

Innovative fault location system  
for low-voltage systems with new  
ICEPlus Prelocation technology

# SPG 5-1000



## Benefits:

- ▶ **Highest operator comfort for all user levels**
- ▶ **Highest safety standards**
- ▶ **Technology for reliable prelocation of faults in LV networks, including T- joints**
- ▶ **Compact and light construction**



**sebaKMT**

# Innovative fault location system for low-voltage systems with new ICEPlus Prelocation technology

The liberalisation of the energy market led to deep structural changes of the power supply utilities. With a lot of imaginativeness the utilities try to reduce their costs in all areas without causing an impact on the availability and reliability of the network. These criteria are included increasingly into the discussion the net using costs.

In the context of the costs reduction measures and possible fusions of power utilities, the existing equipment for cable testing and fault location are usually decentralized and new investments into Cable Fault Location Systems were considerably reduced.

Resulting in many utilities the available Cable Test Vans are responsible for a large area, which leads as consequence to the fact of substantially longer access respectively waiting times for an employment in the faulted area.

During breakdowns in medium voltage net a redundant supply possibility is usually ensured by according switching procedures and the extended waiting period increases only the risk of possible sub sequential failures.

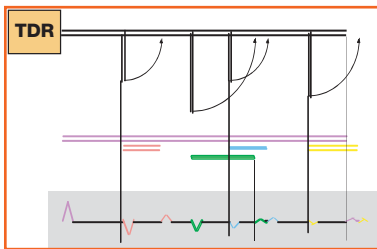
In low-voltage systems however the periods up to a re-supply depends substantially on the speed of a fault location and the no appearing extended waiting periods of distant test van systems become very problematic.

Not only the rights for compensation of customers in case of a supply loss or of power suppliers with loss of the necessary transmission capacity cause financial problems but long lasting faults have also an impact on the image of the responsible power utility.

With the new fault location system SPG 5-1000 well-known measuring technologies with state-of-the-art control philosophy are implied. The very complicated prelocation of cable faults in the branched low-voltage systems, becomes with the new ICEPlus technology the pure measuring fun.

## ► The technical problem of the locating in branched networks

Due to cost reasons and safety issues in low-voltage systems less switchboards and distribution are installed while the amount of houses connected to one supply line increased to 15 houses and more. The large problem of the accessibility of the House connection terminal for removal of the fuses unfortunately still cannot be avoided, since the fault location of high resistive faults still requires the use of high voltage DC and surge impulses. Another serious problem for the location of faults in cables with many connected T-connections is the high attenuation of the reflectometer pulses and the complexity of the received reflectograms caused by the impedance changes at the multiple T-joints and terminations (fig. 1)



**Fig. 1: schematic representation of the absorption and complexity of reflection measurements (TDR)**

Often faults behind the third or fourth t-joint are no longer recognizable due to these effects.

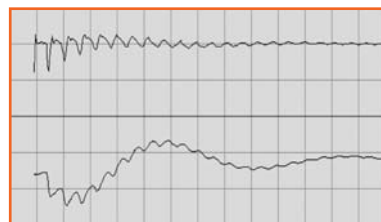
Even more difficult are faults in T-joints themselves, since these have a large own reflection. Also the for many years well-known Arc Reflection Method (ARM) is equally limited by these effects. Also well-experienced fault location technicians must locate the fault by approaching the branched cable from different end points. Sometimes it even required to set boundaries by cutting the cable. A time and money consuming procedure and because of this also a never-racking procedure, not only for the technician, but also for the customers involved.

## ► The solution? ICEPlus

The target of the considerations was to develop a durable, reliable and simply to operate measuring procedure, which is completely independent of the above mentioned impedance and attenuation problems.

Since the beginnings of the cable fault location the so-called Impulse Current Procedure (ICE) is well known. Here the transient current signal of a surge pulse discharge is recorded in the moment of the fault ignition. This technology has been successfully used on medium voltage cables without branches.

At cables with t-joints however the ICE procedure like a reflection measurement has the limitations caused by the multiple impedance changes and is resulting very complicated if not impossible.

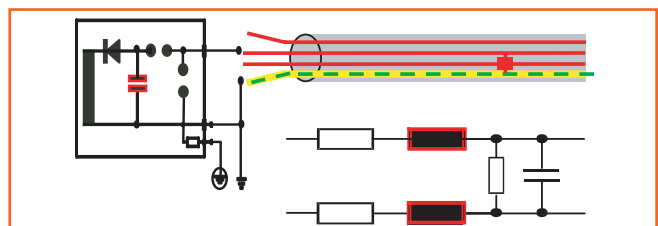


**Fig. 2: Transient current decoupling complete current with base wave**

The measuring signal generated during a breakdown does not only contain the well-known current pulses, but it contains also an oscillating current (base wave), on which the transient current pulses are over imposed (fig. 2)

The frequency of this oscillation depends on the parameters of the measuring setup.

The well-known capacity of the surge capacitor in the SPG 5-1000 and the inductivity per length of the faulty cable up to the fault position are the dominating parameters, which affect the oscillating frequency of the base wave (fig. 3). The capacity of the faulty cable is to be neglected in relation to the surge capacitor, and the internal inductivity of the measuring system and its leads are known and accordingly considered in the evaluation.



**Fig. 3: Surge capacity and cable inductivity as dominating components of the resonant circuit**

# SPG 5-1000

By determination of the oscillating frequency of the base wave by the following well-known resonant circuit equation

$$f_o = \frac{1}{2\pi\sqrt{LC}}$$

the inductivity of the resonance circuit can be determined by

$$L = \frac{1}{\omega_o^2 C}$$

The substantial Know-How of the ICE Plus technology is based on the reliable determination of the oscillating frequency respectively the period duration as most important measured parameter.

