

USER MANUAL

HIGH VOLTAGE INSULATION TESTERS

S-50 DC • S-80 DC • S-110 DC • S-120 DC



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S-50 / 80 / 110 / 120 DC is a modern, easy in use and safe testing device. Please acquaint yourself with this manual in order to avoid measuring errors and prevent possible problems in operation of the tester.

CONTENTS

1 Safety	4
1.1 Warnings	4
2 Overview and functions	5
2.1 Design of the set	5
2.2 Functionality	6
2.3 Application	6
3 Preparation for use	7
3.1 Front plate of the device	7
3.2 Operating requirements	7
3.3 Assembling the discharge rod	8
3.4 Attaching the corona ring	9
3.5 Connecting the test equipment	10
4 Operating the device	13
4.1 Controls and displays	13
4.2 Operating procedure	14
4.2.1 Setting the operating parameters	14
4.2.2 Performing measurements	14
4.2.3 Ending testing	16
4.2.4 Safety measures	16
5 Maintenance and repair	17
6 Technical specifications	17
7 Accessories	19
7.1 Standard accessories	19
7.2 Optional accessories	19
8 Manufacturer	19

1 Safety

All persons involved in the transport, installation, operation, maintenance and repair of this system must have read this user manual carefully.

The system and its accessories are in accordance with the current state of safety technology at the time of delivery. Owing to the work processes involved, however, there may be parts of the system and its peripherals which cannot be given optimum protection without an unreasonable reduction in function and usability.

The following safety instructions must be complied with:

- General instructions
 - ⇒ Work on this system and its peripherals must only be performed by qualified and/or trained staff. Other persons must be kept away.
 - ⇒ This user manual must be available for the supervisory, operating and maintenance staff to refer to.
 - ⇒ Improper use may endanger life and limb, the system and connected equipment, as well as the efficient functioning of the system.
 - ⇒ Always use correct tools in perfect condition.
 - ⇒ Checks must be made to ensure that the relevant safety regulations are being complied with.
 - ⇒ Only operate the system if it is in technically perfect condition.
 - ⇒ No non-original parts may be used for the system and its peripherals, as the necessary safety will not be guaranteed. No mode of working which detracts from the safety of the system must be used.
 - ⇒ The user is under an obligation to report any changes in the system to the supervisor responsible without delay.
- Electrotechnical instructions
 - ⇒ The system and all additional equipment must be connected properly. The relevant regulations must be complied with.
 - ⇒ Maintenance work must only be carried out when the system is switched off (dead) and then only by qualified and/or trained staff.

1.1 Warnings

Important instructions concerning personal protection, work safety and technical safety are indicated as follows:



WARNING

Warning indicates work and operating procedures which must be complied with in full to exclude the possibility of persons being put at risk. This includes instructions concerning particular dangers when handling the system.



NOTE!

Attention indicates work and operating procedures which must be complied with in full to prevent the system/peripherals from being damaged or destroyed.



The note indicates special technical requirements to which the user must pay particular attention when using the system.

2 Overview and functions

The S-50 / 80 / 110 / 120 DC is a generator of high direct voltages. The insulation of cables, electrical plant and plant components can be tested for electric strength with this set. The insulation resistance of test objects can be determined by measuring current and voltage using integrated measuring instruments according to the equation:

$$R = \frac{U}{I}$$

where:

U – measuring voltage,

I – measured current.

A special protective ground circuit ensures a high level of safety.

2.1 Design of the set

The test set consists of the operating unit and the high-voltage unit. All the controls and displays are arranged clearly in the operating unit. The high-voltage transformers, measuring dividers and rectifiers are housed in the high-voltage unit, which is filled with oil (see fig. Fig. 2.1).

The two units are linked by a five-pole cable which is connected to the back of the operating unit.

