Megger

digiPHONE+ NT

Surge Wave Receiver and Earth Fault Locator

USER GUIDE

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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.

Should any question remain unanswered or should you need the help of an authorized service station, please contact:

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Terms of Warranty

Megger accept responsibility for a claim under warranty brought forward by a customer for a product sold by Megger under the terms stated below.

Megger warrant that at the time of delivery Megger products are free from manufacturing or material defects which might considerably reduce their value or usability. This warranty does not apply to faults in the software supplied. During the period of warranty, Megger agree to repair faulty parts or replace them with new parts or parts as new (with the same usability and life as new parts) according to their choice.

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.

This warranty does not apply to any fault or damage caused by exposing a product to conditions not in accordance with this specification, by storing, transporting, or using it improperly, or having it serviced or installed by a workshop not authorized by Megger. All responsibility is disclaimed for damage due to wear, will of God, or connection to foreign components.

For damage resulting from a violation of their duty to repair or re-supply items, Megger can be made liable only in case of severe negligence or intention. Any liability for slight negligence is disclaimed.

Since some states do not allow the exclusion or limitation of an implied warranty or of consequential damage, the limitations of liability described above perhaps may not apply to you.

Contents

1 Fundamental Information

Safety precautions

This manual contains basic instructions on commissioning and operating the digiPHONE^{+} NT. For this reason, it is important to ensure that the manual is available at all times to authorised and trained personnel. Any personnel who will be using the devices should read the manual thoroughly. The manufacturer will not be held liable for any injury or damage to personnel or property through failure to observe the safety precautions contained in this handbook.

Locally applying regulations have to be observed.

Labelling of safety instructions

Important instructions concerning personal, operational and technical safety are marked in the text as follows:

Symbol	Description
 WARNING	Indicates a potential danger that may lead to fatal or serious injury.
 CAUTION	Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury or material damage.
	The notes contain important information and useful tips for using the system. Failure to observe them can render the measuring results useless.
	Useful tips from practical experience.

Working with products from Megger

It is important to observe the general electrical regulations of the country in which the device will be installed and operated, as well as the current national accident prevention regulations and internal company rules (work, operating and safety regulations).

Use genuine accessories to ensure system safety and reliable operation. The use of other parts is not permitted and invalidates the warranty.

Operating staff

This system and its peripheral equipment may only be operated by trained or instructed personnel. Anyone else must be kept away.

The system may only be installed by an authorised electrician. DIN VDE 0104 (EN 50191), DIN VDE 0105 (EN 50110) and the German accident prevention regulations (UVV) define an electrician as someone whose knowledge, experience and familiarity with the applicable regulations enables him to recognise potential hazards.

Repair and maintenance

Repairs and service must only be done by Megger or authorised service departments of Megger. Megger recommends having the equipment serviced and checked once per year at a Megger service location.

Megger also offers direct on-site support. Please contact our service office for more information.

Checking the scope of delivery

Check the contents of the package for completeness and visible damage right after receipt. In the case of visible damage, the device must under no circumstances be taken into operation.

If something is missing or damaged, please contact your local sales representative.

Declaration of Conformity (CE)

The digiPHONE^{+} NT meets the following security requirements of the European Council Directives:

Directives:	EMC directive (204/108/EG)	
Standards:	EMC	Technical Safety
	EN 55011, EN 61000-6-4 , EN 61000-4-2, EN 61000-4-3, EN 61000-4-4, EN 61000-4-8	EN 61010-1, EN 50249, GPSG

2 Technical Description

2.1 System Description

Description The digiPHONE$^+$ NT is a portable device suitable for outdoor use which combines the following two functions:

Surge wave receiver for precisely pinpointing flashover faults in buried cables (digiPHONE mode)

A surge generator feeds surge voltage pulses into the end of the faulty wire. These cause voltage flashovers (arcs) at the fault. The resulting flashover noise propagates in the ground and is recorded with the ground noise sensor on the surface. The distance to the fault can be calculated using either the volume of the flashover noise or the time difference between the arrival of the magnetic pulse and the flashover noise.

Earth fault locator for precisely pinpointing sheath faults in plastic insulated PE and VPE medium voltage cables (ESG mode)

The precise location of a sheath fault is carried out using the step voltage method. At the fault position where the test current flows into the ground. A potential gradient forms at the exit point which is measured by means of earth spikes and a connected indicator unit. The step voltage rises when both earth spikes are situated in front of the fault position. If the fault position is passed by, the step voltage polarity changes, which then subsides again the further away you go.

Features When used as a surge wave receiver, the digiPHONE$^+$ NT offers the following features:

- Trend indicator
- Line tracking using the left/right indicator on the display
- Outstanding acoustic qualities for locating faults quickly and reliably
- High level of accuracy due to selective recording of magnetic fields
- Very stable sensor
- Trigger thresholds for acoustic and magnetic channels set fully automatically
- Intelligent Background Noise Reduction (BNR)
- Automatic Proximity Mute (APM)
- Volume limiter which can be switched on and off
- Height-adjustable telescopic handle for sensor

When used as an earth fault locator, the digiPHONE$^+$ NT offers the following features:

- Automatic sensitivity adjustment to the measured voltage
- Automatic zero point reference
- Automatic synchronisation to generator rate
- Wide measuring range (0.01 mV … 200 V) due to high level of sensitivity
- Suppression of interference (50/60 Hz, 16⅔ Hz, 100/120 Hz)
- Elimination of DC voltage interference

Scope of delivery The scope of delivery includes the following:

- DPP-CU indicator unit with carrying strap
- DPP-SU sensor
- Height-adjustable telescopic handle (450 – 750 mm)
- Set of headphones
- Coiled cable for connecting the sensor, 1.20 m
- 2 x measuring spike (18 mm, 75 mm)
- 3-point foot
- 2 x earth spike
- 2 x cable for connecting the earth spikes, 1,50 m
- 2 x contacting sponge
- 6 x AA battery, type IEC R6 (alkaline manganese)
- Manual

Optional accessories The following optional accessories can also be ordered from Megger Sales:

Accessory	**Description**	**Item number**
Carry-bag		118302978, 108301100, 118308525
Measuring spike, 180 mm	Long measuring spike for use on loose ground	899006926
Measuring spike, 300 mm	Long measuring spike for use on extremely loose ground (e.g. sand)	890026254
Base plate	Flat plate for use on smooth surfaces	899006924

2.2 Technical Data

Indicator unit The indicator unit has the following parameters:

Parameter	Value
Power supply	6 x AA batteries, type IEC R6 (alkaline manganese)
Operating time	>20 hours
Voltmeter • Input resistance • Measuring range • Sensitivity	 650 kΩ max. 200 V <5 µV
Operating temperature	-20°C to 55°C
Operating humidity	Max. relative humidity 93% at 30°C
Storage temperature	-30°C to 70°C
Display	TFT colour display with 320 x 240 pixels
Weight	<0.9 kg
Dimensions	225 mm x 65 mm x 100 mm (W x H x D)
Protection rating (according to IEC 60529 (DIN VDE 0470-1))	IP 54

Sensor unit The sensor unit has the following parameters:

Parameter	Value
Acoustic amplification	>120 dB (facility for limiting amplification to 84 dB(A) can be switched on and off)
Dynamic range of the sensor • Acoustic channel • Magnetic channel	 >110 dB >110 dB
Frequency range of sensor	100 to 1,500 Hz
Filter stages • Low pass • Band pass • High pass	 100 to 400 Hz 150 to 600 Hz 200 to 1,500 Hz
Weight (incl. telescopic handle)	<2.2 kg
Dimensions	230 mm x 140 mm (Ø x H)
Protection rating (according to IEC 60529 (DIN VDE 0470-1))	IP 65 (only for plugged-in connector)

Earth spikes The earth spikes have the following parameters:

Parameter	Value
Weight	750 g
Length	1.02 m

2.3 Connections and Controls on the Indicator Unit

The following illustration shows the connections and controls on the indicator unit:

Element	Description
1	Display
2	Knob
3	Indicator unit on/off (when pressed for long time), Backlight on/off (when pressed for short time), LED for indicating that the device is turned on (green) or that the batteries are low (red)
4	Mute on/off
5	Connection socket for sensor
6	Connection socket for headphones
7	Connection sockets for earth spikes

3 Basic Operation of the Indicator Unit

Switching on the indicator unit

The indicator unit can be switched on by briefly pressing the button. The device is ready for use after just a few seconds.

If the connection cables have already been plugged in according to the intended mode of operation, the indicator unit automatically starts in the correct mode.

Otherwise, the selection has to be made manually in the following selection screen:

If the device is not used for 10 minutes (this includes touching the sensor or telescopic handle), it switches off automatically.

Battery test

After switching on the device, you should check the battery status immediately using the charging bar in the top right corner of the display. If the bar is almost empty, we recommend that you take spare batteries with you. If the remaining battery power drops under 20%, the battery status LED next to the button as well as the battery status symbol light red.

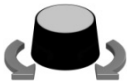
Backlight

The backlight of the display is automatically activated straight after the indicator unit is switched on. Because the unit has a transflective display, when there is enough sunlight you should turn off the backlight by **briefly pressing** the button. This extends the operating time of the indicator unit.

