

## INSTRUCTION MANUAL

### Portable Fault Locating System Surgeflex 15 / Surgeflex 25



## **INTENDED APPLICATION**

The SFX 15/25 Fault Locating System is intended to be used for locating faults on primary power cables. It must be operated by trained and certified Power Utility personnel in accordance with all applicable federal, state, local and company regulations and safety standards, including, but not limited to all standards describing the proper handling of High Voltage.

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## **Technical SUPPORT & ASSISTANCE**

For assistance, contact your local Rep or

**Megger**  
Service department  
Dr. Herbert Iann Str. 6  
Baunach, Germany  
Tel: +49 (9544-68130)  
Fax: +49 (9544-68310)  
e-mail: [service@Megger.com](mailto:service@Megger.com)

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## 1.0 INTRODUCTION

Today's state of the art URD fault locating method comprises four steps, which, when implemented and followed correctly, provide for a safe and restoration time sensitive process that also will eliminate or minimize any additional damage to the cable.

The four-step procedure will be applicable in the vast majority of typical URD faults:

- **trace** (locate) cable
- **assess** type of fault using an insulation tester
- **prelocate** fault, e.g. with the Arc Reflection Method (ARM)
- **pinpoint** exact location

## 2.0 INTEGRATED SFX SERIES FAULT LOCATING SYSTEM

The SFX Series models locate efficiently high and low resistance as well as intermittent cable faults on primary and, under certain circumstances, secondary power cables. Due to a sequential safety interlock system it is not possible to inadvertently apply high voltage to the cable under test.

The SFX Series models combine **three modes of operation**, with a maximum voltage of either 15 or 25 kV in each mode (complete specifications for each model are listed in the appendix):

- **Arc Reflection Mode, ARM** in combination with internally integrated filter
- **Direct Thump Mode**
- **DC Highpot Mode** (optional leakage current measurement)

The SFX Series Models use an electronically controlled feed back circuit to control the voltage at the high voltage discharge contact, which is solenoid operated. This design ensures optimum energy transfer from the impulse capacitor into the faulty cable. The surge generator (SG 15/25) is under normal use maintenance free for many years.

The SFX Series Models automatically discharge the cable under test and their own internal capacitor(s)

- when the power to the unit is turned off
- when "High Voltage" in any of the operating modes is switched off
- when the HV switch is pulled in order to change the mode of operation

The SFX Series Models contain a built-in ARM filter, which is essential in the application of the Arc Reflection Method for fault locating. The filter isolates and protects the TDR from the high voltage pulse produced by the surge generator and couples the low voltage, high frequency TDR pulse onto the energized cable.

The TDR detects "opens" (cable end or fault) and "shorts", cable splices and transformers as well as any change in impedance in the cable under test. High resistance phase to ground faults, also referred to as "pinhole faults" (typically higher than 200 ohms) do not produce a detectable reflection on a TDR. By using the thumper in combination with the TDR it is possible to detect this type of fault. The flashover, which is generated by the thumper, converts the high resistance fault temporarily into a low resistance fault (several Ohms), which can be detected by the TDR. The distance between the cable hook-up (start marker) and the fault location (end marker) is displayed on the TDR screen.

## 3.0 GENERAL SET UP INSTRUCTIONS

### 3.1 IMPORTANT NOTES

#### **!!! WARNING !!!**

***DO NOT TEST-FIRE THE SFX SERIES FAULT LOCATING SYSTEM BEFORE PROPER TEST SETUP. DANGER TO OPERATOR AND DAMAGE TO THE EQUIPMENT MAY RESULT. TEST FIRING OF THE SFX SERIES FAULT LOCATING SYSTEM WILL VOID WARRANTY.***

***ALWAYS*** operate the SFX Series Fault Locating System in a **VERTICAL** position. Grounding and HV contacts both require a vertical orientation to ensure proper functioning as well as a “Fail Safe Position” in case of an AC or DC power failure or if the unit is shut off.

