

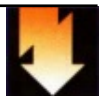
## Operating Manual

### SPG 12-1100 / 16-2000 / Surgeflex 12 / 16

#### Mess- und Ortungstechnik Measuring and Locating Technologies

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Elektrizitätsnetze  
Power Networks



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Kommunikationsnetze  
Communication Networks



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Rohrleitungsnetze  
Water Networks



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Leitungsortung  
Line Locating





## Consultation with Megger

The present system manual has been designed as an operating guide and for reference. It is meant to answer your questions and solve your problems in as fast and easy a way as possible. Please start with referring to this manual should any trouble occur.

In doing so, make use of the table of contents and read the relevant paragraph with great attention. Furthermore, check all terminals and connections of the instruments involved.

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This warranty does not cover wear parts, lamps, fuses, batteries and accumulators.

Megger reject all further claims under warranty, in particular those from consequential damage. Each component and product replaced in accordance with this warranty becomes the property of Megger.

All warranty claims versus Megger are hereby limited to a period of 12 months from the date of delivery. Each component supplied by Megger within the context of warranty will also be covered by this warranty for the remaining period of time but for 90 days at least.

Each measure to remedy a claim under warranty shall exclusively be carried out by Megger or an authorized service station.

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## **1 Description**

### **1.1 General**

As a stand-alone device, the SPG 12/16 serves for cable fault pinpointing by the acoustic method (surging), for sheath fault location as per the DC step voltage method and for testing of cable installations up to 17 or 24 kV DC respectively.

### **1.2 Lifting and carrying**

The device must only be lifted and carried using the handles provided on the side. The handles mounted on the front panel cannot withstand the forces caused by lifting the device and could break or tear off as a result.

### **1.3 Design**

The SPG 12/16 is a fully enclosed, autonomous instrument and can be operated without any accessory devices. For reasons of weight, however, a transport vehicle of suitable size is required. In conjunction with a cable drum rack, operation from the inside of a cable test van is possible. Naturally, the unit can also be transported directly to the test site by means of a small trolley. In this case, short connection leads are sufficient and a cable drum rack is not required.

All operating and indicating elements are mounted on the front panel of the instrument, thus ensuring an easy operation.

The operating and indicating elements belonging to the safety equipment are also situated on the front panel with the exception of the detachable-key switch. All connections are made on the connection panel at the rear of the instrument, thus isolating the operator from the high voltage carrying output sockets.



#### 1.4 Operation as a complete test- and fault location system Surgeflex

Through the combination with an appropriate reflectometer (e.g. T3060, Teleflex SX, Teleflex VX), the abilities and functions of the SPG 12/16 are complemented by modern fault location methods, without losing its mobility.



These Surgeflex 12/16 systems are mostly delivered hardwired on a trolley or as in-vehicle installation. It is also possible to upgrade an existing SPG 12/16 with a reflectometer. Please get in touch with the local Megger-representation.

## 1.5 Function

The SPG 12/16 has several functions which are described hereunder. It is to be noted that all these functions are accommodated in one housing.

### 1.5.1 Shock discharge generator

Figure 1 shows the basic function of a shock discharge generator. The impulse capacitor C (with voltage levels 3, 6, 12 kV or 4, 8, 16 kV respectively) which is charged by the switchable high voltage power supply unit, discharges into the faulty cable via the working spark gap AF. A possible residual charge of the cable or the instrument is shunted through the earthing spark gap EF when the instrument is switched off.

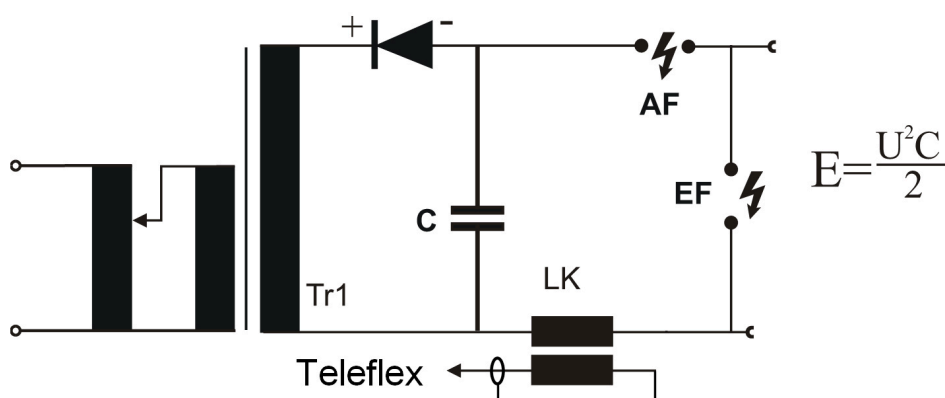


Figure 1 : Functional diagram of a shock discharge generator.

- AF = Working spark gap
- E = Energy content in Joules or Ws
- EF = Earthing spark gap
- C = Impulse capacitor in  $\mu\text{F}$
- U = Voltage in kV
- Lk = Linear coupler for impulse current measurement

The output of a shock discharge generator is determined by the formula in figure 1.

Example for SPG 16-2000 (16 kV-level  $\rightarrow$  C = 15,6  $\mu$ F):

U = 16 kV  $\rightarrow$  E = 2000 Joule

U = 8 kV  $\rightarrow$  E = 500 Joule

Example for SPG 12-1100 (12 kV-level  $\rightarrow$  C = 15,6  $\mu$ F):

U = 12 kV  $\rightarrow$  E = 1100 Joule

U = 6 kV  $\rightarrow$  E = 275 Joule

### 1.5.2 Arc reflection method (ARM)

In the arc reflection method (ARM), the voltage coming from the impulse capacitor C generates a flashover at the fault. The resulting arc is maintained by the resistance R which enables a pulse reflection measurement to be carried out during the arc duration. Coupling of the reflectometer (Teleflex) is made via high voltage proof capacitors. The setup of the arc reflection method is shown in figure 2.

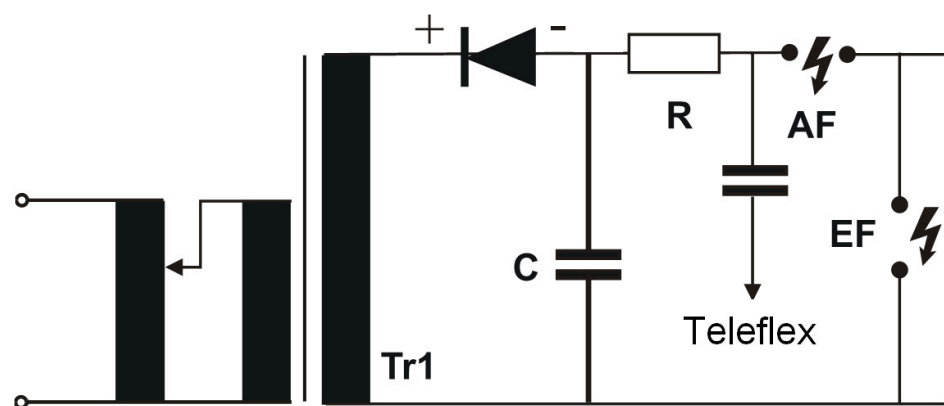


Figure 2 : Functional diagram of the arc reflection method

### 1.5.3 Sheath fault location

For the location of sheath faults in plastic insulated medium and high voltage cables, DC impulses are used which are fed in between screen and earth. The current escapes at the sheath fault and generates a voltage peak in the surrounding earth which is pinpoint located by the step voltage method. In the operation mode "MFO" (sheath fault location) the SPG 12/16 can be used as a supply for sheath fault location. Figure 3 shows the basic function. Of special importance is the series resistance R, which prevents the full charging power of the impulse capacitor from reaching the point of fault. This avoids a thermal overload at the fault.

