



HV9000 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 9001-2015 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 many of these problems can be studied.

TERCO High Voltage Construction Kit HV9000 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; are designed to minimize partial discharge. It's 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 HV9000 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 for high voltage test equipment.

Connection should be made with low inductance connections copper cables which connect all components of the high-voltage circuit that must be earthed to ONE earth terminal.

Earthing connections should be made 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 cables and to earth. 4 aluminium 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 or local regulation values.

Screening

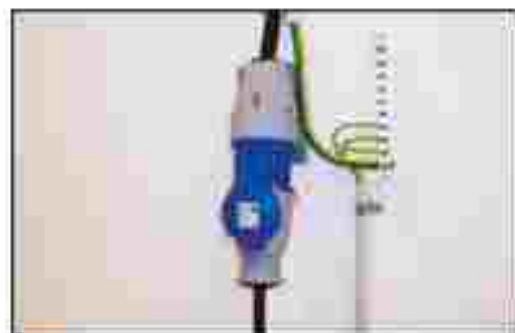
All experiments that we have listed in our catalogue can be performed without screening, why we will not go in to that here. If any customer is interested in screening we will be most happy to help.

Installation and Training

The HV-Lab must be installed inside an appropriate protective shell. If installation and training is ordered from TERCO, the Safety Cage must also be included (compulsory).

Height of the Testroom :

1-Stage: min 3.0 m, 2-Stage: min 3.5 m, 3-Stage: min 4.0 m



Power Supply for HV9000 is 220/230V,
50/60Hz single phase.
Fuse 25A D characteristic.

Good earthing quality is recommended
and should be carried out in accordance
with local regulations.



HV CAGE SUGGESTION FOR LAYOUT OF HV9000 SET-UP



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

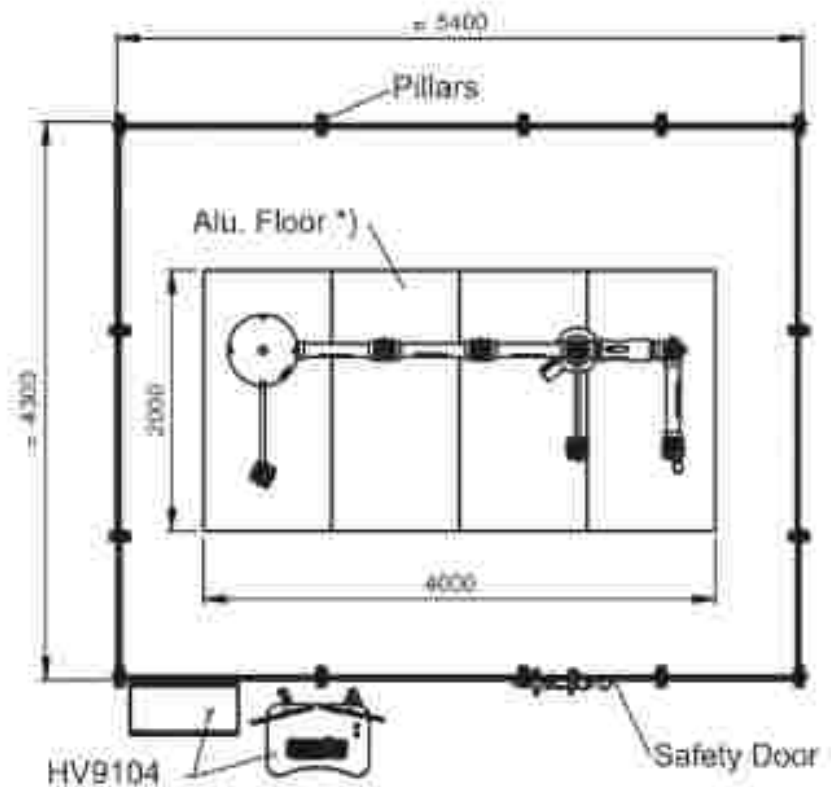
Aluminum floor (8sqm) comprising:
4 pcs aluminium sheets 2000 x 1000 x 2mm
Set of Cables and Screws.