*In order to disconnect the SFX Series Fault Locating System from mains, unplug the power outlet before you disconnect the mains cable from the device.*

#### **!!! SAFETY !!!**

***BEFORE CONNECTING THE SFX SERIES FAULT LOCATING SYSTEM TO THE CABLE TO BE TESTED, BE SURE THAT THE CABLE HAS BEEN ISOLATED, TESTED AND GROUNDED AT BOTH ENDS IN COMPLIANCE WITH ALL OSHA & COMPANY PROCEDURES. ALWAYS LOCATE FAULT LOCATING SYSTEM OFF TO THE SIDE OF THE CABLE PATH, NEVER ON TOP OF CABLE PATH !!***

#### **Five safety rules**

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

1. De-energise
2. Protect against re-energising
3. Confirm absence of voltage
4. Ground and short-circuit
5. Cover up or bar-off neighbouring energised parts



#### **Wear Ear Protection**

Surge operation can cause high and sudden noise levels. It is strongly recommended to wear hearing protection during surge operation. Keep in mind that this will limit the operators awareness for ambient dangers.



#### **Ventilation**

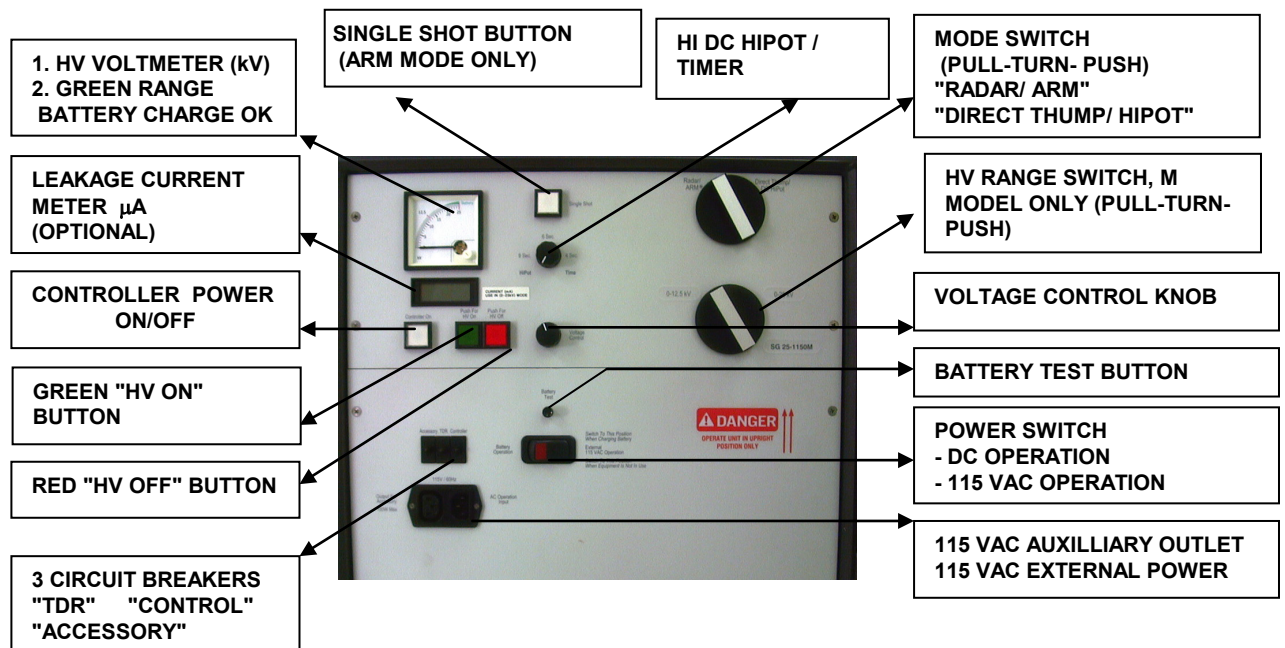
The surge operation creates ozon. It is necessary to operate the instrument under well ventilated condition to keep ozon levels below limit values for the operator.

### 3.2 POWER OPTIONS & FRONT PANEL LAYOUT



1. unit can be operated from internal battery (battery sufficient for a full day of typical URD fault locating activities)
2. unit can be operated from an AC source (115VAC / 3A, cable included with equipment, *only source for remote controlled truck mount models*)

Fig.2 Typical SFX SERIES Configuration (Fully Self Contained System)



**NOTE: Battery Charging Jack is on Rear Side of Instrument Enclosure!**

FIG. 3 Front Panel Layout of the surge generator SG 15/25

#### **4. CONNECTING THE SFX SERIES UNIT**

**Connect the safety ground lead** from the SFX Series unit (flexible copper braid) to a good system ground, preferably the ground rod in the pad mount or at the base of the riser pole. This grounding technique is called “single-point grounding”. Due to changing ground conditions, **locally driven grounds** (in addition to the system ground) are no safe substitute for single-point grounding and **should not be permissible** in place of properly installed system grounds.