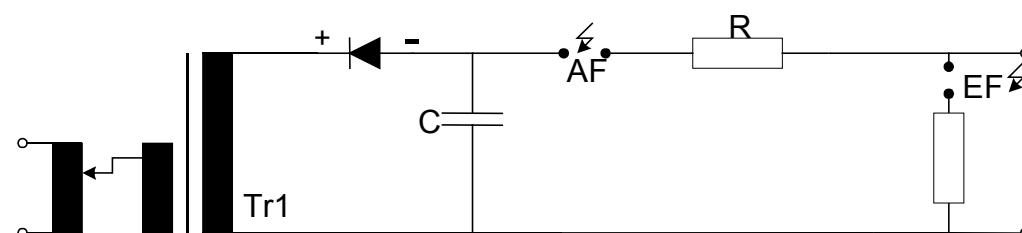
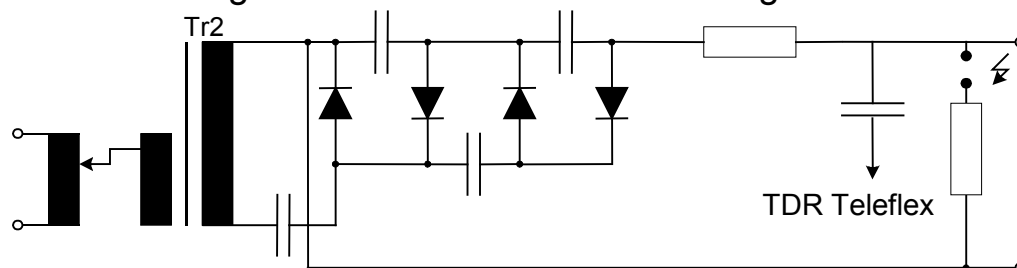


Figure 3 : Functional diagram of sheath fault location.

#### 1.5.4 High voltage testing up to 17 kV (SPG 12) or 24 kV (SPG 16)

For high voltage testing, a special high voltage source is installed in the SPG 12/16, which is fed from the transformer Tr 2. This ensures, that no capacitance is paralleled to the test object. The functional diagram of this circuit is shown in figure 4.



**Figure 4 : High voltage generation for the test branch.**

In case of a flash-over, the capacitively coupled reflectometer (Teleflex) allows a pre-location of the flash-over location by means of the recorded oscillating voltage curve (DECAY method).

#### 1.6 Power Supply

For power supply of the SPG 12/16, a 230 V AC mains with a frequency of 45 - 60 Hz is required. If a portable generator is used for external current supply, it has to have an output power of at least 2 kVA due to the largely varying load on shock discharge operation.

## 1.7 Technical characteristics SPG 12

### 1.7.1 Shock discharge operation "SWG"

a.	Output stage I.	0 – 3 kV	1100 Ws
b.	Output stage II.	0 – 6 kV	1100 Ws
c.	Output stage III.	0 – 12 kV	1100 Ws
d.	Impulse rate approx.	2.5 – 10 seconds	
e.	Single impuls	triggered manually	
f.	Short circuit current	0 – 3 kV	400 mA
		0 – 6 kV	200 mA
		0 – 12 kV	100 mA

### 1.7.2 Arc Reflection Method "ARM"

a.	Max. ignition voltage	12 kV
b.	Arc duration	1 – 10 ms

### 1.7.3 Sheath fault location "MFO"

a.	Output voltage	0 – 5 kV
b.	Output current	0 – 120 mA
c.	Pulsed output approx.	2.5 – 10 sec.
d.	Sheath fault location	0 – 5 V

### 1.7.4 High voltage testing "HPG"

a.	Output voltage	0 – 17 kV
b.	Test current	0 – 1 mA

### 1.7.5 General data:

a.	Weight	135 kg
b.	Dimensions (WxDxH)	520 x 430 x 750 mm
c.	Protection type	IP 20

## 1.8 Technical characteristics SPG 16

### 1.8.1 Shock discharge operation "SWG"

a.	Output stage I.	0 – 4 kV	2000 Ws
b.	Output stage II.	0 – 8 kV	2000 Ws
c.	Output stage III.	0 – 16 kV	2000 Ws
d.	Impulse rate approx.	2.5 – 10 seconds	
e.	Single impuls	triggered manually	
f.	Short circuit current	0 – 4 kV	400 mA
		0 – 8 kV	200 mA
		0 – 16 kV	100 mA

### 1.8.2 Arc Reflection Method "ARM"

a.	Max. ignition voltage	16 kV
b.	Arc duration	1 – 10 ms

### 1.8.3 Sheath fault location "MFO"

a.	Output voltage	0 – 5 kV
b.	Output current	0 – 120 mA
c.	Pulsed output approx.	2.5 – 10 sec.
d.	Sheath fault location	0 – 5 V

### 1.8.4 High voltage testing "HPG"

a.	Output voltage	0 – 24 kV
b.	Test current	0 – 1,4 mA

### 1.8.5 General data:

a.	Weight	135 kg
b.	Dimensions (WxDxH)	520 x 430 x 750 mm
c.	Protection type	IP 20

## 1.9 Scope of supply

### 1.9.1 Standard accessories:

- |    |   |     |       |
|----|---|-----|-------|
| a. | Shock discharge, high voltage testing and sheath fault location unit. | SPG | 12/16 |
| b. | Set of cables consisting of   |     |       |
|    | 1. High voltage connection lead                                       | HSK | 20    |
|    | 2. Trigger cable for current coupling                                 | VK  | 24    |
|    | 3. Connection lead arc reflection method (ARM)                        | VK  | 24    |
|    | 4. Trigger cable arc reflection method (ARM)                          | VK  | 24    |
|    | 5. Trigger cable for voltage coupling                                 | VK  | 24    |
|    | 6. Mains connection lead  | NKG | S     |
|    | 7. Earthing lead  | EK  | 1     |

### 1.9.2 Special accessories:

- |    |   |     |   |
|----|---|-----|---|
| a. | Isolation transformer (2.000 or 2.500 VA) | GTV |   |
| b. | Emergency – Off switch                    | NAG | 1 |
| c. | Internal F-Ohm safety device              |     |   |

### 1.9.3 Racks and cable drums

Various racks for installation in a cable test van or for combination with other measuring systems are available. A connection of F-Ohm and FU safety equipment is possible.

