturdy welded construction on four wheels for easy storage of HV components. Can hold 8 cylindric components and 16 connecting cups / Floor pedestal.

Dim.: 745 x 560 x1145 mm
Weight: 25 kg



This picture shows HV9191 holding HV-components



HV 9105-CON Cascade Connection Set

To be used to couple 3 pcs HV 9105 Transformers in a cascade position including base plate with four wheels.

HV CAGE

HV-CAGE 1 Safety Cage for Stage 1, 2 and 3

Floor area : 4 x 5 m²

Comprising :
 Net-section 1.5 m x 2.2 m 8 pcs
 Net-section 1.0 m x 2.2 m 5 pcs
 Safety door with Master lock 1 pc
 Pillar 50 x 70 mm, height 2.3 m 14 pcs
 Green & Red Lamps

Aluminum floor (8sqm) comprising:
 4 pcs aluminum sheets 2000 x 1000 x 2mm
 Set of Cables and Screws.



HV Cage

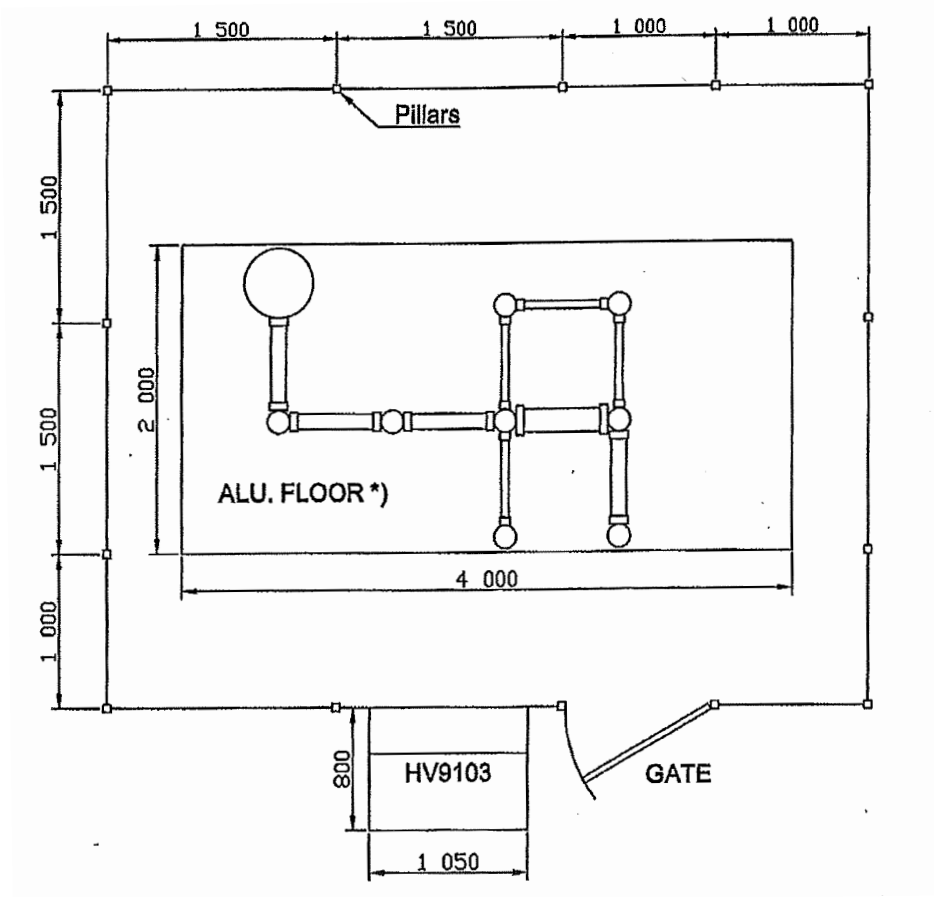


Safety Door Lock

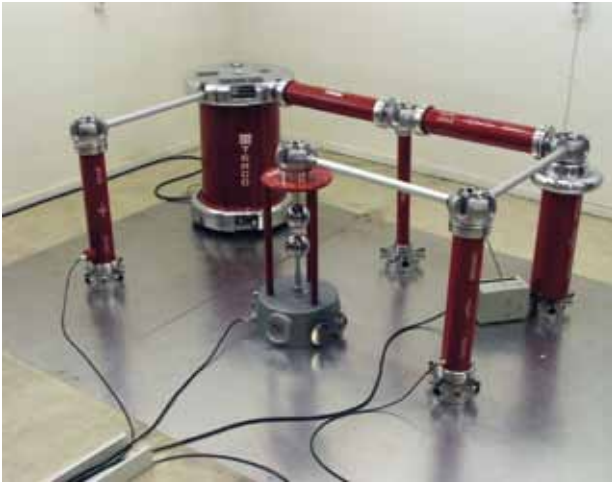


Green & Red Lamps

Suggestion for layout of HV 9000 set-up



Different Experiment Set-ups and Safety Net Installation



Measurement of flashover



Measurement of flashover voltage in vacuum and under pressure



Impulse Set-up



Demonstrating easy assembly



Installation of Safety Net



HV Cage

Experiments Manual

The Terco High Voltage Experiments Manual is a comprehensive manual which contains traditional laboratory exercises with detailed text and figures how to connect the equipment