Safety Door Lock



Green & Red Lamps



DIFFERENT EXPERIMENT SET-UPS AND SAFETY NET INSTALLATION



Measurement of flashover



Measurement of flashover voltage in vacuum and under pressure



Impulse Set-up



Installation of Safety Fence



Demonstrating easy assembly



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:		Output:		Output:	
Continuous	5 kVA	Continuous	5 kVA	Continuous	5 kVA
< 60 min	10 kVA	1 Hr. on	10 kVA	1 Hr. on	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:	4% approx.
Frequency	50/60 Hz	Frequency	50/60 Hz	Frequency	50/60 Hz

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

HV9104	Control Desk	1
HV9105	Test Transformer	1
HV9107	Discharge Rod	1
HV9108	Connecting Rod	1
HV9109	Connecting Cup	1
HV9110	Floor Pedestal	1
HV9141	Measuring Capacitor	1
HV9130-AC	Low Voltage Divider	1

Cables and connectors are included



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	200 kV	Rated no load voltage	400 kV
Rated current	10 mA	Rated current	10 mA	Rated current	7.5 mA

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

HV9104	Control Desk	1
HV9105	Test Transformer	1
HV9107	Discharge Rod	1
HV9108	Connecting Rod	0
HV9109	Connecting Cup	3
HV9110	Floor Pedestal	3
HV9111	HV Rectifier	2
HV9112	Smoothing Capacitor	1
HV9113	Measuring Resistor	1
HV9114	Earthing Switch	1
HV9119	Spacer Tube	2
HV9124	Insulating Rod	1
HV9130-DC	Low Voltage Divider	1
HV9138	Top Electrode	1

Cables and connectors are included



2-stage Impulse 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: 1. HV9112 (25 nF) 245 J	Maximum stored energy with: 1. HV9112 (25 nF) 490 J	Maximum stored energy with: 1. HV9112 (25 nF) 735 J
Voltage efficiency (approx) 92 %	Voltage efficiency (approx) 92 %	Voltage efficiency (approx) 92 %

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

HV9104	Control Desk	1	HV9130-IMP	Low Voltage Divider	1
HV9105	Test Transformer	1	HV9121	Charging Resistor	1
HV9107	Discharge Rod	1	HV9122	Wave Front Resistor	1
HV9108	Connecting Rod	2	HV9123	Wave Tail Resistor	1
HV9109	Connecting Cup	7	HV9124	Insulating Rod	2
HV9110	Floor Pedestal	7	HV9125	Sphere Gap	1
HV9111	HV Rectifier	2	HV9126	Drive for Sphere Gap	1
HV9112	Smoothing Capacitor/Impulse Capacitor	1	HV9128	Top Electrode	1
HV9113	Measuring Resistor	1			
HV9114	Earthing Switch	1		Measuring and Control Equipment	
HV9119	Spacer Tube	5	HV9130-DC	Low Voltage Divider	1
HV9120	Load Capacitor	1	HV9132	Electronic Trigger Sphere	1

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

HV9104 DATA ACQUISITION AND CONTROL UNIT (DAQC)



The TERCO HV9104 DAQC unit is a unique solution for the comprehensive control of High Voltage AC, DC and impulse test equipment. Via the latest TERCO DAQC software included in the package, the high-speed acquisition and presentation of real-time test measurement data, and system measurement values, can be viewed and manipulated easily on the attractive user interface comprising of 2 high-quality displays, keyboard, mouse and PC.

Both manually-controlled and automated test sequences with data recording are possible. Test measurement data can be exported to EXCEL or GSV file-format for easy calculations or importation to popular 3rd-party software such as MATLAB.

The HV9104 DAQC comprises of 2 physical modules, the Control Module and the Switching Cabinet Module.

The Control Module houses a Dual Screen User interface including all control elements for manual and automated operation of the high voltage test equipment.

All control module components including PC equipped with the TERCO DAQC software, Emergency Stop button and Key Operated Mains Switch are mounted on an easily maneuverable roller-table with motorized height-adjustment for optimized versatility and user-comfort.

The Switching Cabinet Module contains all equipment for the actuation of commands received from the Control Module. The equipment includes the motor-operated regulating unit which consists of a ring-core regulating transformer and an isolating transformer.

The regulating module, which includes contactors, over-current tripping relays and equipment protection components, serves to energize the High Voltage test transformer HV9105.

Data Acquisition and Control Unit HV9104 replaces Control Unit HV9103.

All measurement components, pneumatics drive components and protection components for personal safety are also contained in the Switching Cabinet Module. The unit is powered via a standard 230V CEE socket. All controllable TERCO Test Apparatus can be remotely maneuvered via the HV9104 DAQC.