For operation of the SPG 12/16 from inside of a vehicle, different cable drum systems can be offered.

Offers for racks (modules) and cable drums can be had on request. For this purpose, we would require detailed information, e.g. about the type of vehicle, payload space available and the required lengths of cables.



2 Operation and indication panel of the SPG 12/16

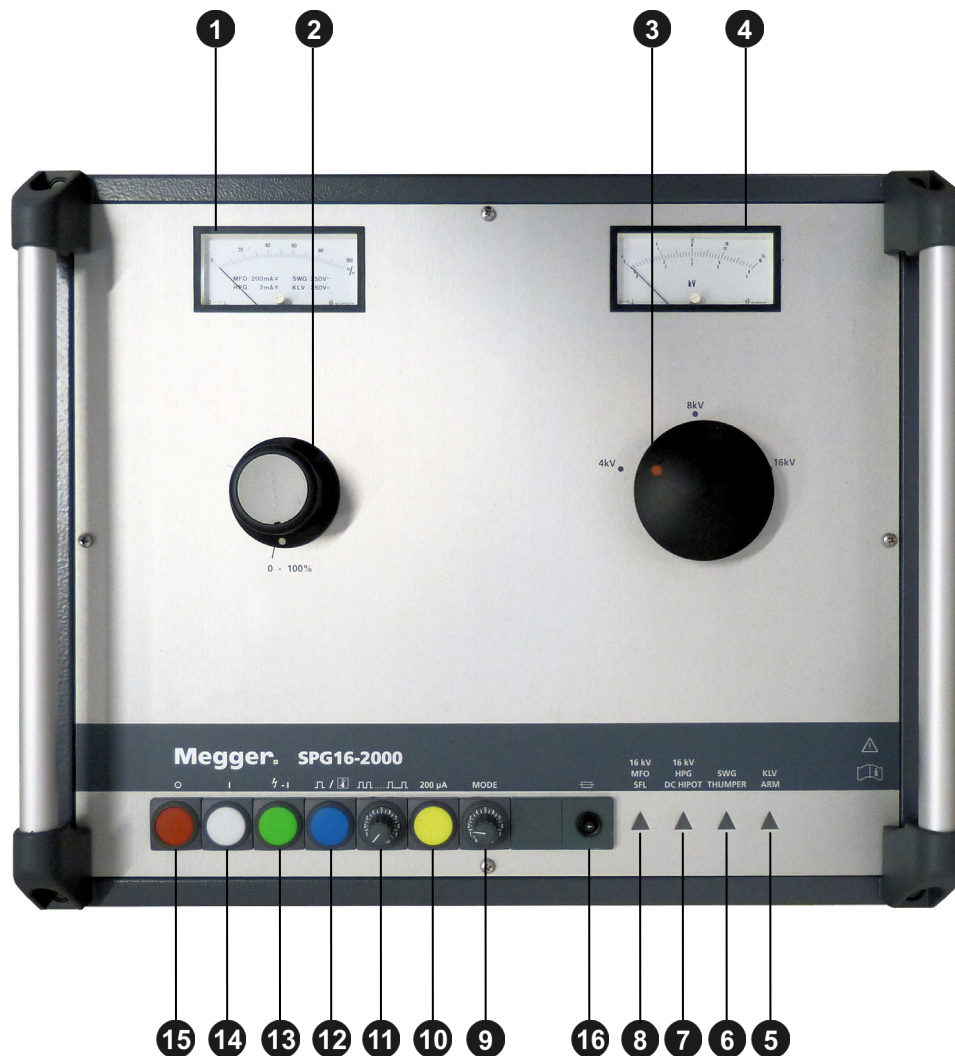
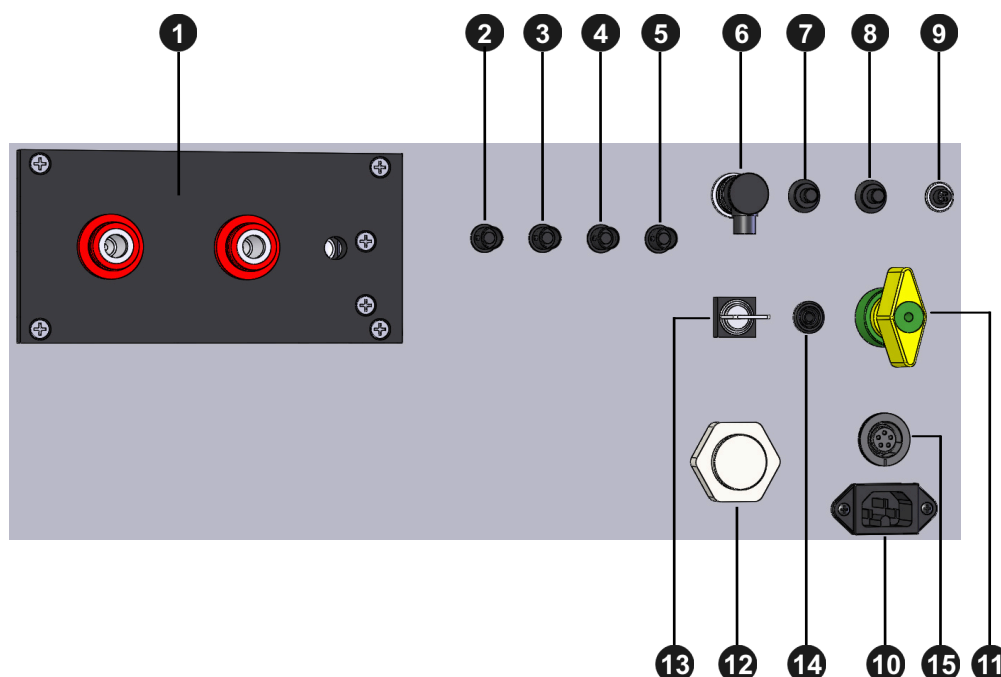


Figure 5 : Operation and indication panel of the SPG 16

Legend on next page.