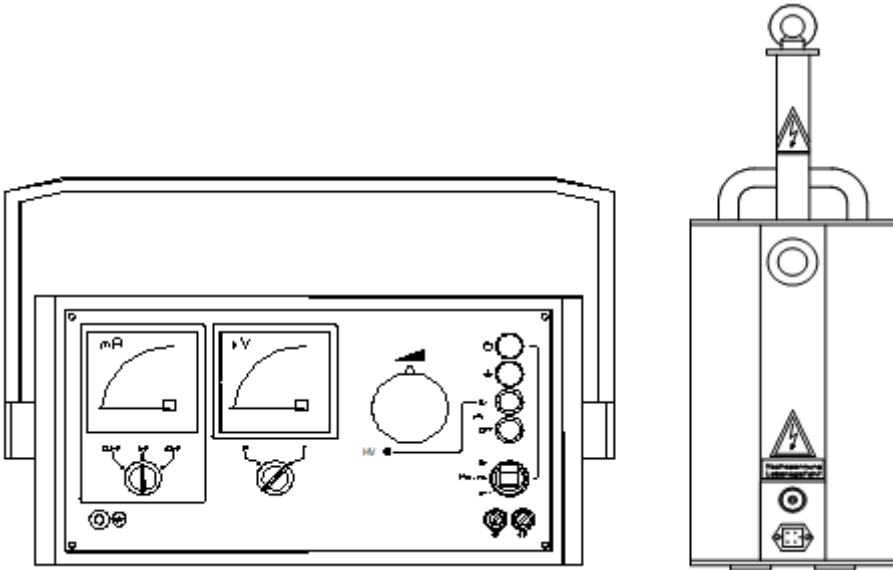


Fig. 2.1 View of operating unit (left) and high-voltage unit (right)

2.2 Functionality

- Before the set can be used, the operating unit and high-voltage unit have to be grounded properly.
- When the high-voltage adjuster is set to zero, the test voltage can be switched on at the press of a button and increased continuously between 0 V and the nominal voltage. This voltage is generated in the high-voltage unit using transformers with rectifiers connected in outgoing circuit.
- The condition of the test object with regard to electric strength and insulation quality can be determined from the values for test voltage and leakage current displayed on the operating unit.
- When testing has been completed, the test object is discharged and short-circuited with the grounding and discharge rod.

2.3 Application

The S-50 / 80 / 110 / 120 DC is used for electrical testing of power cables and plant with direct voltage. Areas of application include:

- testing at re-commissioning of cable systems after maintenance and repair,
- testing of newly installed cables and cable joints before commissioning,
- voltage testing at cable sheath,
- regular cable testing,
- testing of electrical equipment.

The following test voltages are recommended by HD 621 S1 for testing with direct voltage:

Nominal voltage U_0/U [kV/kV]	3.6/6	6/10	12/20	18/30	20.8/36
DC test voltage [kV]	20...29	34...48	67...96	76...108	87...124



WARNING

- Owing to the high voltages which occur, special safety measures are required. These are explained in later sections of the manual (see also sec. 1).
- **DIGITAL** The digital meters only work when the tester is powered on. In the case of power loss check with external test equipment, if the device under test is charged. Alternatively connect the tester to a working power supply or discharge the device under test with the ground and discharge rod.

3 Preparation for use

3.1 Front plate of the device

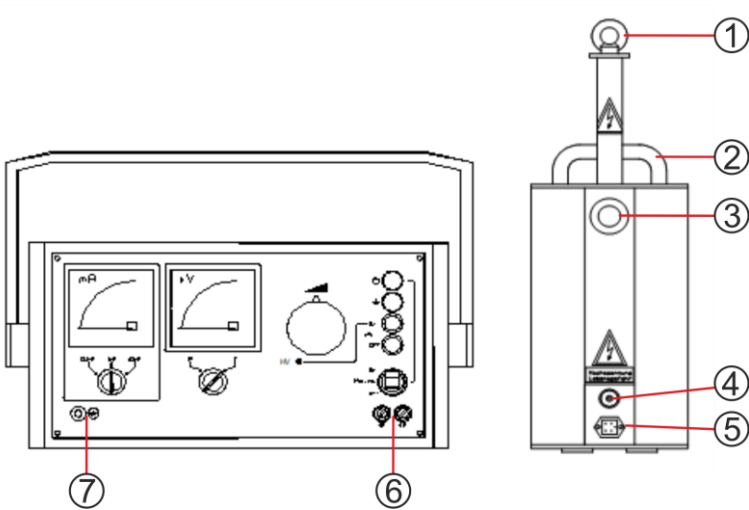


Fig. 3.1 Tester connections

- ① HV attachment with high-voltage terminal
- ② Carrying handle
- ③ Oil-level lens
- ④ Ground terminal
- ⑤ Terminal for connecting cable to operating unit
- ⑥ Primary fuses
- ⑦ Ground terminal for operating unit

3.2 Operating requirements

The carrying handle of the operating unit is designed for one-hand operating. After putting down the device carrying handle can be locked in 30°-steps by using a pull spring. Pulling on handle unfixes the lock.