TERCO HV9104 DAQC together with the HV9105 Test Transformer are the basic components for every configuration of high voltage test setups, whether it be for HVAC, HVDC, or HV Impulse testing.

Data acquisition / monitoring / control

Reference standards: IEC60060-1, IEC60060-2, IEC61083-2
PC: Windows PC, monitor, keyboard, mouse
Digitizer: 12 bit, 200MS/s

- Programmable voltage sequence and capture control.
- Measurement display of HV AC / HV DC / Impulse output voltages:
0 - 300kV/420kV
- Measurement display of input values: 0-250V AC voltage, 0-25A AC current
- Waveform display of HV AC/DC/Impulse
- Impulse trigger sequence control (Auto/Manual)

Digital output and control

- Earthing Switch (HV9114)
- Sphere Gap (HV9125 / HV9126)
- Measuring spark Gap (HV9133)
- Vessel for Vacuum and Pressure (HV9134)
 - HV9134-A1 Vacuum Pump
 - HV9134-A2 Compressor
- Door contact and lights etc.
- Report generation and Export capability

Dimension and weight Control Unit:

Approx.: 800 X 1050 X 1950 mm.
Electrically Height- Adjustable
Approx.: 40 kg

Dimension and weight Switching Cabinet:

Approx.: 800 X 550 X 1100 mm
Approx.: 250 kg

Supply Voltages: 230V 50/60 Hz
Power rating: 5kVA continuous and 10kVA, 2 min. duty

Environment

Temperature range: 5-40 °C
Humidity: 20-80% relative (non-condensing)

The HV9104 Control and Data Acquisition Unit replaces the HV9103 Control desk which is no longer produced.

HV9105 TEST TRANSFORMER



Three HV9105 connected in cascade

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 first 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.

The second winding 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.

Technical data

Number of phases:	Single
Frequency:	50/60 Hz
Rated voltage:	100kV
Rated capacity:	10kVA
Rated current:	0.1 A
Short circuit impedance:	≤ 10%
PD under rated voltage:	≤ 5 pC
Dimensions (height x diam.):	845 x 550 mm
Weight:	220 kg

BASIC ELEMENTS FOR AC/DC/IMPULSE SET-UPS



HV9111 Silicon Rectifier

Technical data

Inverse Peak voltage:	140 kV
Rated current:	20 mA
Protective Resistor:	100 k Ω
Length/ Height:	743 mm
Weight:	6 kg

Application

Rectifier for use in impulse voltage and DC voltage generation.



HV9112 Impulse Capacitor

Technical data

DC and impulse voltages:	140 kV
Capacitance:	25nF
Length/Height:	743 mm
Weight:	20 kg

Application

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



The picture shows HV9130-IMP mounted on HV9120.

HV9120 Load Capacitor

Technical data

DC and impulse voltages:	140 kV
Capacitance:	1.2nF
Length/Height:	743 mm
Weight:	9 kg

Application

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



HV9141 Measuring Capacitor

Technical data

AC voltages:	100 kV
Capacitance:	100 pF
Length/Height:	743 mm
Weight:	9 kg

Application

High voltage divider capacitor for measurement of AC voltages.



HV9130-AC Low Voltage Divider

Value:	0.1 μ F
1-stage ratio:	1000:1
Max. output:	200V
HV capacitor:	HV9141

HV9130-DC Low Voltage Divider

Value:	280k Ω
1-stage ratio:	1000:1
Max. output:	200V
HV resistor:	HV9113

HV9130-IMP Low Voltage Divider

Value:	1.2 μ F
1-stage ratio:	1000:1
Max. output:	200V
HV capacitor:	HV9120



HV9132 Electronic trigger sphere

Technical data

Supply voltage:	220 V 50 Hz
Measuring Range:	100-1000 \bar{U} / $\sqrt{2}$ kV
Dimensions:	Diam. 100 mm
Weight:	1 kg


HV9113 Measuring Resistor
Technical data

DC voltage:	140 kV
Resistance:	280 M Ω
Rated continuous current:	0.5 mA
Length/ Height:	743 mm
Weight:	5 kg

Application

High voltage resistor for measurement of DC voltages.