1. Multipurpose meter with % indication 200 mA for sheath fault location 2 mA for high voltage testing 250 V for arc reflection method (ARM) and shock discharge operation.
2. Variac for voltage setting
3. Rotary plug switch for coarse voltage selection  
3 – 6 – 12 kV (SPG 12) or  
4 – 8 – 16 kV (SPG 16)
4. kV-meter (scale depends on model)
5. Pilot lamp : function short-term arc reflection ("ARM")
6. Pilot lamp : function shock discharge
7. Pilot lamp : function high voltage testing
8. Pilot lamp : function sheath fault location
9. Rotary switch for function selection
10. Switch for test current 2 mA - 0.2 mA (MFO and HPG mode)
11. Timing pulse rate 2.5 - 10 s
12. Single impuls in shock discharge operation and overtemperature indicator
13. High voltage "ON"
14. "ON" and mains supply indicator
15. "Off" (all functions)
16. Circuit breaker 6 A

## 2.1 Connection panel



**Figure 6 : Connection panel**

1. High voltage terminal (output)
2. Trigger lead for current coupling
3. ARM connecting lead
4. Trigger lead ARM
5. Trigger lead for voltage coupling
6. Connection terminal for emergency off device
7. Mains fuse 10 A
8. Mains fuse 10 A
9. Fuse for control circuits 0.8 A
10. Socket : Mains connection 230 V AC
11. Socket : Protective earthing
12. Signal device for faulty operation
13. Detachable-key switch
14. Operational earth connection (only relevant when installed in a test van)
15. Protected 14.5 VDC power output for TFX SX

### 3 Safety



#### **Using cardiac pacemaker**

Physical processes during operation of high voltage may endanger persons wearing a cardiac pacemaker when near these high voltage facilities.

The SPG 12/16 delivers a dangerous contact voltage of >1kV and must hence only be operated by trained personnel. The following safety measures have to be observed:

#### **3.1 Detachable-key switch**

For reasons of product liability, it must be made sure that test instruments, which deliver a dangerous contact voltage cannot be switched on unintentionally by unauthorized persons. The SPG 12/16 has a detachable-key switch, which has to be kept in safe keeping by the responsible person. This detachablekey switch is situated on the connection panel at the rear of the instrument (item 13).

#### **3.2 Safety terms as per VDE 0104 (EN 50191)**

##### **3.2.1 Mains connection**

Indicated by the white illuminated button (14). Mains voltage is connected. The instrument is not yet switched on. The white illuminated button (14) lights continuously and cannot be switched off.

##### **3.2.2 Ready for operation**

Indicated by the green illuminated button (13). The instrument is switched on, but no high voltage is present. The output is shorted and earthed.

### 3.2.3 Ready for switching on

Indicated by the red illuminated button (15). The green illuminated button (13) extinguishes. The instrument is switched on. High voltage can be present ! Caution : DANGER.

Note: If the green illuminated push button (13) when depressed extinguishes, but the red illuminated push button (15) does not light up, the switching state "Ready for switching ON" is also valid. **DANGER !!**

## 3.3 VDE regulations 0104 (EN 50191)

### 3.3.1 Non-steady test equipment

As per VDE 0104, the place of setting-up and connecting the instrument, including the start end of the cable to be tested, constitutes a non-steady test equipment and is considered a test rig which is not protected against physical contact. The same goes for the far end (or ends) of the cable under test.

### 3.3.2 Danger zone

Test rigs without protection against physical contact have to be cordoned off, secured and marked with danger notices since they constitute danger areas with different danger zones.

### 3.3.3 Emergency-Off switch

On principle, test rigs have to be fitted with an emergency-Off switch. For the SPG 12/16, an emergency-Off switch NAG 1 is available as an optional extra. It is connected to socket (6) on the connection panel at the rear of the instrument. For the purpose of operating the instrument with other emergency switching devices, a dummy plug is mounted to the socket (6).

## **4 Putting into operation**

### **4.1 General attentions**

Prior to putting the instrument into operation, the following safety measures have to be taken:

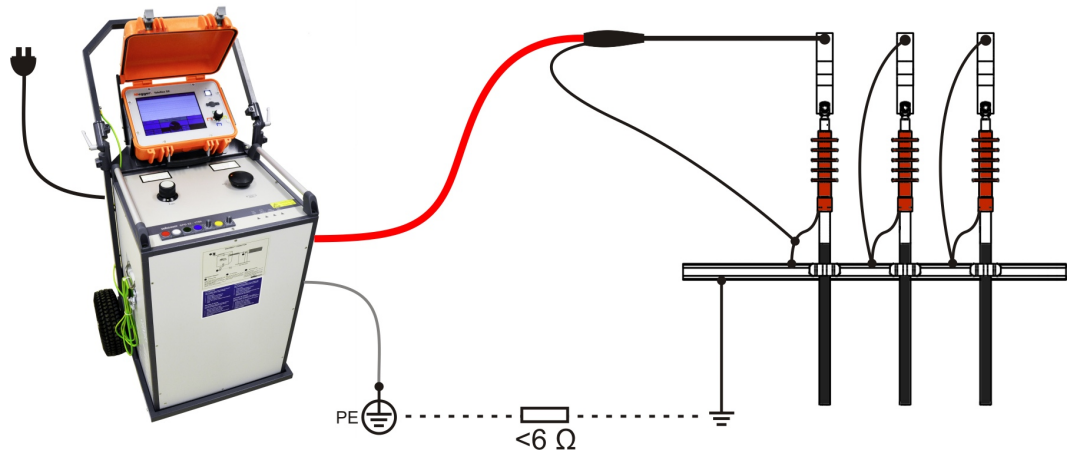
- Five security rules
- Earth the instrument
- Connect the high voltage lead to the instrument
- Connect the high voltage lead to the faulty cable
- Cordon off open cable ends

#### **4.1.1 The five safety rules**

The five safety rules must always be followed when working with HV (High Voltage):

- a. De-energise
- b. Protect against re-energising
- c. Confirm absence of voltage
- d. Ground and short-circuit
- e. Cover up or bar-off neighbouring energised parts

#### 4.1.2 Connection diagram



#### 4.1.3 Earthing the instrument

Prior to putting into operation, the SPG 12/16 has to be earthed. For this purpose, the earthing lead EK 1 supplied is connected to the earthing socket (11) and to a reliable protective earth. Take care to see that the earthing clamps are connected to clean metallic contact points. The protective earthing provided through the earthing contact mains lead is not sufficient!

If the equipment is installed in a cable test van, then this protective earthing is already provided. An additional earthing is not required.

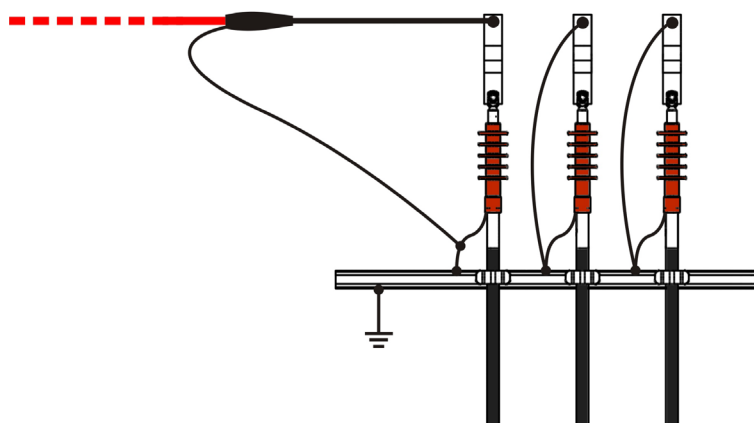
#### 4.1.4 Connecting the high voltage lead to the instrument

The connection between the instrument and the faulty core must only be made by means of the high voltage lead HSK 20 supplied. The plug of this high voltage lead is connected to the socket (1) and locked with the fastening screw. This closes a micro-contact inside the instrument and establishes one of the pre-conditions for switching the instrument on. On fastening the locking screw, a distinct click of the microswitch can be heard. Without this click, the instrument cannot be switched on. It is not possible to switch on the instrument without the high voltage lead mounted, since in no-load operation, the socket (1) might be destroyed! When installed in a cable test van, the high voltage lead is fixed. No other connection is required.