During operation the operating unit can stay inside of its soft case. The connecting cables are in the front cover of the operating unit.

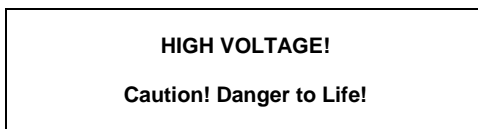
The high-voltage unit must always be set up in an upright position and secured against accidental contact during operation.

**WARNING**

The clearance between the high-voltage unit and grounded or live parts as stipulated in EN 50191 must be complied with.

**NOTE!**

During the test, warning signs with the text:



must be put up, and the area of testing must be cordoned off with a barrier. Set up the operating unit at a distance of approx. 3 m from the barrier. It should preferably be set up on a surface which is at operating height. Use personal protective equipment intended for high voltage work.

When the high-voltage unit is set up in accordance with the above instructions, it must be placed in close proximity to the test object, so that the ground and high-voltage cables can be kept as short as possible.

When the equipment is set up in the field, it must be placed outside the cable trench and protected against dirt and moisture.

3.3 Assembling the discharge rod

Before the HV test set is started up, the ground and discharge rod has to be assembled. The individual parts should be taken out of the protective case and assembled as shown in Fig. 3.1.

The discharge rod varies depending on which version of the test set is used (50, 80, 110 or 120 kV).

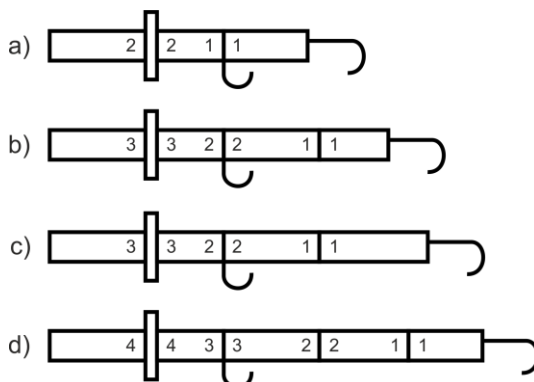


Fig. 3.2 Assembling the ground and discharge rod

- a) 50 kV for S-50 DC: 7500 J (6 μ F at 50 kV)
- b) 80 kV for S-80 DC: 11 250 J (4 μ F at 75 kV)
- c) 110 kV for S-110 DC: 15 000 J (3 μ F at 100 kV)
- d) 125 kV for S-120 DC: 18 750 J (2.4 μ F at 125 kV)

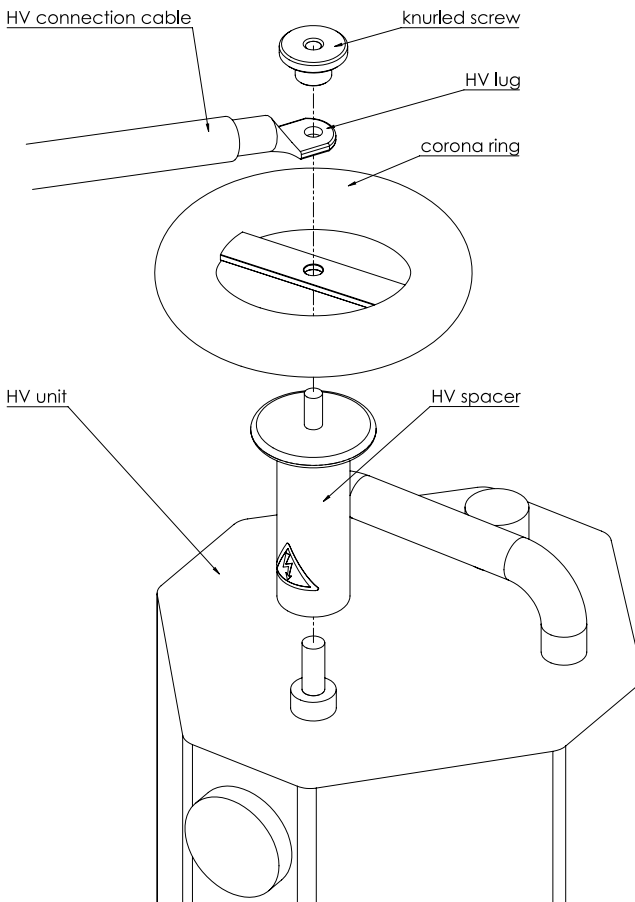
3.4 Attaching the corona ring

The corona ring smoothens electrical fields around the outlet of the HV Unit. These circumstances cause lower corona discharge of the HV unit.