**Connect the HV return lead** to the cable sheath or concentric of the specific cable to be tested. The resistance between the HV return (operational ground) and system ground (safety ground) should be **less than 5 ohms** (Ohm meter check).

***If the resistance is greater than 5 ohms, an additional ground cable should be connected from the concentric directly to the system ground rod.***

**Connect the HV test lead** to the phase conductor to be tested (optional elbow adapter or vice grip).


## 5. OPERATING THE SFX SERIES FAULT LOCATING SYSTEM

### 5.1 PRELOCATION PROCEDURE WITH TDR (ARM MODE)


After locating the cable path the SFX Series Fault Locating System is set up to the side of it. After opening the front door the power switch on the front panel is put in the "Battery Operation" position. The TDR is set up on top of the system. The 115 VAC power cable and the 2 coax cables are securely connected to the rear side of the TDR.



For detailed information on the electrical connection between the TDR and the surge generator SG 15/25, please refer to the operating manual of the TDR.

1	Before making any connections make sure to observe the five safety rules (see page 5).
2	Take the safety ground cable and make the connection to station ground.
3	Connect the High Voltage Output cable to the cable under test. Connect the HV Return lead to the concentric neutral.
4	Put the System Mode Switch (upper) in the "RADAR/ARM" position (- PULL - TURN - PUSH -).
5	Use the switch on the lower front panel to choose between battery and power supply operation.
6	Push "CONTROLLER ON" button (upper control panel). Light will come on.
7	Put the voltage control knob fully counter-clockwise
8	Remove all grounding elbows or grounding jumpers
9	Use the TDR to record a reference trace and make the necessary adjustments (gain, range, $v/2$ ) required for best representation of the trace. Prepare the TDR for fault trace recording.
	 <p>For detailed instructions on how to operate the TDR, please refer to the operating manual of the TDR.</p>
10	Make sure everyone is in the clear!
11	Put lower HV switch on system in the required position (- PULL - TURN - PUSH -). Best suited position depends on the voltage required to ignite an arc at the fault location: <div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p>SFX 15:            &lt;7.5 kV -&gt; set range to 0 – 7.5 kV            &gt;7.5 kV -&gt; set range to 0 – 15 kV</p> </div> <div style="width: 45%;"> <p>SFX 25:            &lt;12.5 kV -&gt; set range to 0 – 12.5 kV            &gt;12.5 kV -&gt; set range to 0 – 25 kV</p> </div> </div>
12	Push the green "HV ON" button on the front panel (red button will light up).
13	Use "Voltage" control knob to adjust the surge voltage (indictaed on the voltmeter).
14	Push "SINGLE SHOT" button to trigger a shot.



15	If no voltage flash-over took place, increase the surge voltage and trigger another shot.
16	Push the red "HV OFF" button
17	Try to determine the fault distance by means of the two traces. <hr/> <hr/>  For detailed instructions on how to operate the TDR, please refer to the operating manual of the TDR. <hr/> <hr/>
18	Pinpoint the fault (see next section).

## 5.2 PINPOINTING PROCEDURE

After locating the cable path the SFX Series Fault Locating System is set up to the side of it. After opening the front door the power switch on the front panel is put in the "Battery Operation" position.

1	Before making any connections make sure the cable under test is de-energized and grounded and system is off.
2	Take the safety ground cable and make the connection to the system ground.
3	Connect the High Voltage Output cable to the cable under test. Connect the HV Return lead to the concentric neutral.
4	Put the System Mode Switch (upper) in the "DIRECT THUMP" position (- PULL - TURN - PUSH -).
5	Use the switch on the lower front panel to choose between battery and power supply operation.
6	Push "CONTROLLER ON" button (upper control panel). Light will come on.
7	Turn the voltage control knob fully counter-clockwise.
8	Remove all grounding elbows or grounding jumpers.
9	Put the "HIPOT / TIME" knob to the "6 SEC" position.
10	Make sure everyone is in the clear!
11	Put lower HV switch on system in the required position (- PULL - TURN - PUSH -). Best suited position depends on the voltage required to ignite an arc at the fault location:  <div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p>SFX 15: &lt;7.5 kV -&gt; set range to 0 – 7.5 kV &gt;7.5 kV -&gt; set range to 0 – 15 kV</p> </div> <div style="width: 45%;"> <p>SFX 25: &lt;12.5 kV -&gt; set range to 0 – 12.5 kV &gt;12.5 kV -&gt; set range to 0 – 25 kV</p> </div> </div>
12	Push the green "HV ON" button on the front panel (red button will light up). Thumper starts cycling.
13	Adjust the "Voltage Control Knob" to bring up the required kV on the voltmeter (each cycle should "SNAP" and the voltmeter should drop to almost zero).
14	Pinpoint the fault using the Digiphone.
15	After pinpointing fault turn "Voltage Control Knob" fully counter-clockwise and push red "HV OFF" button.
16	Cable under test is now discharged and grounded by system.