#### 4.1.5 Connecting the high voltage lead to the faulty cable

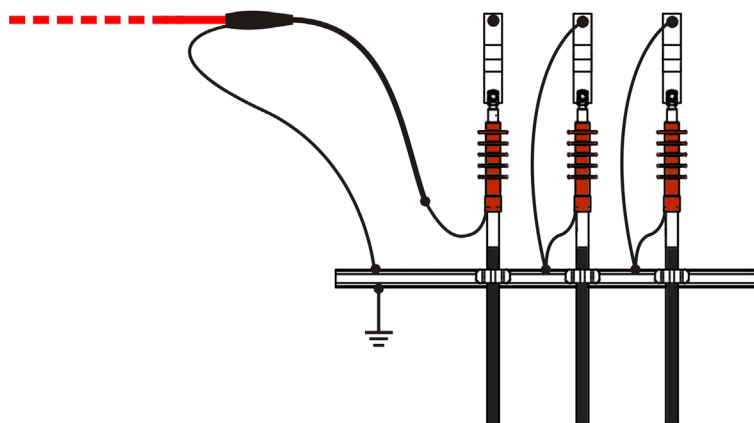
- a) Shock discharge, arc reflection (ARM) and high voltage testing operation.

After the faulty cable has been disconnected and verified to be dead, the high voltage lead can be connected. For this purpose, the core clamp is connected to the faulty phase conductor whereby a good contact has to be ensured. The cable shield clamp is connected to the shield of the faulty cable.



- b) Sheath fault location operation

In this operating mode, the core clamp of the high voltage connection lead HSK 20 is connected to the floating screen of the faulty cable. The cable shield clamp is connected to system earth.



The earth resistance between protective earth and operational earth (shield of the faulty cable) must not exceed 6  $\Omega$ . If you are unsure, check with ohmmeter.

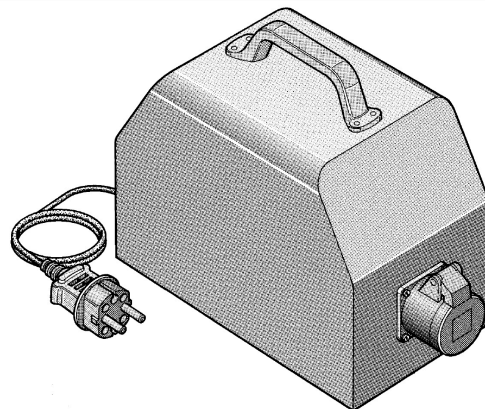


#### 4.1.6 Cordoning off open cable ends

Since the high voltage impulses to be applied to the faulty cable assume dangerous values, the cable ends have to be protected against physical contact as prescribed by VDE 0104. This also goes for feed low voltage cables which, if need be, have to be disconnected in order to avoid flashovers in the fittings or terminal boxes.

#### 4.1.7 Connecting the voltage supply

Voltage spikes and overvoltage, especially due to poor grounding conditions, may occur in the power grid and will eventually lead to damage of the test or fault location system. To prevent these effects, **the system should only be operated with the supplied isolation transformer!**



The isolation transformer needs to be connected between the power input of the system and the power socket (see instruction leaflet of the isolation transformer).

## 4.2 Switching on

After all connection leads have been mounted and the desired function selected, the instrument can be switched on by means of the white illuminated button (14). Now, readiness for operation is established which is indicated by the green illuminated button (13). In this switching state, no high voltage is present and the output is earthed. If this switching state, i.e. green illuminated button lights up, cannot be reached, this might be due to one of the following causes :

- a. Dummy plug not connected to socket 6.
- b. High voltage connection cable not properly mounted or locking screw not fastened.
- c. Rotary plug switch (3) not properly locked in place.
- d. Rotary control (2) not in Zero position (fully at the left).
- e. The loop resistance between operational and protective earth must not exceed 6  $\Omega$ . Note: Automatic monitoring only takes place, if the device is equipped with an internal F-Ohm safety device!

After checking these points and taking corrective measures, the instrument is to be switched on.

## 4.3 Function selection

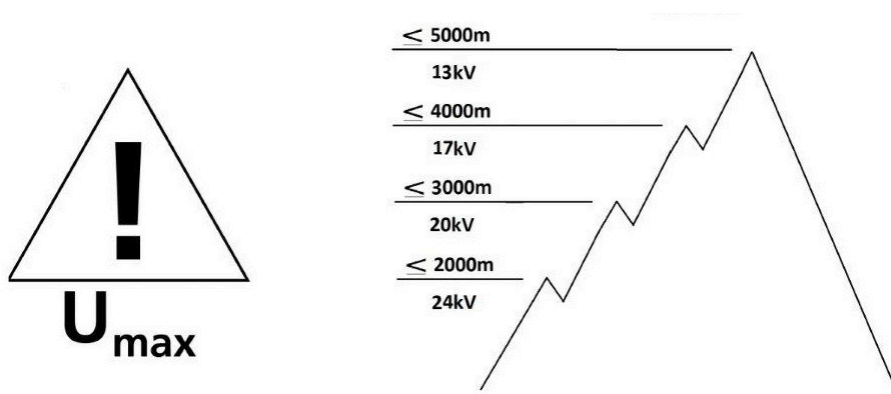
One of the four functions can now be selected by means of the rotary switch (9). A function selection is only possible when the instrument is on. The selected function is indicated by one of the pilot lamps (5 to 8). The selectable functions are as follows:

- a. Sheath fault location
- b. High voltage testing
- c. Shock discharge operation
- d. Shock discharge operation with arc reflection (ARM)

## 5 Shock discharge operation

### 5.1 Selection of the surge voltage

The surge voltage to be selected depends on the test voltage of the faulty cable on the one hand and on the ignition behaviour of the fault on the other.



Since the shock discharge generator in the SPG 12/16 is intended both for low and medium voltage cables, the surge voltage to be set has to be carefully selected. In low voltage cables, the surge voltage will mainly depend on the constitution of the end users' fuse boxes. The coarse selection 3, 6, 12 kV (SPG 12) or 4, 8, 16 kV (SPG 16) is carried out with the rotary plug switch (3). This switch must only be operated when the instrument is switched off. If the switch is not properly locked in place, then the instrument is blocked.