Assemble the corona ring and the high voltage connection cable like shown in the schematic. The HV spacer is only plugged onto the HV unit without screwing. Connect the HV lug only hand-tight with the knurled screw.

Consider following differences to the standard design:

- The smoothing of electricals fields causes a very quiet environment even during maximum voltage output. Always make sure the equipment is discharged before disassembling.
- The ground rod and discharge rod can be attached to the corona ring to discharge and ground the test object safely. Keep the test object grounded during reassembling the test setup.



3.5 Connecting the test equipment



NOTE!

Before connecting the equipment, make sure that the oil level is visible in the centre of the oil-level lens ③. If not, measurements are forbidden.

Before the test equipment is connected, safe isolation from supply must be established and safeguarded in accordance with EN 50110-1. The requirements of EN 50191 and EN 50110-1 standards must be complied with. The test equipment should be connected in the following order:

- ① Ground and short-circuit the conductor of the test object that is not going to be tested (connect to station ground or auxiliary ground point). In the case of ungrounded test objects, the test set can only be used if an auxiliary ground is provided.
- ② Establish a conductive connection between the station/auxiliary ground and the ground terminal of the high-voltage unit ④.
- ③ Screw the high-voltage attachment ① onto the high-voltage unit and connect the high-voltage terminal ① to the test object.
- ④ Connect the ground terminal of the operating unit ⑥ to the station/auxiliary ground.
- ⑤ Connect the ground and discharge rod to the ground terminal of the test object and hold the discharge rod at the ready.
- ⑥ Connect the five-pole connecting cable, which is permanently attached to the operating unit, to the high-voltage unit (terminal ⑤).
- ⑦ Connect the operating unit to the mains.



NOTE!

The blue connecting cable between high-voltage terminal and test object is to use as uninsulated overhead cable.



If the device is powered by Mains Voltage from a grounded Mains socket (the yellow control light lights on), there is no need of additional grounding by the green/yellow protection ground cable. That's important to avoid ground loops.

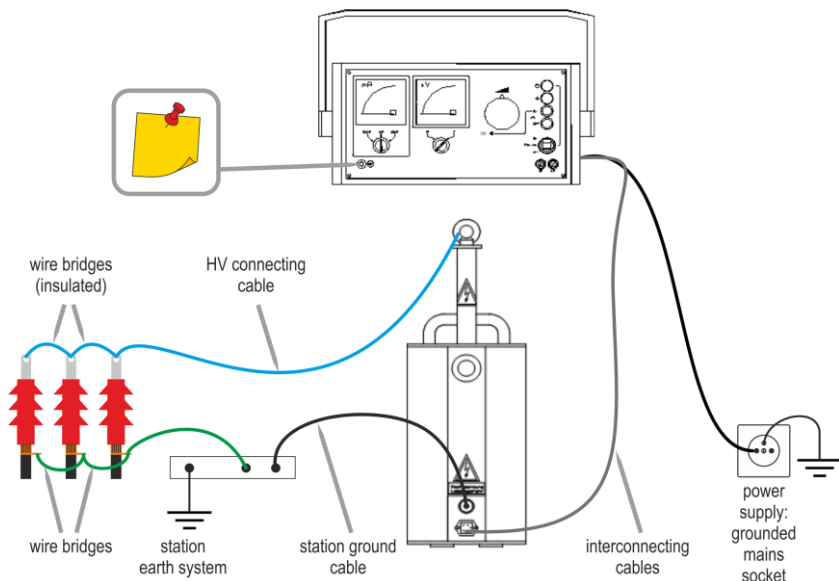


Fig. 3.3 Connecting the test equipment for insulation testing: of a 3x single-core system or a three-core cable with separate shield on each core. All three cores can be tested at the same time.