The evaluation of the measured signals with high attenuation of the base wave, up to the evaluation of aperiodic half oscillations or by the intermittent arc very noisy signal is done by a digital signal processor (DSP) and a multi-level approximation software, as well as by various evaluation algorithms.

With the measured angular frequency  $\omega$  and the computed resonant circuit quality Q the inductivity up to the fault location  $L_F$  can be calculated.

$$L_F = \frac{1}{\omega^2 C_s (1 + 1/4Q^2)}$$

From this determined inductivity value  $L_F$  it is possible to determine the fault distance via the inductivity per kilometre. This specific inductivity of the cable depends primarily on the geometrical arrangement of the different cores to each other.

In order to generate good database for the calculation of the fault distance, it was necessary to accomplish extensive field trials to achieve the typical inductivity values for the different cable types and their geometrical core arrangements.

By a simple measuring arrangement with known cable length it is possible to determine in the future also the parameters of exotic Cable types, which are at present not yet contained in the data base.

With this ICEPlus procedure with patent pending any untrained user can accomplish without any problem the prelocation of cable faults.

For the exact pinpointing of the cable faults the usual location procedures are available as described in the following section .

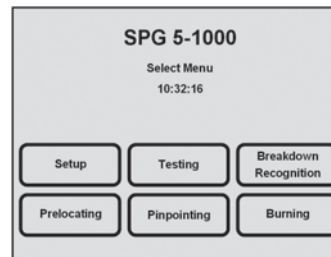
## ► Fault location made easy

The operating conception of the entire measuring system is based on our

**easyGO** philosophy.

The user can operate the equipment intuitively, without the prior study of many pages of an operating manual.

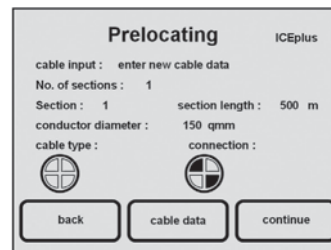
Due to the 1/4 VGA display of the equipment, sufficient display area is available to present a graphical display of status, information and operating instructions, as well as all measuring and test parameters.



**Fig. 4: main menu for selection of the measuring functions**

A further helpful function is the breakdown recognition. The breakdown voltage of the fault is automatically determined, to provide in the prelocation and pinpointing menu automatically the most suitable surge voltage amplitude. This prevents the use of unnecessary high voltage level and resulting it prevents the danger of secondary damages.

In the prelocation function with ICEPlus the user follows the menue guided operating instructions at the display, which essentially consists of the entry of the conductor cross section,

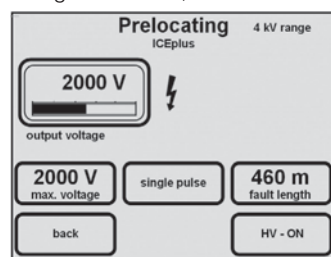


**Fig. 5: Entry menu for the prelocation with ICEPlus**

If the case that the cable is assembled of different segments of different cable types, a sectionalising possibility permits the entry of different cable data for each section.

The correct entry of the conductor crosssection and the connection situation are essential for the exact distance evaluation of the cable fault. If the fault is located in a branch, e.g. in the area of a house connection, the unconsidered change in cross section can result in a shift of the fault distance. But this change is normally in the range of the normal inaccuracies as the happen in the field anyway.

If the measured error distance indicates the situation of the fault being in a branch, and this branch has a length of more than 20 m,



**Fig. 6: Prelocation Display ICEPlus**

The operation by a rotary encoder with enter function provides a simple navigating in the menu and the fast entry of all parameters.

For the fast and easy orientation of the user which fault condition is present, the test function indicates at the same time leakage current and insulation resistance values.

the cable construction and the geometrical core arrangement to which the equipment is connected. The user is presented with a selection list in a graphical display of the cable core arrangement (e.g. 3, 4 or 5 core cable, with screen, neighbouring cores or opposite cores) offered.

then an additional measurement from the end of the branch has to be considered.

The error distance for ICEPlus is indicated directly in meters and no interpretation of complicated reflection pictures is necessary!



# We are happy to provide you with information!



For the exact pinpointing of cable faults the DC step voltage method and the sound / distance method can be selection in the SPG 5-1000 menu.

For the step voltage method an adjustable direct current with selectable duty cycle is used. The surge capacitor is not connected in this mode.

For the distance method the voltage ranges of 2 and 4 kV with 1000 joule surge energy in each range are available. This provides an easy fault pinpointing with the distance method also in a situations with high background noise.

Summary overview of the technical capabilities of the System SPG 5-1000

- Intuitive menu guidance
- One button operation
- DC testing up to 5 kV
- Insulation resistance in Mohm
- Automatic Breakdown detection
- Prelocation with ICEPlus
- Burning
- Pinpointing with DC step voltage
- Pinpointing with SWG function (1000 J with 0-2 kV and 0-4 kV)

With the SPG 5-1000 the utilities have an efficient and simple operation, portable fault location system at their hands. This provides a fast and from Cable Test Vans independent Fault location and repair in low voltage systems.

With the prelocation technology ICEPlus an absolute innovation for the process of cable fault location is available.



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Our range of products: Equipment and systems to locate faults in power and communications networks, as well as for leak location on pipe networks · line location equipment · seminars · service · contracting.

We reserve the right to make technical changes.

**ISO 9001:2000**