HV9121 Charging Resistor
Technical data

Impulse voltage:	140 kV
Resistance:	10 M Ω
Length/ Height:	743 mm
Weight:	5 kg

Application

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


HV9122 Wave Front Resistor
Technical data

Impulse voltage:	140 kV
Resistance:	350 Ω
Length/ Height:	743 mm
Weight:	5 kg

Application

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


HV9123 Wave Tail Resistor
Technical data

Impulse voltage:	140 kV
Resistance:	2800 Ω
Length/ Height:	743 mm
Weight:	5 kg

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.


HV9127 Load Resistor

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

Resistance:	2.5 Mohm
Length/ Height:	743 mm
Weight:	4.5 kg


HV9124 Insulating Rod
Technical data

AC voltage:	100 kV
DC and impulse voltage:	140 kV
Length/ Height:	743 mm
Weight:	1.5 kg

Application

Insulating component


HV9125 Sphere Gap
Technical data

Impulse voltage:	140 kV
Sphere Diameter:	100 mm
Max. gap settings:	60 mm
With gap settings indicator	
Length/ Height:	743 mm
Weight:	7 kg

Application

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


HV9126-D Drive for Sphere Gap
Technical data

Input:	220 kV
Frequency:	50/60 Hz
Dimensions:	65x115x185 mm
Weight:	1.9 kg

Application

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


HV9140 Electrode 300
Technical data

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

Application

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


HV9106 HV Connection

Length:	approx 1.5 m
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HV9106-3 HV Connection

Length:	approx 2 m
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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.


**HV9114 Earthing Switch,
Electrically Operated**
Technical data

Impulse voltage:	140 kV
DC voltage:	140 kV
Service voltage:	24 V, 50/60 Hz
Dimensions (excl. earth rod):	230 x 115 x 160 mm
Weight:	8 kg

Application

For automatic safety earthing of the high voltage construction kit when de-energized.


HV9138 Electrode
Technical data

Diameter:	300 mm
Weight:	1 kg

Application

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


HV9107 Discharge Rod
Technical data

Length:	2.5 m
Weight:	2.5 kg

Application

For manual discharging of HV components.


HV9109 Connecting Cup, Aluminium
Technical data

Dimension:	Ø 157 x h 80 mm
Weight:	2.2 kg

Application

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


HV9110 Floor Pedestal, Aluminium
Technical data

Dimension:	200 x 200 x 80 mm
Weight:	2 kg

Application

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


HV9108 Connecting Rod, Aluminium
Technical data

Length:	743 mm
Weight:	1 kg

Application

Conductive connection element.


HV9119 Spacer Tube, Aluminium
Technical data

Length:	718 mm
Weight:	1 kg

Application

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

**HV0142 Two Stage Measuring Capacitor****Technical data**

AC voltages: 200 kV
Capacitance: 100 pF

Height: approx 1.70 m
Weight: approx 75 kg

Application

High voltage divider capacitor for measurement of AC voltages.

**HV0143 Three Stage Measuring Capacitor****Technical data**

AC voltages: 300 kV
Capacitance: 100 pF

Height: 2.30 m
Weight: approx 125 kg

Application

High voltage divider capacitor for measurement of AC voltages.

**HV0146 Coupling Capacitor****Technical data**

Rated Voltage: 120 kV
Capacitance: 1 nF
Partial Discharge: 5 pC

Height: 1.30 m
Weight: 56 kg

Application

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

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

TEST APPARATUS

HV9134 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 HV9134 picture.

Technical data

AC Voltage 100kV
DC Impulse Voltage 140 kV

Max. operating pressure (abs):
0-6 bar
Height approx 800 mm
Weight 12 kg



Flat and 20 mm
Sphere Electrodes

Needle and
Rod Electrodes

The vessel is delivered with the following different electrodes:

- Sphere electrodes 20 and 50 mm
- Needle electrodes
- Rod electrodes
- Flat electrodes
- Case for all parts



HV9134-A1 Vacuum Pump

The Vacuum Pump HV9134-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	m ³ /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



HV9134-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





HV9133 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.

HV9133 can also be used as spark gap by mounting HV9132 Electronic Trigger Sphere.

10 m cable for remote spark gap control via the HV9104 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. 600 mm
Weight:	18 kg



HV9133-EL Sphere Electrode

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

The 100 mm sphere electrodes are mounted on the HV9133 above.
All electrodes come in a specially fitted protective case.



HV9135 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 HV9135 Corona Cage.

Picture "b" shows HV9135 mounted in to HV9134, vessel for vacuum pressure.