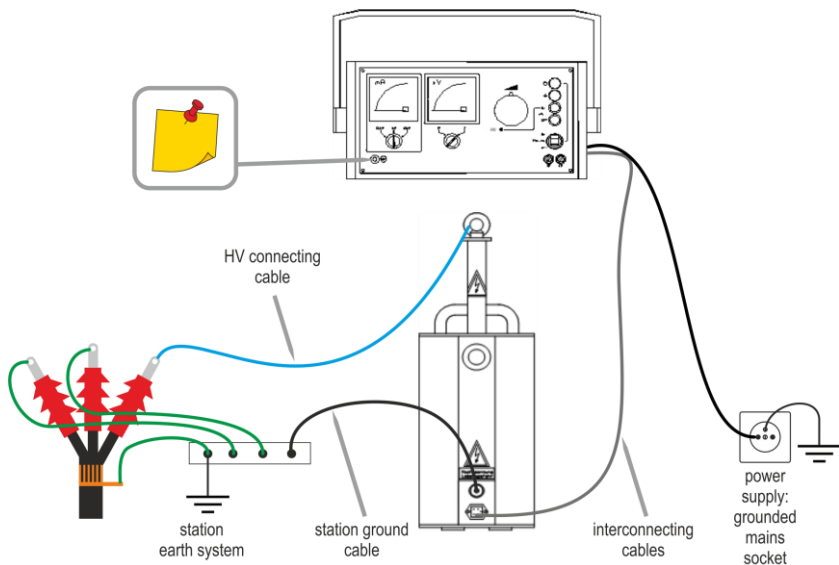


Fig. 3.4 Connecting the test equipment for insulation testing of a three-core cable with only one common shield (e.g. PILC). Each core must be tested separately, the other two cores must be shorted to ground.

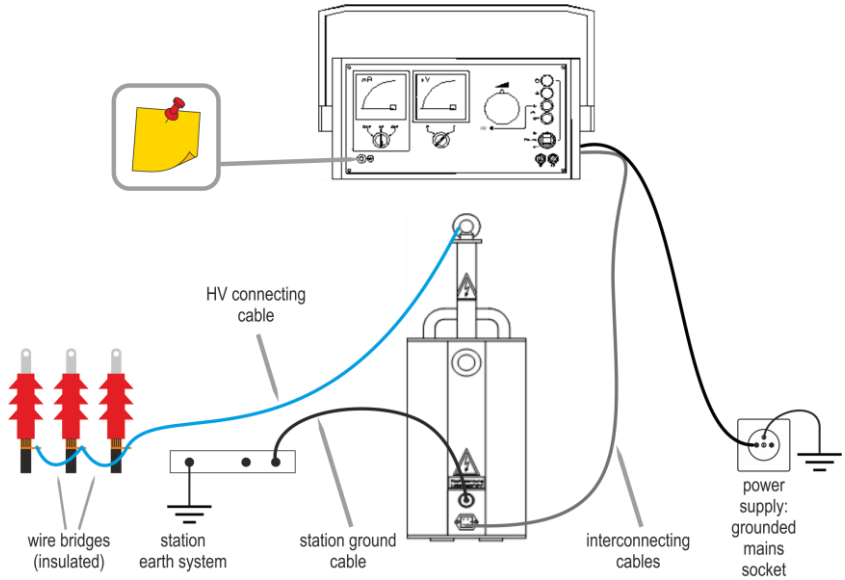


Fig. 3.5 Connecting the test equipment for sheath testing of a 3x single-core system. The sheaths of all three cores can be tested at the same time. The cable shields at the other end of the cable must be disconnected from ground too!

4 Operating the device

4.1 Controls and displays

The controls and displays needed to operate the S-50 / 80 / 110 / 120 DC are on the front of the operating unit.