### 5.3 LEAKAGE CURRENT MEASUREMENT (OPTIONAL) IN CONJUNCTION WITH HIPOT TEST

The SFX Series Fault Locating System can be optionally equipped with a leakage current meter. A digital Milli Amp meter with a LED backlight is installed right below the voltmeter in the top panel of the system.

The current meter is active when the mode switch is switched to "DC HIPOT" and to the **higher of the two** voltage ranges ('0 - 15 kV' or '0 - 25 kV' respectively). Only in the higher voltage range will the circuitry compensate for the leakage resulting from the internal bleeding resistors, which are connected across the capacitors (safety provision).

The meter has a resolution of 10  $\mu$ A and a full range of 2 mA. If during the test the DC voltage is lowered the meter will read negative till a steady state has been reestablished.

## **6.0 MAINTENANCE**

The SFX Series system will need very little maintenance under normal operating conditions. If not in use the system should be stored in an if possible dust free and dry environment. Humidity (condensation) by itself or in combination with dust can reduce critical distances within the equipment, which are necessary to maintain safe high voltage performance.

## Appendix

### Technical Specifications

<p><b>THREE MODES OF OPERATION</b>  0-15/0-25 kV ARC Reflection Mode (prelocate)</p> <ul style="list-style-type: none"> <li>• 0-15/0-25 kV DC Hipot  (current measurement optional)</li> <li>• 0-15/0-25kV Continuous thumping at 4-12 second intervals for pinpointing</li> <li>• 0-15/0-25 kV Surge Pulse Mode (optional)  (special prelocating method)</li> </ul> <p><b>INTEGRATED FILTER SUPPORTS</b></p> <ul style="list-style-type: none"> <li>• ARC Reflection Mode</li> <li>• Surge Pulse Mode (optional)</li> </ul> <p><b>THUMP (SURGE) ENERGY</b>  1150 Joules</p> <p><b>THUMP (SURGE) VOLTAGE</b>  Adjustable from 0-7.5/ 0-15KV  Adjustable from 0-12.5/0-25kV</p> <p><b>THUMP (SURGE) RATE</b>  Adjustable between 4-12 seconds  (1150 Joules every 7 seconds)</p> <p><b>DC HIPOT TEST</b>  0-15 kV DC  0-25 kV DC</p> <p><b>SUPPLY VOLTAGE</b>  90 - 120 V 50/60 Hz (230V optional)</p> <p><b>INPUT POWER</b>  max. 700 VA  Fuse: 230 V slow blow 4 A / 250 V  117 V slow blow 4 A / 250 V</p>	<p><b>OPERATING TEMPERATURE:</b>  -20 C to +40 C</p> <p><b>GROUNDING CONNECTION / CABLE</b>  Heavy duty brass stud / 50 ft of # 2 braided copper wire with clear jacket</p> <p><b>HV OUTPUT CABLE</b>  50 ft of 50 kV output cable hardwired, male MC connector at the cable end</p> <p><b>POWER OUTLET, ACCESSORIES</b>  115 VAC, for TDR or accessories (100 W)  Fuse: slow blow 4 A /250 V</p> <p><b>BATTERY (optional):</b>  Deep Cycle Marine Gel Cell Battery (built-in inverter converts 12V battery power to 115 VAC (230 V optional) to operate the unit, TDR and light duty accessories)  Fuse: 2x BUSS MDL 20 A</p> <p><b>WEIGHT</b> Approximately 240 lbs incl. TDR</p>
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## **SPECIFICATIONS OF TIME DOMAIN REFLECTOMETER**



For the specifications of the TDR, please refer to the respective operating manual.

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