The next step is to set the rotary control (2) to Zero position - fully to the left. Otherwise the instrument cannot be switched on.

## 5.2 Putting the shock discharge generator into operation

The instrument is made "ready for switching on" by pressing the green illuminated button (13). This switching state is indicated by the red illuminated button (15). The green illuminated button (13) extinguishes.

The desired voltage - e.g. 0.8 kV - is set on the rotary control (2) and indicated on the kV meter (4).

### 5.2.1 Setting the impulse sequence

The rotary control (11) is combined with a rotary switch. When the rotary control is set fully to the left, the automatic impulse sequence is switched off. When the rotary control is turned clockwise, then the impulse sequence can be set continuously after a switching threshold has been passed. The shortest impulse sequence (fully at the left) is approx. 2 seconds and the longest (fully at the right) 10 seconds. One graduation line corresponds to approx. 0.8 seconds. The impulse sequence should be adjusted to the monitoring mode over the point of fault. It should be noted that a certain period of time elapses between the positioning of the ground microphone at the different points. Additionally, the settling time of the ground microphone has to be taken into account. At larger time intervals, a full charge of the impulse capacitors and hence the full output power will be obtained.

### 5.2.2 Single pulse

In order to trigger single pulses, e.g. upon request via remote control or by radio, the rotary control (11) has to be set fully to the left, whereby a switching threshold has to be passed. A single pulse is triggered by pressing the illuminated button (12).

### 5.2.3 Current coupling measurement

This prelocation method requires a reflectometer (Teleflex) that can be synchronized (by default included in machines of the type Surgeflex 12/16). The following models are available:

- Teleflex T3060
- Teleflex SX
- Teleflex VX



Please read the corresponding operating manual for information on connecting and operating the measuring device.

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A single pulse is triggered by pressing the blue illuminated button (12). In order to obtain the full charging voltage of the shock discharge capacitors, the kV meter has to be observed. When a flashover occurs at the fault, the prelocation result is instantly available in most cases. Subsequently, the rotary control (2) has to be set to Zero position.

### 5.3 Switching the shock discharge generator off.

After the measurement, the instrument is switched off by pressing the red illuminated button (15). The red illuminated button (15) extinguishes. The white illuminated button (14) keeps indicating "Mains connected". On switching off, an automatic discharge of the shock discharge generator and the connected faulty cable is initiated. This discharge is also indicated on the kV-meter. In the event of a mains failure, the instrument switches off automatically and can only be put into operation again by following the normal switch-on procedure. This is also the case after an emergency switching.

## **5.4 Safety information for shock discharge operation**

### **5.4.1 Fault location in plastic insulated cables**

On fault location in plastic insulated low voltage cables, e.g. NAYY, shock discharge operation must not be carried out against earth, since voltage peaks develop which endanger the lives of human beings and animals. Measurements have to be carried out in order to determine whether the faulty core has earth contact. Only if a fault between two cores or between core and neutral conductor is floating can a shock discharge generator be applied without any danger.

### **5.4.2 Working on open cable trenches**

As per VDE 0104, open cable trenches, service boxes and joint boxes have to be regarded as non steady test equipment and hence as danger areas which as prescribed by the VDE 0104 have to be protected against physical contact. Abstain from touching the joint boxes or measuring e.g. with the ground microphone, since the joint box housing might be live and hence might endanger human life.

## **5.5 Disconnecting the leads**

Prior to disconnecting the high voltage lead from the faulty cable, both connections have to be touched by means of an earthing rod for a "visible" discharge and earthing. (Make sure that the cable is dead !). Only thereafter must the high voltage lead be disconnected.

## **6 Shock discharge operation with arc generation (ARM)**

Here also, point 4.2 and all relevant safety instructions have to be observed.

### **6.1 Connection mode for the arc reflection method (ARM)**

As for normal shock discharge operation (see section 4.1.5 a.) the high voltage lead HSK 20 is connected to the faulty cable.



For information on how to connect the reflectometer please read the corresponding operating manual.

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### **6.2 Function: shock discharge operation with arc reflection (ARM)**

Prior to selecting the function ARM, set the rotary control (11) to Zero position, since this mode works with single pulses only. Additionally, the rotary plug switch (3) has to be set to the desired voltage.

Now, the ARM function is selected by means of the rotary switch (9) and indicated on the pilot lamp (5). However, this switching state can only be obtained after the instrument has been made ready for operation which is indicated by the green illuminated button (13).

### 6.3 Working with the short-term arc reflection method (ARM)

When the green illuminated button (13) lights, the high voltage is switched on by pressing this button (13). The illuminated button (15) indicates readiness for switching on and standby for high voltage generation. The desired voltage - e.g. 0.8 kV - is set on the rotary control (2) and indicated on the kV meter (4).

Use the reflectometer to record a reference trace in ARM mode and prepare the device for recording the fault trace.



For information on how to operate the reflectometer please read the corresponding operating manual.

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By pressing the blue illuminated button (12) a single pulse is triggered and an ARM measurement is initiated. Subsequently, the rotary control (2) is to be set to Zero position.

The recorded fault trace from the reflectometer can now be compared to the reference trace and conclusions can be drawn regarding the fault location.

If the first measurement does not bring the desired result, it can be repeated. If several measurements are carried out successively, the instrument might warm up and switch off. Prior to a new measurement, the voltage has to be set to the desired value again by means of the rotary control (2). At values below 3 kV, the application of the arc reflection method does not always meet with success.

### 6.4 Switching off the ARM-function

After switching the instrument off by pressing the OFF push button (15) (refer to section 5.3), the leads can be disconnected as described in section 5.5.



## **7 Sheath fault location**

In this operation mode, the SPG 12/16 is used for pinpoint location of sheath faults in plastic insulated medium and high voltage cables. Prior to switching this function on, the high voltage connection lead HSK 20 has to be connected to the faulty cable as described under point 4.1.5 (b).

### **7.1 Sheath fault location operation**

First, the rotary plug switch (3) is set to position 12 kV (SPG 12) or 16 kV (SPG 16) respectively. The two rotary controls (2) and (9) must be in Zero position.

After switching the instrument on by means of the white illuminated button (14), the rotary switch (9) is set to the function "MFO". This is indicated by the pilot lamp (8).

Now the rotary control (2) is turned clockwise until the kV meter (4) shows 3 or 5 kV. These are the max. voltages with which sheath faults are located (5 kV for faults on PE sheaths and 3 kV for faults in PVC sheaths). If by mistake a higher voltage has been set, this is indicated by an acoustic signal and current supply is cut off. The instrument switches on again after the voltage has been reduced.

The clock rate is set on the rotary control (11). A longer clock rate of 5 seconds is recommended, since it takes some time to change the position of the earth spikes over the track of the cable. With each DC pulse discharge, the sheath fault current is indicated on the meter. In order to withdraw a continuous voltage, e.g. for sheath testing, the rotary control (11) has to be set to Zero position.