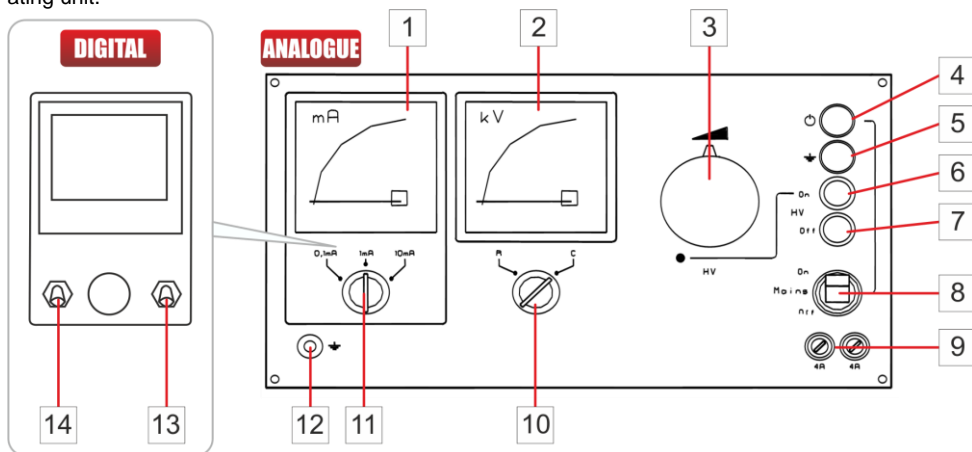


Fig. 4.1 Interface of the operation unit

- 1 **Ammeter**
Displays the current flowing through the test object
- 2 **Voltmeter**
Displays the voltage connected to the test object
- 3 **HV adjuster**
Adjuster for the high-voltage. Active only if it is in the leftmost position while enabling the 6 button.
- 4 **"Unit on" lamp (white)**
Lights up when the unit is switched on with the mains switch 8 and mains voltage is connected
- 5 **"Ground terminal" lamp (yellow)**
Lights up when the operating unit and high-voltage unit are grounded properly
- 6 **Illuminated "HV On" button (green)**
Button for switching on the high voltage (lights up, when operational readiness)
- 7 **Illuminated "HV Off" button (red)**
Illuminated button for switching off the high voltage (lights up when the high-voltage is switched on)
- 8 **Mains switch**
Key-switch
- 9 **Primary fuses**
- 10 **"Load" selector switch**
Switches between resistive and capacitive load

- 11 **ANALOGUE** **Selector switch – current measuring range**
Switches between the current measuring ranges
- 12 **Ground terminal**
Connection of the operating unit to ground potential (protective ground)
- 13 **DIGITAL** **Display selection switch – voltmeter**
Switches between meter- and graph-display, changes time base
- 14 **DIGITAL** **Display selection switch – ammeter**
Switches between meter- and graph-display, changes time base

4.2 Operating procedure

4.2.1 Setting the operating parameters

When measuring the insulation resistance of plant or plant components with primarily resistive content, the "Load" selector switch [10] has to be set to "R". This is necessary if an exact reading of the measured value is to be obtained. If cables, plant or plant components with primarily capacitive content are tested, the selector switch must be set to "C".

Before starting measurement, select the largest current measuring range (10 mA).

4.2.2 Performing measurements

When the mains switch is turned on, the white pilot lamp [4] lights up. If the equipment is grounded properly, the yellow pilot lamp [5] also lights up. If this does not happen, the operating unit still has to be grounded with cable 1 (ground cable for operating unit to station ground).

Pilot lamp [5] signals proper connection of the station and protective grounds independently of the high voltage being connected. The equipment will only work when both lamps are lit.

The green "HV On" [6] button switches the high voltage on if the voltage regulating transformer [3] in zero position at left stop (second switching operation, interlock, forced zero position).

The red illuminated "HV Off" [7] button lights up at the same time, indicating that the high voltage is switched on. Once the prescribed test voltage has been reached, the leakage current of the test object can be measured by operating the selector switch for the current measuring range (0.1 mA, 1 mA, 10 mA).

The test voltage can now be set by slowly turning the adjuster clockwise. While doing this, remember to follow the increase in voltage and current on the instruments. Once the prescribed test voltage has been reached, the leakage current of the test object can be measured by operating the selector switch for the current measuring range (0.1 mA, 1 mA, 10 mA).

The following guide values can be quoted for paper-insulated mass-impregnated cables.

Table 4.2 Guide values for leakage currents

Nominal cable voltage [kV]	Test voltage [kV]	Leakage current per wire [μ A/km]	
		permitted	min. achievable
6	35	500	23
10	50	700	30
20	80	700	80
30	110	700	100

Measurement must be repeated at least three times during testing. The test time should be at least 15 min and max. 30 min. The tendency of the leakage current should be followed.

The following are all signs of increased wear to the test object:

- the leakage current indicated is greater than the permitted leakage current,
- the leakage currents of different wires in the same cable differ by more than 1:3,
- the leakage current measured after approx. 60 seconds is less than the leakage current at the end of the test time.

If the maximum operating current is exceeded, the overcurrent trip will respond and disconnect the equipment from the mains. If this happens, the test object is defective.