The backlight can be switched back on at any time by briefly pressing the button again.

Operation using the knob

Apart from a few functions (backlight, headphone mode), the indicator unit is operated solely using the knob. The functions available vary according to the current view:

Action	Function in the measurement screen	Function in the menu screen
	Opens the **menu screen**	Opens the currently selected menu item
	Adjusts the volume (“digiPHONE” mode) or the zoom level (“ESG” mode)	Selects the menu item

4 Pinpointing Cable Faults (“digiPHONE” Mode)

 CAUTION	If the volume limiter is deactivated, when listening to flashover noise, additional airborne sound and excessive amplification can lead to dangerous sound levels in the headphones!

4.1 Preparatory Measures

4.1.1 Starting Up the Surge Wave Generator

 WARNING	To pinpoint a cable fault, a surge wave generator is needed. When equipment creating such high voltages is used, certain safety regulations must be complied with. It is essential to read the surge wave generator’s manual before.

Connect the generator to the faulty wire and start applying surges with a surge voltage that will cause a flashover at the fault but which is also permitted for the cable type.

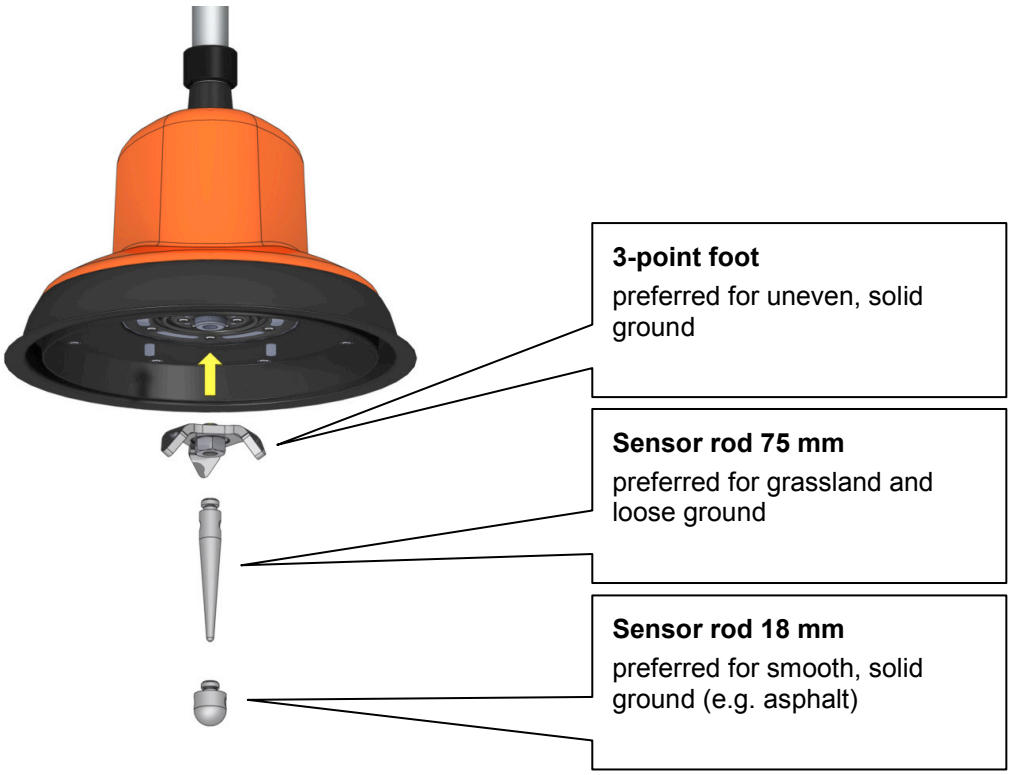
For more details about starting up the surge wave generator, please read the accompanying instructions.

For effective background noise reduction (see page 27) a stable magnetic pulse is necessary. When the surge voltage is maximised, and with it the magnetic pulse level, this generally improves detection of the flashover noise.

4.1.2 Preparing the Sensor

Fitting a suitable probe on the sensor

Three different probes are supplied with the sensor as standard (two sensor rods and one 3-point foot). They can be screwed onto the underside of the sensor to suit the ground conditions.



The 18 mm rod and the 3-point foot can both be used on smooth and solid ground. Because their acoustic qualities are different, it is for the operator to decide which probe they prefer to use on such ground.

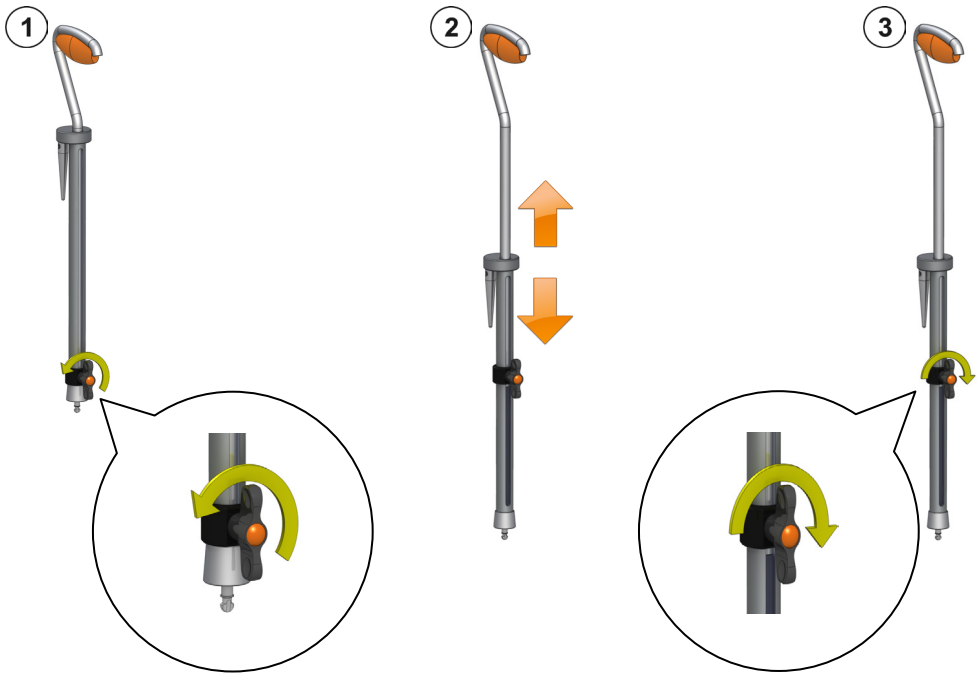
An advantage of the 3-point foot is that a sensor rod can be fitted on its underside. This means that the foot does not need to be constantly unscrewed when the ground changes.

Attaching the telescopic handle to the sensor

This is how to attach the telescopic bar to the sensor:

Adjusting the height of the telescopic handle

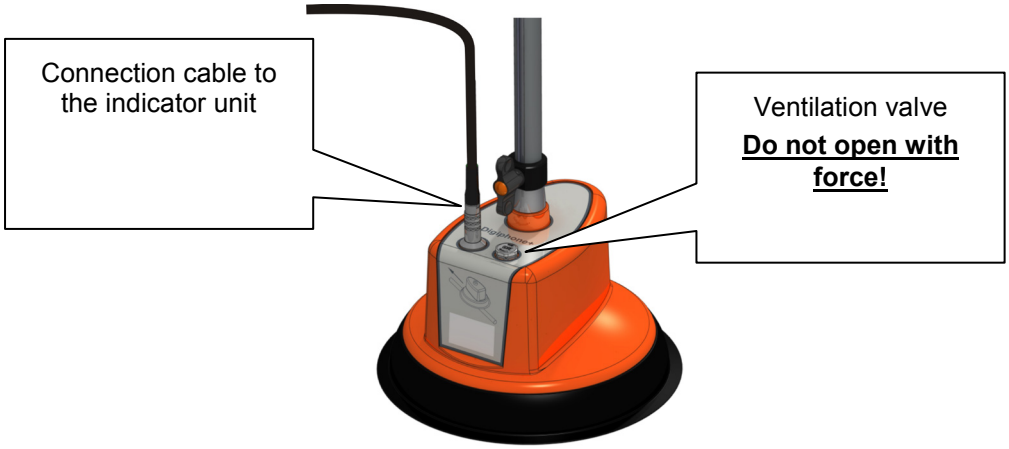
This is how to adjust the height of the telescopic handle:



4.1.3 Connecting the Sensor and Headphones to the Indicator Unit

The headphones are connected to the black socket 6 on the indicator unit. When the plug is inserted, the white markings on the plug and socket must line up. The plug has to slot into place and must not be turned!

The coiled cable supplied is used to connect the sensor. Because the plug type and pin configuration match at both ends of the cable, you can choose any cable alignment. One end of the cable is connected to the socket 5 on the indicator unit and the other end to the socket on the top of the sensor (see illustration). The plug is aligned by the guides on the plug and the grooves on the socket. You must hear and feel the plug engage.