After the sheath fault location has been completed, the instrument is switched off by means of the illuminated button (15). The connection leads are to be disconnected as described in section 5.5. Do not forget to touch the connection points with an earthing rod.

## 8 High voltage testing

The SPG can generate a test voltage of up to 17 kV DC (SPG 12) / 24 kV DC (SPG 16) for testing of cable sheaths and cable installations. As described in section 1.5.4, this test voltage is generated in a special high voltage generator and fed to the cable under test via the high voltage connection lead which is connected as described in section 4.1.5 (a).

### 8.1 Working with the testing mode

The rotary control (2) is to be set to Zero position. Now the instrument is switched off by means of the white illuminated button. The green illuminated button (13) lights up. Take care to see that the rotary plug switch (3) is in position 12 kV (SPG 12) or 16 kV (SPG 16) respectively.

Select the function "HPG" on the rotary control (9). This is indicated by the pilot lamp (7). After pressing the green illuminated button, readiness for switching on is established, which is indicated by the red illuminated button (15).

The desired high voltage can now be set by means of the rotary control (2). The meter (1) has automatically changed over to the measuring range 2 mA and indicates the leakage current. At the commencement of the measurement, the capacitance of the cable under test has to be charged. The actual leakage current can only be indicated when full charge has been reached. When dealing with long cables, this can take a few minutes. In order to measure low residual currents, the push button (10) has to be pressed. As long as the button is pressed, the measuring range is switched over to 200  $\mu$ A.

## 8.2 Voltage coupling

In testing operation, one can also use the voltage coupling method for location of flashovers with the reflectometer.



For information on how to connect the reflectometer please read the corresponding operating manual.

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When the voltage is increased and a flashover occurs at a weak point of insulation, then the resulting transient is recorded in the memory of the pulse reflection instrument and can subsequently be evaluated on the still picture.

## 8.3 Switching off testing operation

The instrument is switched off by pressing the red illuminated button (15). Simultaneously, the connected test object is discharged and earthed. The leads are disconnected as described in section 5.5.

## **9 Malfunctions and error messages**

### **9.1 Switch-on not possible !**

If it is not possible to switch the instrument on, check the following:

- a. Is the white illuminated button lighting? If not, mains voltage is not connected.
- b. Is the high voltage lead HSK 20 properly connected and the white locking screw secured?
- c. Is the dummy plug (with internal bridge) connected to socket (6) or is the emergency-OFF switch connected to this socket and in OFF position?
- d. Is the detachable-key switch on the connection panel in position "ON"?
- e. Is the rotary plug switch (3) properly locked in place?
- f. Is the rotary control (2) in Zero position?
- g. Is the instrument overheated? If yes, this is indicated by the blue illuminated button, which lights continuously. Wait until the instrument has cooled down.

### **9.2 Excess temperature**

In the event of an excess temperature in the unit, current supply to the instruments is interrupted and the instrument output and the test object are shortcircuited and earthed. This switching state is indicated by the blue illuminated button (12). After the unit has cooled down, the blue button (12) starts blinking. The unit can now be put into operation again. First, however, it has to be switched off by pressing the illuminated button (15).

### **9.3 Acoustic signal**

An acoustic signal indicates that in the operation mode "sheath fault location" (MFO) too high a test voltage has been set. The maximum test voltage is 5 kV. The acoustic signal stops when the rotary control (2) is turned back to a value below 5 kV. The instrument can be operated again.





Tento symbol indikuje, že výrobek nesoucí takovéto označení nelze likvidovat společně s běžným domovním odpadem. Jelikož se jedná o produkt obchodovaný mezi podnikatelskými subjekty (B2B), nelze jej likvidovat ani ve veřejných sběrných dvorech. Pokud se potřebujete tohoto výrobku zbavit, obraťte se na organizaci specializující se na likvidaci starých elektrických spotřebičů v blízkosti svého působistě.



Dit symbool duidt aan dat het product met dit symbool niet verwijderd mag worden als gewoon huishoudelijk afval. Dit is een product voor industrieel gebruik, wat betekent dat het ook niet afgeleverd mag worden aan afvalcentra voor huishoudelijk afval. Als u dit product wilt verwijderen, gelieve dit op de juiste manier te doen en het naar een nabij gelegen organisatie te brengen gespecialiseerd in de verwijdering van oud elektrisch materiaal.



This symbol indicates that the product which is marked in this way should not be disposed of as normal household waste. As it is a B2B product, it may also not be disposed of at civic disposal centres. If you wish to dispose of this product, please do so properly by taking it to an organisation specialising in the disposal of old electrical equipment near you.



Този знак означава, че продуктът, обозначен по този начин, не трябва да се извърля като битов отпадък. Тъй като е B2B продукт, не бива да се извърля и в градски пунктове за отпадъци. Ако желаете да извърлите продукта, го занесете в пункт, специализиран в извърлянето на старо електрическо оборудване.



Dette symbol viser, at det produkt, der er markeret på denne måde, ikke må kasseres som almindeligt husholdningsaffald. Eftersom det er et B2B produkt, må det heller ikke bortskaffes på offentlige genbrugsstationer. Skal dette produkt kasseres, skal det gøres ordentligt ved at bringe det til en nærliggende organisation, der er specialiseret i at bortskaffe gammelt el-udstyr.



Sellise sümboliga tähistatud toodet ei tohi käidelda tavalise olmejäätmena. Kuna tegemist on B2B-klassi kuuluva tootega, siis ei tohi seda viia kohalikkude jäätmeäituspunkti. Kui soovite selle toote ära visata, siis viige see lähimasse vanade elektriseadmete käitlemisele spetsialiseerunud ettevõttesse.



Tällä merkinnällä ilmoitetaan, että kyseisellä merkinnällä varustettua tuotetta ei saa hävittää tavallisen kotitalousjätteen seassa. Koska kyseessä on yritysten välisen kaupan tuote, sitä ei saa myöskään viedä kuluttajien käyttöön tarkoitettuihin keräyspisteisiin. Jos haluatte hävittää tämän tuotteen, ottakaa yhteys lähimpään vanhojen sähkölaitteiden hävittämiseen erikoistuneeseen organisaatioon.



Ce symbole indique que le produit sur lequel il figure ne peut pas être éliminé comme un déchet ménager ordinaire. Comme il s'agit d'un produit B2B, il ne peut pas non plus être déposé dans une déchetterie municipale. Pour éliminer ce produit, amenez-le à l'organisation spécialisée dans l'élimination d'anciens équipements électriques la plus proche de chez vous.



Cuireann an siombail seo in iúl nár cheart an táirgeadh atá marcáilte sa tslí seo a dhiúscairt sa chóras fuíoll teaghlaigh. Os rud é gur táirgeadh ghnó le gnó (B2B) é, ní féidir é a dhiúscairt ach oiread in ionaid dhiúscairtha phobail. Más mian leat an táirgeadh seo a dhiúscairt, déan é a thógáil ag eagraíocht gar duit a sainfheidhmiú i ndiúscairt sean-fhearas leictreach.