If the nominal test voltage of the equipment is exceeded by approx. 5 kV, the overvoltage trip will respond. If this happens, the high voltage will have to be switched back on (set the high-voltage adjuster to zero first).

DIGITAL

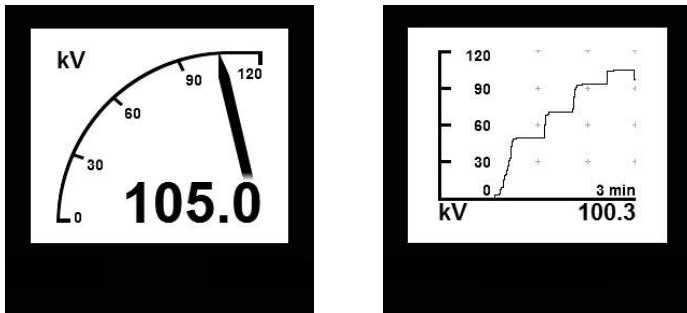


Fig. 4.2 Left: meter display. Right: graph display


During measurement both digital meters can be switched independently between a meter display and a graph display. The right switch **13** is for the voltmeter and the left switch **14** is for the ammeter.

To display the meter, keep the switch in the lower position. For the graph display switch into the middle position. The time base for the graph display can be changed by holding the switch upwards for less than 2 seconds. At the first switch the actual time base is displayed. The next switch activates the next lower time base in predefined steps: 14, 7 days; 72, 48, 24, 12, 6 hours; 60, 30, 15, 3 minutes.



Switching the time base deletes the internal memory of the digital meter. Choose a time base at the beginning of your measurement, which is equal to your expected measure time!

4.2.3 Ending testing

Once testing is complete, turn the voltage down and switch the equipment off ("HV Off" 

When the test voltage has dropped by about 10%, discharge the test object by holding the ground and discharge rod against the high-voltage terminal of the high-voltage unit.



WARNING

Make absolutely sure that the ground and discharge rod is grounded properly. Only capacitances of less than 6 μF may be discharged, in which case the cooling time for the discharge rod is approx. 30 minutes.

The discharge process of the test object can be followed on the measuring instrument.

To short-circuit the connected test object, the middle hook of the grounding and discharge rod must be attached to the high-voltage terminal of the high-voltage unit. The equipment can now be unplugged from the mains.

Finally ground/short-circuit the test object itself.

4.2.4 Safety measures

The set must only be operated by electricians in accordance with EN 50110-1. It must only be operated in areas which have been secured and/or cordoned off and marked in accordance with EN 50191 and EN 50110-1 standards. In an emergency, the high voltage must be switched off by a second operator pressing the red "HV Off" button, and the set must be discharged and short-circuited with the discharge rod..



Never put equipment into operation in the following conditions:

- high humidity,
- condensing water vapour,
- moisture settling the device and measured object.

Please also follow the safety instructions in **chapter 1**. Reliable grounding of the high-voltage unit, the operating unit and the ground and discharge rod is always necessary in addition to adequate protection against electric shock.



WARNING

Make sure that the other end of the cable / cables is fenced before unintentional contact by unauthorized persons.

Be aware that residual charges may still be present after discharge in the case of capacitive tests or the voltage may be rebuilt. After completing the measurements, leave the wires and shield/return core grounded.



WARNING

Parallel cables may also still be charged after testing.

Always check the oil level (oil level in the centre of the oil-level lens) before testing.

5 Maintenance and repair

- The repair work which can be done on the S-50 / 80 / 110 / 120 DC by the user is limited to the replacement of fuses and lamps. Fuses, lamps and tools are included in the service kit.
- Repairs to the high-voltage unit are not permitted.
- No more testing must be done if the oil level drops.
- If the HV test set is defective, the complete set must be sent in for repair, as the operating unit is matched to the high-voltage unit (interchangeability not guaranteed).
- The S-50 / 80 / 110 / 120 DC is test equipment and as such must be handled and looked after with care.
- Moisture, external soiling, direct sunlight and ambient temperatures in excess of 55°C must be avoided.



NOTE!

The high-voltage unit must only be transported in an upright position.