4.1.4 Turning On the Indicator Unit

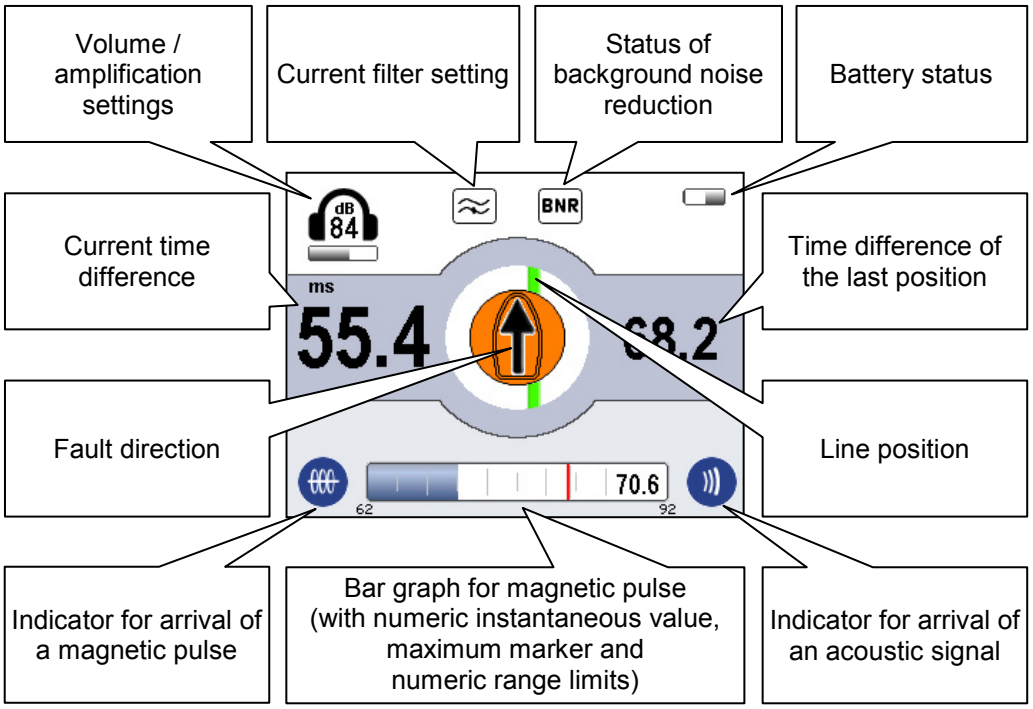
Turning on

Once the sensor unit has been connected to the indicator unit, press the button briefly to switch on. The software automatically detects the connected sensor unit and starts the correct operation mode.

Shortly after switching on, the **measurement screen** appears. The device is now ready to measure.

Layout of the measurement screen

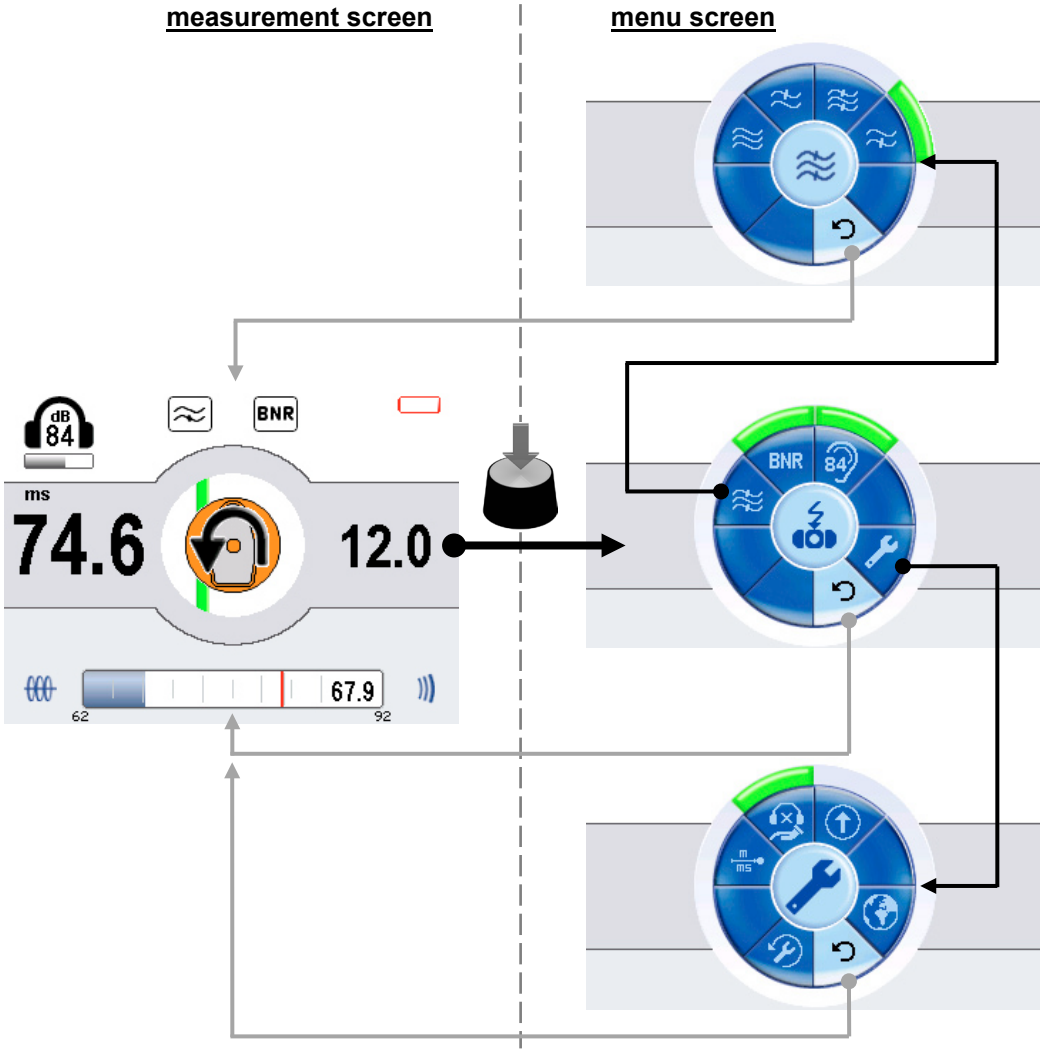
In addition to the acoustic signal in the headphones, the **measurement screen** shows all relevant information that may be useful when approaching the cable fault during the pinpointing procedure:



4.1.5 Adjusting the Settings

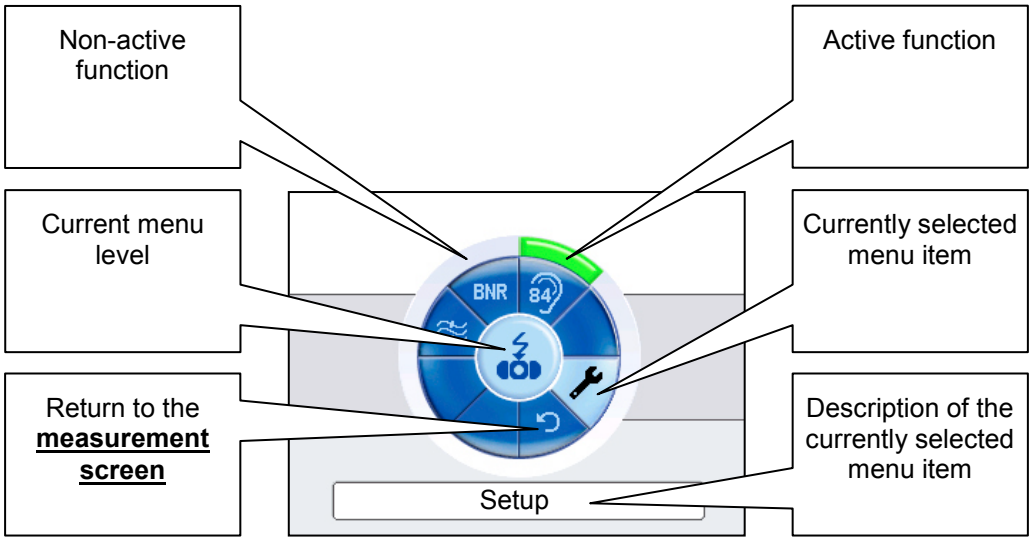
Menu structure

You can switch from the **measurement screen** to the **menu screen** at any time and change any settings in two steps at most:



Layout of the menu screens

Each **menu screen** is made up as follows:



4.1.5.1 Adjusting the Basic Settings

After the indicator unit has been switched on, you can adjust the basic settings. To do so, switch to the **menu screen** by pressing the knob and selecting the menu item . The following menu then appears in the display:

In this menu you can perform the following basic settings:

Menu item	Description
	Sets the display language.
	Sets the measuring unit. The time difference between the arrival of the magnetic pulse and the flashover noise – i.e. the distance to the fault – can be shown either directly (in **milliseconds**) or converted into a unit of length (**metres** or **feet**). To convert time to distance a constant (mean) propagation speed is taken as the basis. However, because the actual ground conditions and hence the sound propagation speed vary greatly, the distances calculated can also differ from the real values to various degrees. The distances displayed can therefore only be considered as guides!
	Activates/deactivates Automatic Proximity Mute (APM). If this function is activated, the headphones are muted as soon as the operator touches the sensor’s telescopic handle with their hand. This protects the operator from excessively loud background noise which often occurs when the sensor is moved. Alternatively, muting or unmuting can also be activated manually at any time using the button (see page 22).
	Activates/deactivates the fault direction indicator. When the fault direction indicator is activated, an additional direction arrow (see page 26) in the display signals whether the user has moved towards or away from the fault.
	Restores the factory settings.