Dieses Symbol zeigt an, dass das damit gekennzeichnete Produkt nicht als normaler Haushaltsabfall entsorgt werden soll. Da es sich um ein B2B-Gerät handelt, darf es auch nicht bei kommunalen Wertstoffhöfen abgegeben werden. Wenn Sie dieses Gerät entsorgen möchten, bringen Sie es bitte sachgemäß zu einem Entsorger für Elektroaltgeräte in Ihrer Nähe.



Αυτό το σύμβολο υποδεικνύει ότι το προϊόν που φέρει τη σήμανση αυτή δεν πρέπει να απορρίπτεται μαζί με τα οικιακά απορρίματα. Καθώς πρόκειται για προϊόν B2B, δεν πρέπει να απορρίπτεται σε δημοτικά σημεία απόρριψης. Εάν θέλετε να απορρίψετε το προϊόν αυτό, παρακαλούμε όπως να το παραδώσετε σε μία υπηρεσία συλλογής ηλεκτρικού εξοπλισμού της περιοχής σας.



Ez a jelzés azt jelenti, hogy az ilyen jelzéssel ellátott terméket tilos a háztartási hulladékokkal együtt kidobni. Mivel ez vállalati felhasználású termék, tilos a lakosság számára fenntartott hulladékgyűjtőbe dobní. Ha a terméket ki szeretné dobní, akkor vigye azt el a lakóhelyéhez közel működő, elhasznált elektromos berendezések begyűjtésével foglalkozó hulladékkezelő központhoz.



Questo simbolo indica che il prodotto non deve essere smaltito come un normale rifiuto domestico. In quanto prodotto B2B, può anche non essere smaltito in centri di smaltimento cittadino. Se si desidera smaltire il prodotto, consegnarlo a un organismo specializzato in smaltimento di apparecchiature elettriche vecchie.



Ští zíme noráda, ka izstrádajumu, uz kura tá atrodas, nedríkst izmest kopá ar parastiem mājšaimniecības atkritumiem. Tā kā tas ir izstrádajums, ko cits citam pārdod un lieto tikai uzņēmumi, tad to nedríkst arī izmest atkritumos tādās izgāztuvēs un atkritumu savāktuvēs, kas paredzētas vietējiem iedzīvotājiem. Ja būs vajadzīgs šo izstrádajumu izmest atkritumos, tad ríktojiet pēc noteikumiem un nogādājiet to tuvākajā vietā, kur īpaši nodarbojas ar vecu elektrisku ierīču savākšanu.



Šis simbolis rodo, kad juo paženklinto gaminio negalima išmesti kaip paprastų buitinių atliekų. Kadangi tai B2B (verslas verslui) produktas, jo negalima atiduoti ir buitinių atliekų tvarkymo įmonėms. Jei norite išmesti šį gaminį, atlikite tai tinkamai, atiduodami jį arti jūsų esančiai specializuotai senos elektrinės įrangos utilizavimo organizacijai.



Dan is-simbolu jindika li l-prodott li huwa mmarkat b'dan il-mod m'ghandux jintrema bhal skart normali tad-djar. Minhabba li huwa prodott B2B , ma jistax jintrema wkoll f'centri civici ghar-rimi ta' l-iskart. Jekk tkun tixtieq tarmi dan il-prodott, jekk joghgbok ghamel dan kif suppost billi tiehdu ghand organizzazzjoni fil-qrib li tispejalizza fir-rimi ta' taghmir qadim ta' l-elettriku.



Dette symbolet indikerer at produktet som er merket på denne måten ikke skal kastes som vanlig husholdningsavfall. Siden dette er et bedriftsprodukt, kan det heller ikke kastes ved en vanlig miljøstasjon. Hvis du ønsker å kaste dette produktet, er den riktige måten å gi det til en organisasjon i nærheten som specialiserer seg på kassering av gammelt elektrisk utstyr.



Ten symbol oznacza, że produktu nim opatrzonego nie należy usuwać z typowymi odpadami z gospodarstwa domowego. Jest to produkt typu B2B, nie należy go więc przekazywać na komunalne składowiska odpadów. Aby we właściwy sposób usunąć ten produkt, należy przekazać go do najbliższej placówki specjalizującej się w usuwaniu starych urządzeń elektrycznych.



Este símbolo indica que o produto com esta marcação não deve ser deixado fora juntamente com o lixo doméstico normal. Como se trata de um produto B2B, também não pode ser deixado fora em centros civicos de recolha de lixo. Se quiser desfazer-se deste produto, faça-o correctamente entregando-o a uma organização especializada na eliminação de equipamento eléctrico antigo, próxima de si.



Acest simbol indică faptul că produsul marcat în acest fel nu trebuie aruncat ca și un gunoi menajer obișnuit. Deoarece acesta este un produs B2B, el nu trebuie aruncat nici la centrele de colectare urbane. Dacă vreți să aruncați acest produs, vă rugăm s-o faceți într-un mod adecvat, ducând-ul la cea mai apropiată firmă specializată în colectarea echipamentelor electrice uzate.



Tento symbol znamená, že takto označený výrobek sa nespíe likvidovať ako bežný komunálny odpad. Každé sa jedná o výrobok triedy B2B, nespíe sa likvidovať ani na mestských skládkach odpadu. Ak chcete tento výrobok likvidovať, odneste ho do najbližšej organizácie, ktorá sa špecializuje na likvidáciu starých elektrických zariadení.



Ta simbol pomeni, da izdelka, ki je z njim označen, ne smete zavreči kot običajne gospodinjске odpadke. Ker je to izdelek, namenjen za druge proizvajalce, ga ni dovoljeno odlagati v civilno odlaganje odpadkov. Če želite izdelek zavreči, prosimo, da to storite v skladu s predpisi, tako da ga odpeljete v bližnjo organizacijo, ki je specializirana za odlaganje stare električne opreme.



Este símbolo indica que el producto así señalado no debe desecharse como los residuos domésticos normales. Dado que es un producto de consumo profesional, tampoco debe llevarse a centros de recogida selectiva municipales. Si desea desechar este producto, hágalo debidamente acudiendo a una organización de su zona que esté especializada en el tratamiento de residuos de aparatos eléctricos usados.



Den här symbolen indikerar att produkten inte får blandas med normalt hushållsavfall då den är förbrukad. Eftersom produkten är en så kallad B2B-produkt är den inte avsedd för privata konsumenter, den får således inte avfallshanteras på allmänna miljö- eller återvinningsstationer då den är förbrukad. Om ni vill avfallshandera den här produkten på rätt sätt, ska ni lämna den till myndighet eller företag, specialiserad på avfallshandtering av förbrukad elektrisk utrustning i ert närområde.