List of Experiments

1. Generation and Measurement of Alternating Voltage

- i.) Capacitive Divider
- ii.) Sphere gaps and standard tables
- iii.) Chubb and Forescue method

2. Generation and Measurement of Direct Voltages

- i.) Load characteristics of Rectifiers
- ii.) Measurement of Ripple Factor

3. Generation and Measurement of Direct Voltages II

- i.) Greinacher Voltage Doubler Circuit
- ii.) Polarity effect and Insulating screens

4. Generation of Impulse Voltages

- i.) Lightning impulse voltage
- ii.) Single stage impulse voltage circuits
- iii.) Peak value measurements with sphere gaps
- iv.) Break down probability

5. Measurement of Impulse Voltages

- i.) Multiplex circuit after Marx
- ii.) Impulse voltage divider
- iii.) Impulse voltage time curves

6. Power Frequency and Impulse Voltage Tests on Power Transformer

- i.) Specifications for high voltage tests
- ii.) Insulation coordination
- iii.) Break down test for insulating oil
- iv.) Transformer test with alternating voltage
- v.) Transformer test with lightning impulse voltage

7. Experiment on Insulating Liquids.

- i.) DC Conductivity
- ii.) Measurement of Tan delta and Capacitance

8. Experiment on Solid and Insulating Liquids

- i.) Fibre- Bridge breakdown in Insulating Oil
- ii.) Breakdown Strength of Hard Board Plate

9. Experiment on Partial Discharge and Corona

- i.) Partial Discharges at Needle Electrode in air
- ii.) Measurement in Corona cage

10. Experiment on PD and Gliding Discharges

- i.) PD Measurement in High Voltage Insulation
- ii.) Measurement of Onset Voltages of Gliding Discharge

11. Break down of Gases

- i.) Townsend mechanism
- ii.) Streamer mechanism
- iii.) Insulating gases

**BASIC CONFIGURATIONS FOR TEST SET-UPS
TERCO HV 9000**

	Stages	AC TEST			DC TEST			IMPULSE		
		1	2	3	1	2	3	1	2	3
Basic Components										
HV 9103	Control Desk	1	1	1	1	1	1	1	1	1
HV 9105	Test Transformer 100 kV	1	2	3	1	1	1	1	1	1
HV 9105-CON	Cascade Connection Set		1	1						
HV 9106	High Voltage Connection	1	1							
HV 9106-3	High Voltage Connection			1						
HV 9107	Discharge Rod	1	1	1	1	1	1	1	1	1
HV 9108	Connecting Rod	1			2	3	3	2	4	7
HV 9109	Connecting Cup	1	1		3	10	14	7	13	21
HV 9110	Floor Pedestal	1			3	5	6	7	8	8
HV 9111	HV Rectifier				2	4	6	2	2	2
HV 9112	Smoothing Capacitor/Impulse capacitor				1	3	5	1	2	3
HV 9113	Measuring Resistor				1	2	3	1	1	1
HV 9114	Earthing Switch				1	1	1	1	1	1
HV 9119	Spacer Tube				2	5	7	5	8	9
HV 9120	Load Capacitor							1	2	3
HV 9121	Charging Resistor							1	2	3
HV 9122	Wave Front Resistor							1	2	3
HV 9123	Wave Tail Resistor							1	2	3
HV 9124	Insulating Rod				1	8	10	2	5	12
HV 9125	Sphere Gap							1	2	3
HV 9126	Drive for Sphere Gap							1	1	1
HV 9138	Top Electrode				1	11	17	1	1	1
HV 9139	Electrode 200		1							
HV 9140	Electrode 300			1						
HV 9141	Measuring Capacitor/100	1								
HV 9142	Measuring Capacitor/200		1							
HV 9143	Measuring Capacitor/300			1						

Measuring and Control Equipment

HV 9130	Low Voltage Divider							1	2	3
HV 9131	Triggering Device							1	1	1
HV 9132	Electronic Trigger Sphere							1	1	1
HV 9150	AC Peak Voltmeter	1	1	1						
HV 9151	DC Voltmeter				1	1	1	1	1	1
HV 9152	Impulse Volt Meter							1	1	1

Test Apparatus

HV 9118	Spacer Bar (for HV 9133)	1			1			1		
HV 9127	Load Resistor				1					
HV 9133	Measuring Spark Gap	1			1			1		
HV 9134	Vessel for Vacuum/ and Pressure	1			1			1		
HV 9135	Corona Cage	1								
HV 9137	Oil Testing Cup	1								
HV 9144	Compressed Gas Capacitor	1								
HV 9146	Capacitor Coupling	1								
HV 9153	Partial Discharge Meter	1								

Terco Headoffice



Terco headoffice and factory outside Stockholm, Sweden.



<p>POWER STATION SIMULATOR (PST)</p>	<p>PROTECTION RELAYS</p>	<p>MECHATRONICS</p>
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