4.1.5.2 Adjusting the Measurement Settings

By pressing the knob, you can at any time switch from the **measurement screen** to the **menu screen** with the most important measurement settings:

In this menu you can perform the following measurement settings:

Menu item	Description
BNR	Activates/deactivates Background Noise Reduction (BNR). Background noise reduction is used to make it easier to detect acoustic pulses in environments with a lot of interference. Often it is not possible to distinguish background noise caused by rain or traffic, for example, from the actual signal and this makes acoustic pinpointing more difficult.
84	Activates/deactivates the volume limiter. If this function is activated, the volume is limited to a maximum of 84 dB(A). When the volume limiter is being used, acoustic amplification should not be set too high! Excessive amplification, requiring the automatic limiter to constantly intervene, will attenuate the flashover noise. The background noise, on the other hand, would become more dominant as it is also amplified.
	Filter settings (see next page)

Filter settings

Flashover noise has its own varying sound characteristics. The sound propagation is strongly affected by the environment through which the sound travels. The sound propagation speed and the distance to the sound source influence the frequencies received by the sensor. The higher the speed and the smaller the distance, the less the high frequencies are attenuated.

This means, in practice, that on hard surfaces with a high propagation speed (such as stone slabs) a high-pitched flashover noise can be expected. In this case, reducing the less relevant low frequencies using high-pass filtering can therefore have a highly positive effect on the acoustic pinpointing process.

On sandy or soft ground on the other hand, the high frequencies will be greatly attenuated, especially when the sensor is far away from the source of the flashover noise. Accordingly, for this ground conditions, it is advised to suppress the high frequencies using low-pass filtering.

In addition, the sound characteristics can be affected by the type of connection between the sensor and transmission medium.

This frequency behaviour applies of course to the unwanted background noises as well. These are also affected by the composition of the transmission path.

Depending on the situation, you can select one of the filter settings below by pressing the knob when in the **measurement screen** and switching to the **menu screen**:

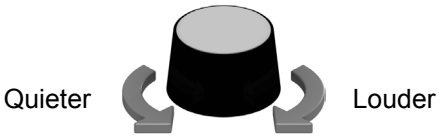
Setting	Description
Filter off	This filter setting provides the maximum bandwidth so that the flashover noise can be heard with as little distortion as possible. However, high-level low-frequency interference often occurs which makes time measurement more difficult when filtering is disabled.
Low-pass filter	Low-frequency (muffled) flashover noise, for which this filter setting is particularly suitable, mainly occurs when the distance to the fault is large and the ground is soft. Here again, low-frequency interference, not reduced by this setting, usually has a high interference level and makes the time measurement more difficult. However, reducing high frequencies can have a detrimental effect on precisely the sound characteristics of high-pitched flashover noise (hard ground, close to the fault).
High-pass filter	Low-frequency background noise is best reduced with this filter setting. High frequencies are let through completely. The sound characteristics of high-pitched flashover noise in particular (hard ground, close to the fault) are not changed very much by this.
Band-pass filter	A balanced filter setting which suppresses both low and high frequencies. Usually more suitable than the low-pass filter for measuring time. However, reducing high frequencies can have a detrimental effect on precisely the sound characteristics of high-pitched flashover noise (hard ground, close to the fault).

4.1.5.3 Volume Settings

Volume setting

To protect the operator's hearing from excessive sound levels, the volume regulator on the digiPHONE+ NT has a number of protective mechanisms.

The volume is regulated in the **measurement screen** by turning the knob.

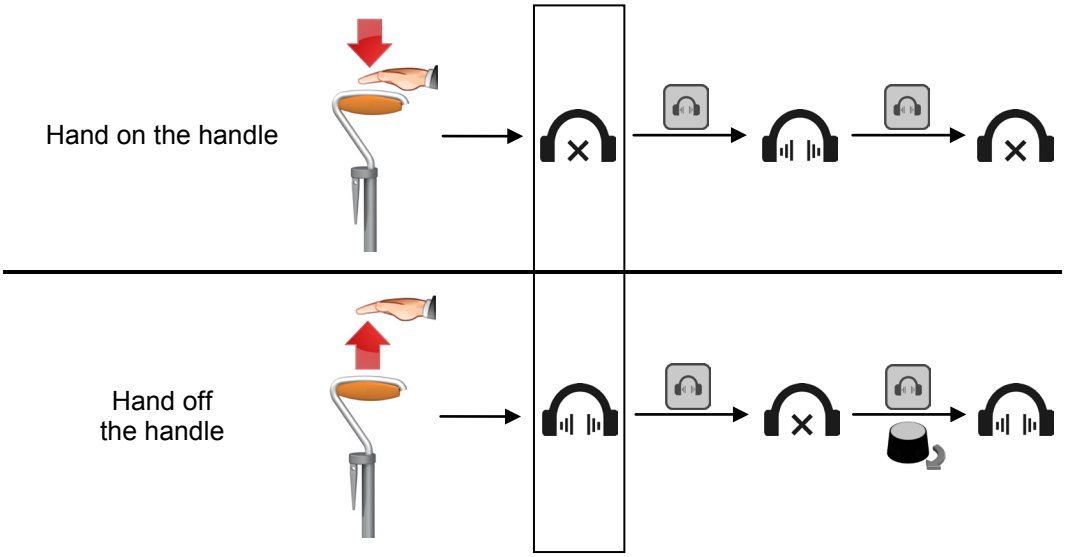


The device settings can limit the maximum sound level to 84 dB(A) through the menu item (see page 20).

Muting

The headphones can be muted at any time with the button. Muting is switched off by pressing the button again or increasing the volume.

Furthermore, the menu item in the device settings can be used to activate the Automatic Proximity Mute (APM) feature (see page 19). When enabled, muting occurs as soon as your hand touches the telescopic handle. In this mode, manual switching can of course also be performed using the button. **With APM enabled** the sequence is as follows:

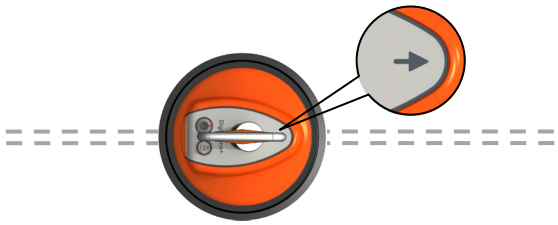
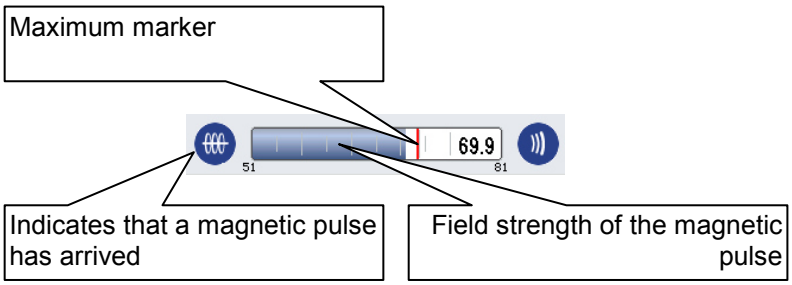


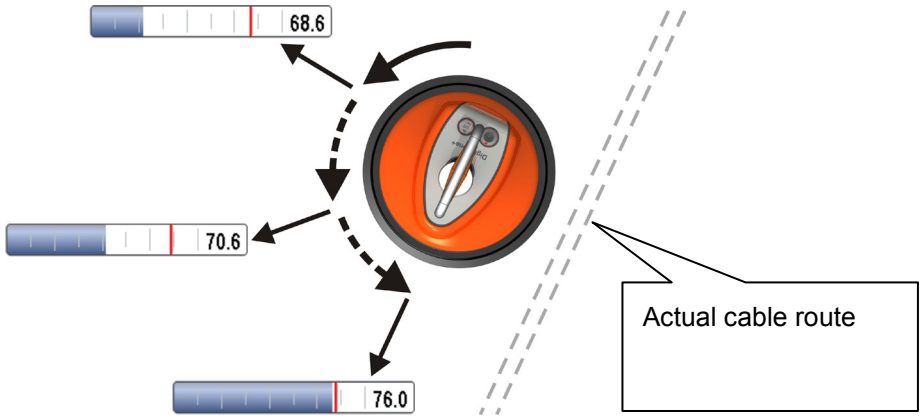
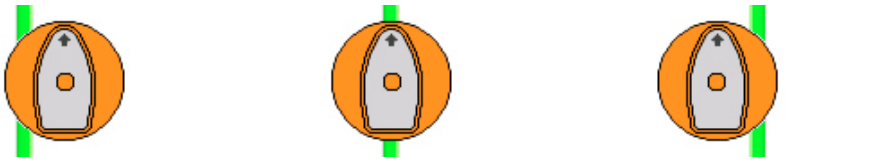
4.2 Tracing the Line

After prelocation, it is usually relatively easy to narrow down where the fault lies in the cable.