6 Technical specifications

- | | | |
|----|---|--|
| a) | power supply (depending on version) | 230 V ± 10% (50 Hz) |
| | | 115 V ± 10% (60 Hz) |
| b) | power consumption | max. 900 VA |
| c) | output voltage..... | negative polarity, infinitely variable |
| | ▪ S-50 DC | 0...50 kV |
| | ▪ S-80 DC | 0...80 kV |
| | ▪ S-110 DC | 0...110 kV |
| | ▪ S-120 DC | 0...120 kV |
| d) | output current | |
| | ▪ S-50 DC | 6 mA |
| | ▪ S-80 DC | 5 mA |
| | ▪ S-110 DC | 4 mA |
| | ▪ S-120 DC | 3.5 mA |
| e) | overcurrent tripping | |
| | ▪ S-50 DC | ≥8 mA |
| | ▪ S-80 DC | ≥7 mA |
| | ▪ S-110 DC | ≥6 mA |
| | ▪ S-120 DC | ≥5.5 mA |
| f) | voltage measuring range | |
| | ▪ S-50 DC | 0...50 kV |
| | ▪ S-80 DC | 0...80 kV |
| | ▪ S-110 DC | 0...110 kV |
| | ▪ S-120 DC | 0...130 kV |
| g) | current measuring range | |
| | ANALOGUE | 0.1 mA / 1 mA / 10 mA |
| | DIGITAL | 0...9.999 mA |
| h) | measuring accuracy | |
| | ANALOGUE | ±2% (temperature range 23°C ± 2K) |
| | DIGITAL | ±1% (temperature range 23°C ± 2K) |
| | | ±5% (temperature range -25...+55°C) |

i)	max. discharge energy	
	▪ S-50 DC	7500 J
	▪ S-80 DC	12 800 J
	▪ S-110 DC	18 150 J
	▪ S-120 DC	14 400 J
j)	operating temperature	-25...+55°C
k)	storage temperature	-40...+70°C
l)	vibration stress	as per DIN 68 T2-6, test group C
m)	weight of operating unit	approx. 13.5 kg
n)	weight of high-voltage unit	
	▪ S-50 DC	17.0 kg
	▪ S-80 DC	18.5 kg
	▪ S-110 DC	20.0 kg
	▪ S-120 DC	20.5 kg
o)	degree of protection as per EN 60529	
	▪ operating unit	IP40
	▪ high-voltage unit	IP65
	▪ high-voltage unit at terminals	IP00
p)	max. voltage / discharge energy for discharge rod	
	▪ S-50 DC	50 kV / 7500 J (6 µF at 50 kV)
	▪ S-80 DC	80 kV / 11 250 J (4 µF at 75 kV)
	▪ S-110 DC	110 kV / 15 000 J (3 µF at 100 kV)
	▪ S-120 DC	125 kV / 18 750 J (2.4 µF at 125 kV)
q)	dimensions – operating unit	370 x 200 x 280 mm
r)	dimensions – high-voltage unit	
	▪ S-50 DC	210 x 380 x 310 mm
	▪ S-80 DC	210 x 400 x 310 mm
	▪ S-110 DC	210 x 420 x 310 mm
	▪ S-120 DC	210 x 430 x 310 mm

7 Accessories

7.1 Standard accessories

Standard set of equipment supplied by the manufacturer includes:

- operating unit – **ANALOGUE** or **DIGITAL**,
- protective case,
- high-voltage unit,
- HV attachment,
- mains cable (permanently attached to operating unit) (length 3 m),
- connecting cable, high-voltage unit to operating unit (permanently attached to operating unit) (length 3 m),
- cable 1 (green/yellow) – ground cable, operating unit to station ground (length 3 m),
- cable 2 (black) – operation ground cable, high-voltage unit to station ground (length 3 m),
- cable 3 (blue) – lead for high-voltage unit (length 2 m),
- cable 4 – ground cable for discharge rod,
- discharge rod,
- case for discharge rod,
- user manual,
- service kit,
- transport case with wheels – **WAWALXXL2**.

7.2 Optional accessories

Additionally, the following items that are not included in the scope of standard equipment may be purchased from the manufacturer or the distributors:

- Corona ring for the high-voltage unit,
- AluCase (IP54) with trolley *if ordered with S-50 / 80 / 110 / 120 DC (no soft case and handle).

8 Manufacturer

The manufacturer of the device and provider of guarantee and post-guarantee service:

SONEL S.A.

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58-100 Świdnica
Poland

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NOTE!

Service repairs must be performed only by the manufacturer.

NOTES



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