If, however, the area is large because the cable plans are inaccurate, we recommend that you trace the cable with a line location device before pinpointing, and mark its route.

On the other hand, if the area for pinpointing is not too large, all you normally need to do is find a starting position with the digiPHONE^{+} NT directly over the cable and start pinpointing from here. Please proceed as follows:

Step	Action
1	Place the sensor on the ground with the arrow pointing in the direction where you believe the cable to be running. 
2	Wait until the indicator unit signals the arrival of the magnetic pulse. 
3	Turn the sensor a little on its own axis and stay in this position until the next pulse is recorded.  Using the maximum marker and the numeric level indicator, check whether the field strength is stronger or weaker with this alignment.

Step	Action
4	Look for the position with the maximum field strength by turning the sensor slowly in time with the pulses.  In this position, the arrow on the sensor casing points along the route of the cable.
5	Keep the sensor aligned this way and observe the line position indicator. This could show the following:  The sensor is to the right of the cable The sensor is over the cable The sensor is to the left of the cable
6	Move the sensor sideways in time with the pulses (crosswise to the cable route) until the indicator shows that it is exactly over the cable. This is the starting position for pinpointing.

4.3 Approaching the Fault

4.3.1 General Notes

Technical principles

When pinpointing a cable fault with the digiPHONE^{+} NT, both the magnetic field created by the surge pulse and the flashover noise are evaluated.

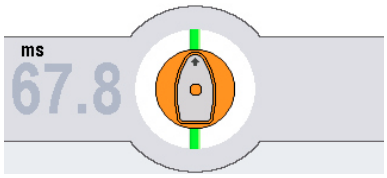
The display on the indicator unit signals when a pulse arrives (the magnetic trigger symbol light up) which helps to discern the flashover noise from the background noise in the headphones. The "coincidence" of these events enables the user to correctly identify the flashover noise when it occurs at the same time as the magnetic pulse. **The volume of the flashover noise normally continues to rise as you near the fault**.

Another indicator for the distance to the fault is the transit time difference between the magnetic pulse and the acoustic flashover signal which is shown permanently on the display.

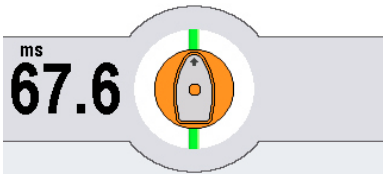
The cause of this difference is the varying propagation speed of the two signals in the ground. The magnetic field spreads at about the speed of light, whereas the propagation speed of the flashover noise is considerably less and varies according to the ground conditions. **As you approach the fault the transit time difference decreases**.

Measurement display

The time difference values logged at the current position are always shown on the left-hand side of the display. The values are shown either in grey or black according to the following agreement:



The most recently taken measurement is either the first measurement at a new position or it deviates by more than 10% from the previous measurement



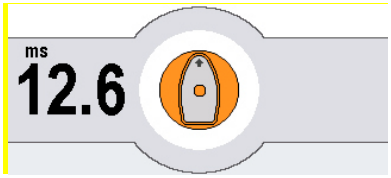
The most recently taken measurement deviates by less than 10% from the previous measurement

If due to constant fluctuations the measurement values are shown only in grey for a longer dwell time, it is recommended to carefully listen to the audio signal. Also, if no periodic acoustic signal can be made out here, it is highly probably that the distance to the fault location is simply too great.

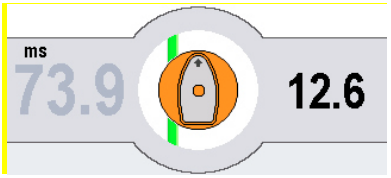
Position change

A change of position is recognised automatically by the sensor and should, if possible, only be carried out when the current measurement value is shown in black (see above). Only in this case is this last measurement value moved to the right-hand side of the display and regarded as a comparison value at the new position.

The first measurement at a new position is always displayed in grey.



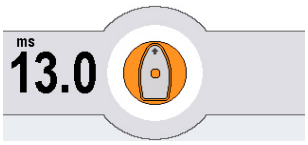
Before position change



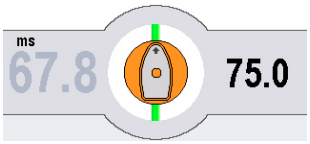
After position change

How to read the direction indicator

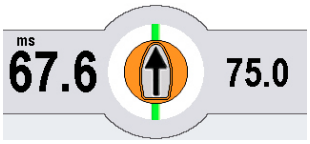
The direction indicator, which can be enabled or disabled through the ⓣ menu item in the device settings (see page 19), shows whether the user has moved towards or away from the fault. This message results from a comparison between the last measured time difference of the previous position and the current time difference. The direction indicator can have the following states:



no information
In the previous position a transit time difference and therefore a comparative value could not be measured

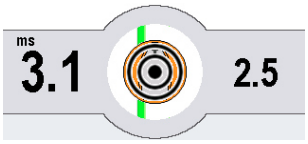


no information
The most recently taken measurement deviates by more than 10% from the previous measurement and is not considered for a direction indication



closer to the fault
The last change in position decreased the distance to the fault

further from the fault
The last change in position increased the distance to the fault



in close proximity to the fault
The last two readings indicate that the sensor is placed near the fault position

When pinpointing faults using the direction indicator, you must **always move forwards** with the sensor (in the direction of the arrow on the sensor). If the direction indicator tells you to turn round, you must indeed turn 180° along with the sensor!

How staying in one position affects background noise reduction

When background noise reduction (see page 20) is switched on, the digiPHONE^{+} NT gathers and analyses information about the interference and signal level. After the first surge pulse from the fault arrives, this information is used to suppress the background noise. Further information is gathered with each additional pulse and the reduction is constantly improved. The longer therefore the operator stays at a position with the sensor receiving pulses, the less audible the interference becomes.

Each time the sensor is moved, the information gained about the background noise is discarded. After each position change, the level analysis starts afresh when the first surge pulse arrives.

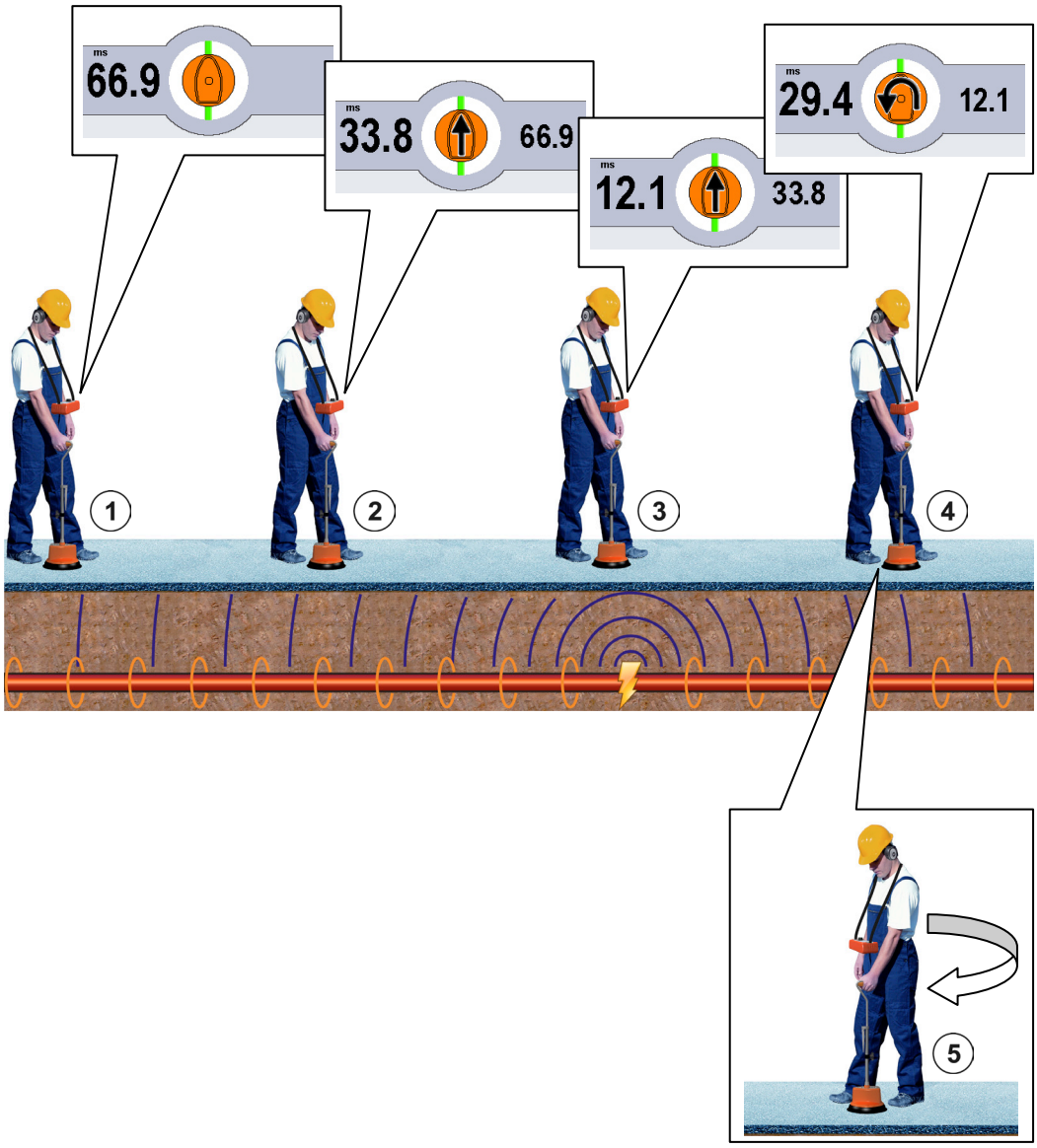
The current status is indicated by a symbol on the top of the display (assuming background noise reduction is enabled in the device settings).

After the sensor is moved, there is no information to analyse yet. Background noise reduction is not in operation.

Information collected is being used to reduce background noise.

4.3.2 Procedure

Diagram The following is an example of how the indicators (transit time / direction indicator) change as the operator nears and goes past the fault:



Procedure This is what to do when approaching the fault:

Step	Action
1	Place the sensor at the starting position (see page 23).
2	If the sensor unit cannot pick up an acoustic signal at this position (the trigger symbol lights up), follow the route until there is an acoustic trigger. Keep a constant eye on the level of the magnetic pulse and line position shown and, if necessary, correct the alignment (see page 24). When the first useful acoustic signal is detected, the transit time difference (or corresponding distance) is shown on the left of the display (position (1) in the example). If no acoustic signal can be picked up using the sensor or the headphones even over a longer section, you should try to continue the search in the other direction (from the starting position).
3	Remain in this position for a few pulses to allow the background noise reduction (see page 27) to improve the accuracy of the measurements and the acoustics.
4	Continue along the cable route one step at a time (correcting the alignment if necessary) and stay for a few pulses in each position. As you near the fault, the transit time difference (distance) shown decreases continually and the direction indicator signals that the change in position is ‘positive’ (– positions (2) and (3) in the example). When you go past the fault, the transit time difference (distance) suddenly rises again. The direction indicator signals that the measurement has risen (– position (4) in the example).
5	Turn 180° (position (5) in the example) and move towards the fault again **taking smaller steps**.
6	Establish the position of the minimum absolute reading as accurately as possible and mark it.

Practical tips

If you are unsure whether a noise is an acoustic flashover noise or just a repeating background noise, we recommend “resetting” background noise reduction by lifting the sensor briefly and putting it down again. If you then detect a similar noise again during magnetic triggering, it is very likely to be the acoustic flashover noise.

‘Knocking’ can occur inside the installation pipe when the cable strikes the pipe wall or adjacent cable because of the surge energy. This noise spreads from the point where the pipe meets the soil up to the surface, meaning that this could be mistaken for the position of the fault.

You will know that this is a ‘phantom fault’ because the magnetic level (bar deflection) does not - as is usual with a real fault - drop considerably directly after you pass the position. Instead, the magnetic level remains virtually unchanged up to and beyond the fault.

Sometimes, the magnetic signal from the actual target line crosses over to an adjacent line and this adjacent line is displayed by the direction indicator. The operator could then even end up following the wrong line.

We therefore recommend that you trace and mark out the exact route of the cable before pinpointing the fault, especially for areas where there are numerous buried cables. To be completely sure, you should trace the route using a special transmission frequency (e.g. “SignalSelect” mode in the Ferrolux series).

4.4 Completing the Work

After the cable fault has been successfully pinpointed, the indicator unit can be turned off by pressing the  button **for 3 seconds**.

Afterwards, the surge wave generator can be switched off and disconnected from the cable under test while making sure that all applicable safety regulations are followed.

5 Pinpointing Sheath Faults („ESG“ Mode)

5.1 Preparatory Measures

5.1.1 Tracing the Line

Trace the route of the faulty cable as exactly as possible in the pre-located area using a line location device. Knowledge of the exact cable route makes it far easier to pinpoint the sheath fault.

5.1.2 Starting Up the DC Impulse Generator

 WARNING	To pinpoint a sheath fault, a DC impulse generator is needed. When equipment creating such high voltages is used, certain safety regulations must be complied with. It is essential to read the manual for the DC impulse generator!

For a DC impulse generator, any equipment and system can be used which can be prepared for pulsed DC voltage to locate sheath faults. This particularly includes equipment from the MFM series, but also various other testing and fault location systems.

Connect the DC impulse generator to the screen of the faulty cable and generate a pulsed DC voltage permissible for the type of sheath.

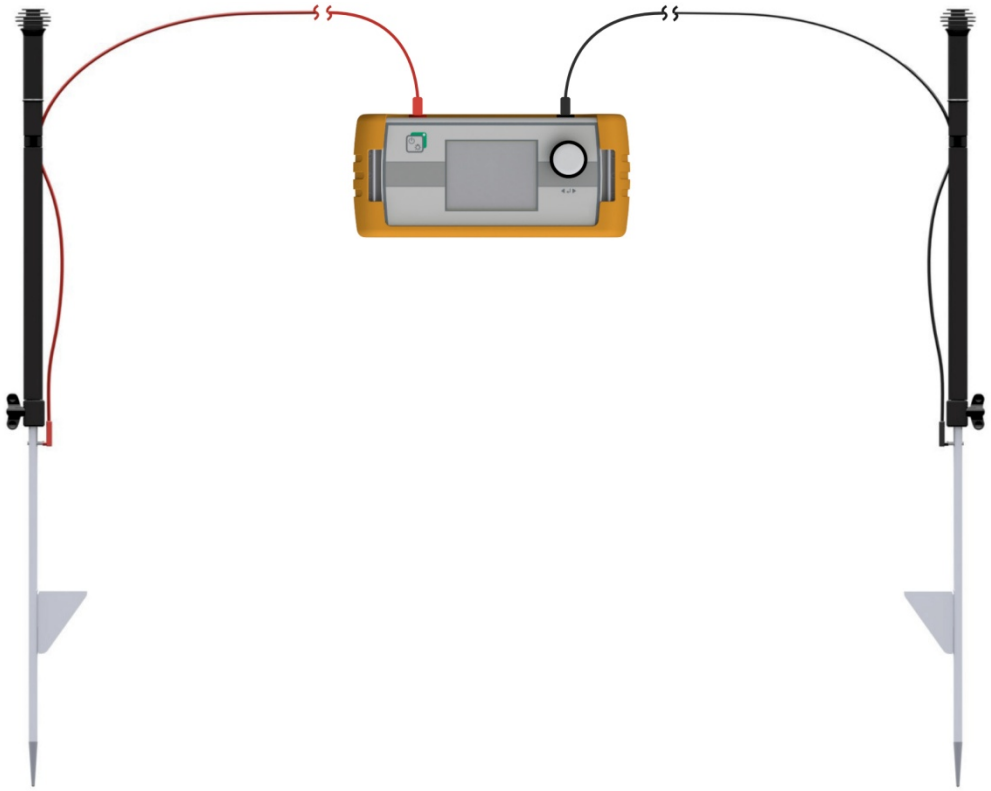
For more details about starting up the device, please read the accompanying instructions.

5.1.3 Connecting the Earth Spikes

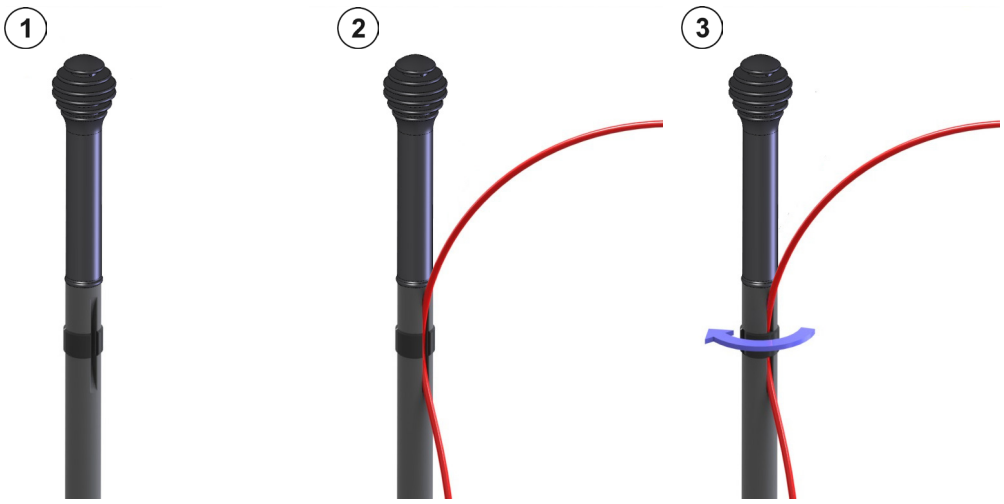
CAUTION	The cables supplied with the unit may only be used in accordance with their intended purpose, which is to connect the earth spikes to the indicator unit!

CAUTION	**Hold the earth spikes by the insulated handles only** In the immediate vicinity of the potential gradient dangerous voltages may occur at the surface. The displayed voltage values are not suitable to draw a conclusion about the actual risk.

When connecting the earth spikes, observe the designated colours of the connection cable and connection socket!



To avoid switching back and forth or even accidently pulling out the cable while operating, it is advisable to attach the cable to the earth spike as shown in the diagram:



In applications in which it was only possible to pre-locate the fault position very vaguely, or even where it was not possible at all, you will have to approach the position from a greater distance. However, to be able to measure the smaller step voltage, the earth spikes need to be placed at larger intervals from one another (see page 39). For this purpose, customised connection cables of 15 metres in length are available as accessories.

5.1.4 Turning On the Indicator Unit

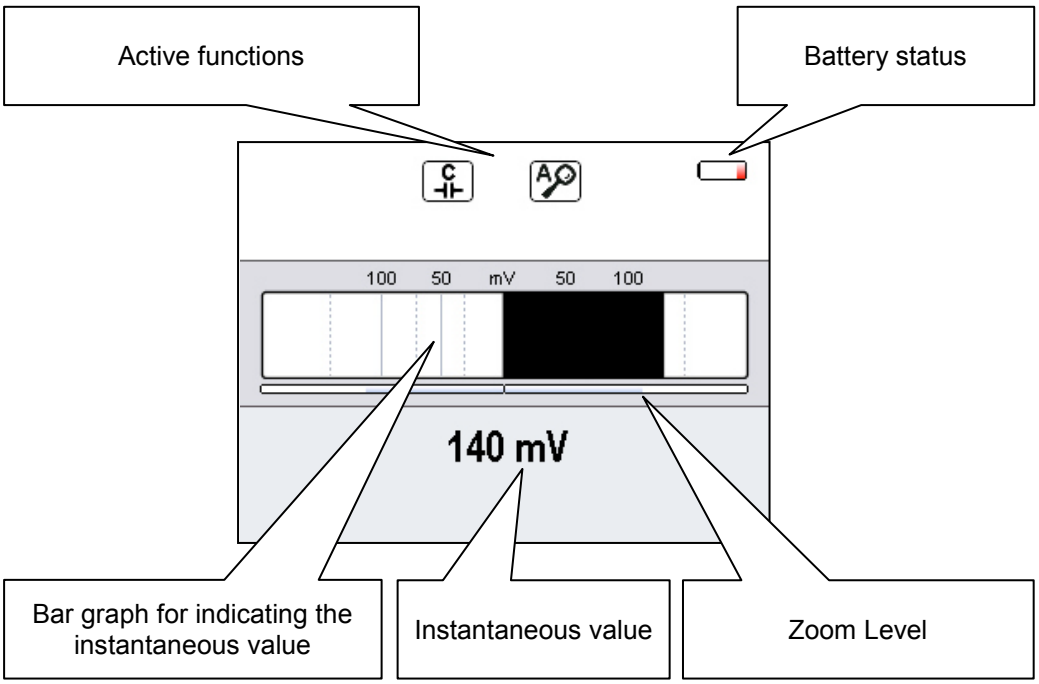
Turning on

Once the earth spikes are connected to the indicator unit, press the button briefly to switch on. The software automatically detects the connected earth spikes and starts the correct operation mode.

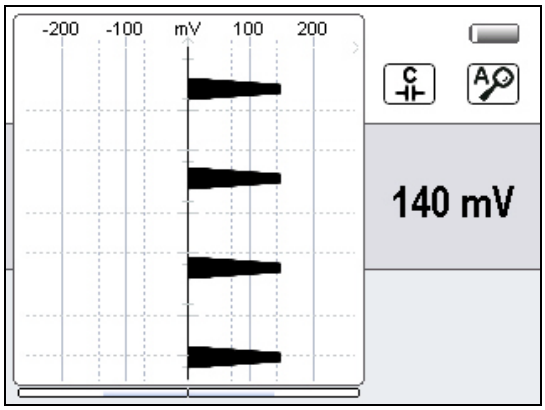
Shortly after switching on, the **measurement screen** appears. The device is now ready to measure.

Layout of the measurement screen

While you are pinpointing, the **measurement screen** displays all the relevant information which could be useful when approaching the sheath fault:



As well as this standard display, the device offers an alternative for showing the time progress of the step voltage over 16 seconds.

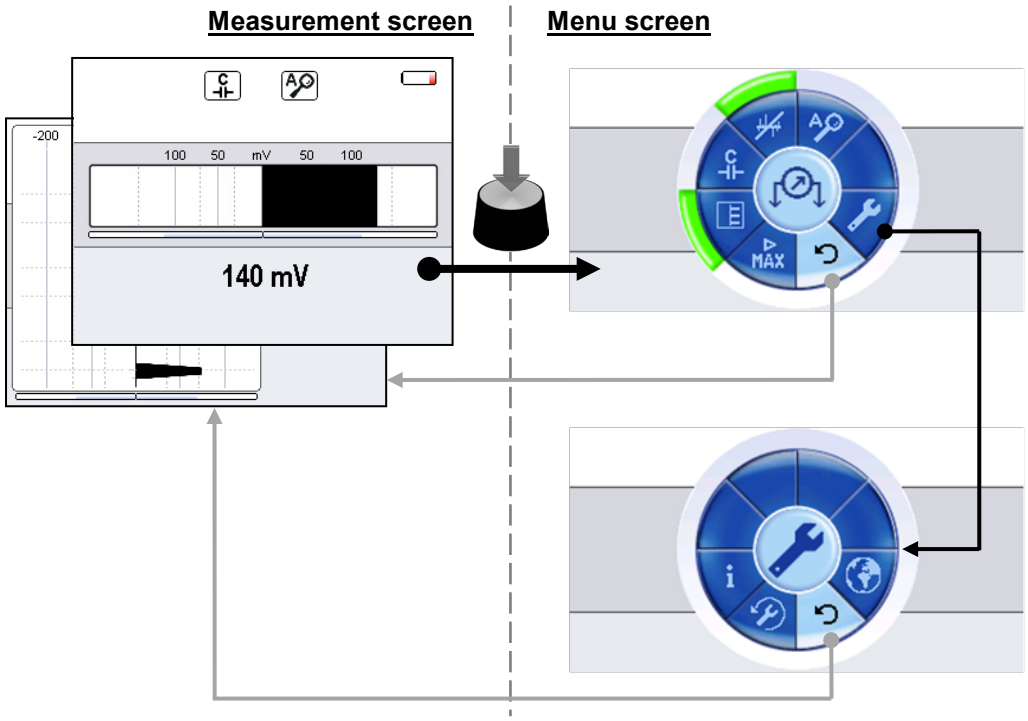


This alternative display can be activated or deactivated at any time via the menu item (see page 36).

5.1.5 Adjusting the Settings

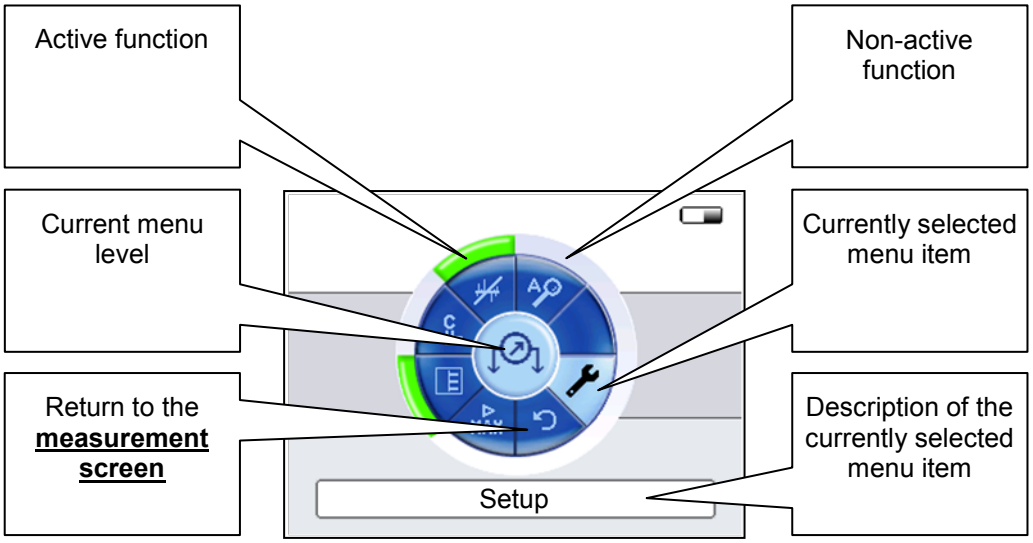
Menu structure

You can switch from the **measurement screen** to the **menu screen** at any time and change any settings in two steps at most:



Layout of the menu screens

Each **menu screen** is made up as follows:



5.1.5.1 Adjusting the Basic Settings

After the indicator unit has been switched on, you can adjust the basic settings. To do so, switch to the **menu screen** by pressing the knob and selecting the menu item . The following menu then appears in the display:

In this menu you can perform the following basic settings:

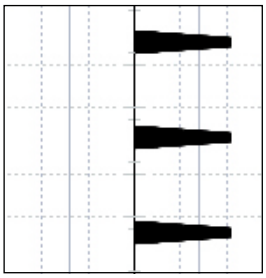
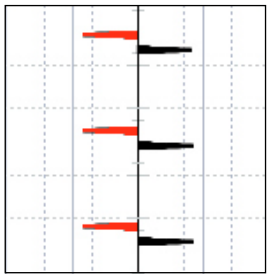
Menu item	Description
	Sets the display language.
	Restores the factory settings.
	Shows the current software version of the indicator unt.

5.1.5.2 Adjusting the Measurement Settings

By pressing the knob, you can at any time switch from the **measurement screen** to the **menu screen** with the most important measurement settings:

In this menu you can perform the following measurement settings:

Menu item	Description
	Activating/deactivating the alternative measurement screen (see page 34) with a display for the time progress of the voltage.
	Activating/deactivating the automatic zoom. If this function is active, the scale of the voltage display automatically adapts to the current measurements all the time. The knob does not have a function in this case. If the function is deactivated, the scale needs to be adjusted manually by turning the knob. The currently set zoom level is permanently displayed in a small bar below the bar graph or diagram (see page 34).

Menu item	Description
C	Activating/deactivating the high passfiltering. Select this function if severe interference affects the measurements (such as in the vicinity of tram installations). The high pass filter suppresses any constant components, whereby only the edges are displayed but not the impulse itself. This is why the device has different indications with active high pass filtering. Each DC pulse causes two deflections at different polarity, where the first indicates the start of the impulse and the second indicates the end. The first deflection indicates the direction of the fault position. **without high pass filtering** **with high pass filtering**  
	Activates/deactivates the smoothing filter. When the smoothing filter is activated, sudden signal peaks which are not part of the actual signal are suppressed.
MAX	Activates/deactivates the maximum sensitivity. By default, the sensitivity of the volt meter is limited to measurement values >1 mV. In this way, low interference signals are ignored by the system and unnecessary adjustments of scaling are avoided. If it becomes necessary to begin fault location at a greater distance from the sheath fault, the useful signal in certain circumstances is barely above noise level. In these situations the maximum sensitivity should be activated and the measurement range be expanded downwards to 5 µV.

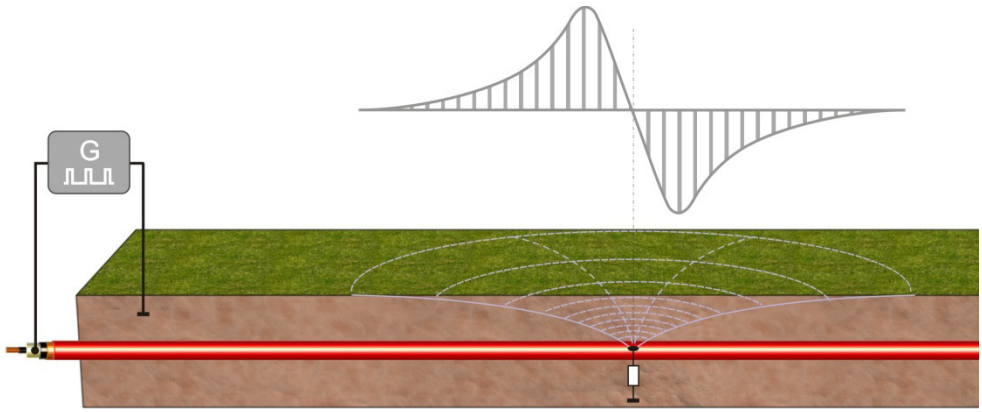
5.2 Approaching the Fault

5.2.1 General Notes

Technical principles

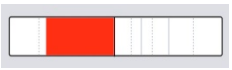
With each coupled DC pulse, current flows into the ground at the position of the fault, which forms voltage gradients around the fault position.

The step voltage, which can be measured on the surface, increases at the fault position and changes polarity directly above the location.



This particular effect is most beneficial for pinpointing sheath faults, by measuring the value as well as the polarity of the step voltage using two earth spikes and approaching the deflection direction following the fault position.

The sheath fault is located in the direction of the earth spike which is connected with the black measuring lead

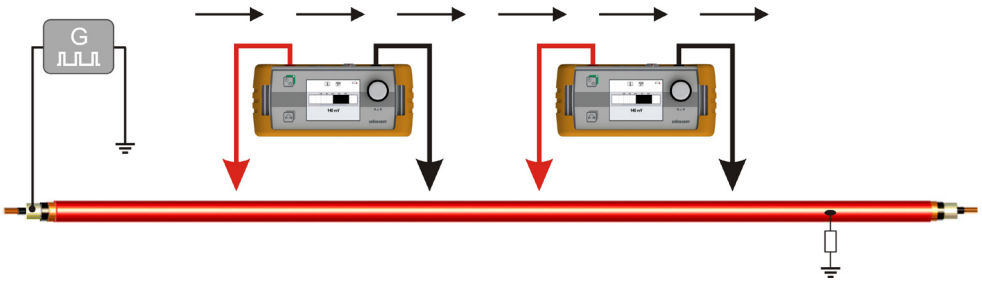


The sheath fault is located in the direction of the earth spike which is connected with the red measuring lead

Orientation

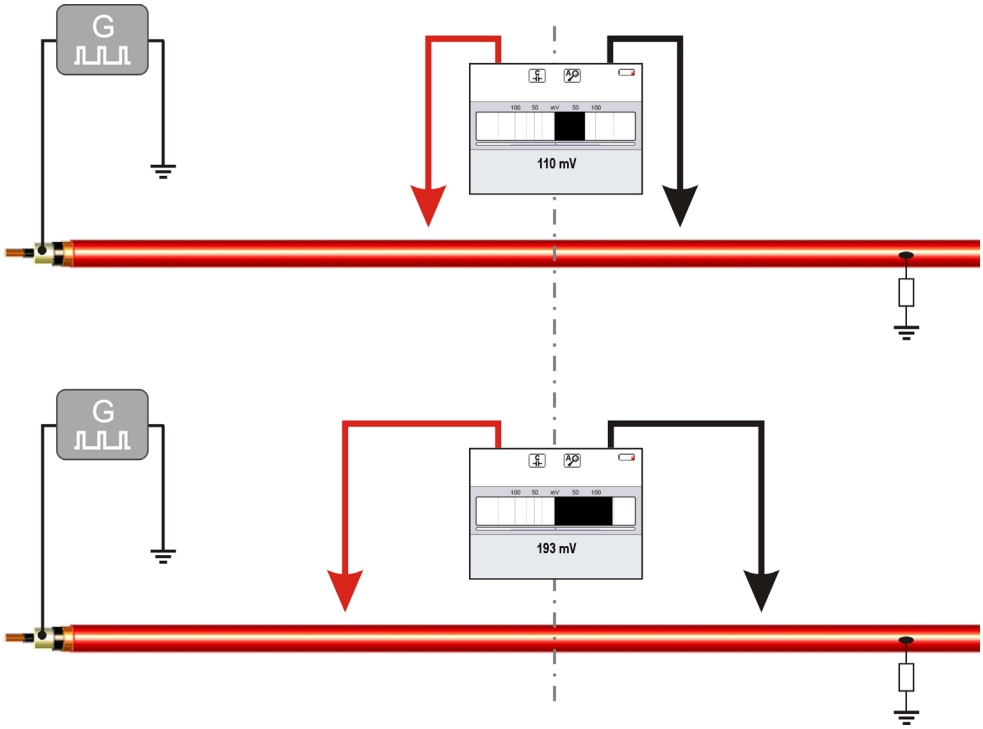
To ensure a reliable indication of the direction, note the following guidelines for basic handling:

- The earth spikes should be placed along the suspected cable route if possible.
- The indicator unit must be kept in a horizontal position along the cable run.
- **While approaching the fault location, the earth spikes must not get mixed up and the alignment of the indicator unit must not change.**



Distance between the earth spikes

The distance between the earth spikes directly affects the step voltage reading. If the distance increases, the potential difference between the two earth spikes rises and therefore the voltage reading shown on the indicator unit as well.



Particularly when you start pinpointing, it is advisable to place the earth spikes at larger distances from each other so that the generator impulse can be identified as clearly as possible, even at greater distances to the fault location.

If, for example, precise pre-location was not possible due to multiple faults, the maximum possible distance is sometimes not enough to measure the impulses due to the connection cables. In this case, a connection cable (or both, in extreme cases) can be replaced with a longer one. This would require a second person to speed up the work!

Impact of ground conditions

The ground conditions have a huge effect on the electrical coupling and the precision of the system.

Changing coupling behaviour while pinpointing can, for instance, cause the measured voltage to drop even when approaching the fault position.

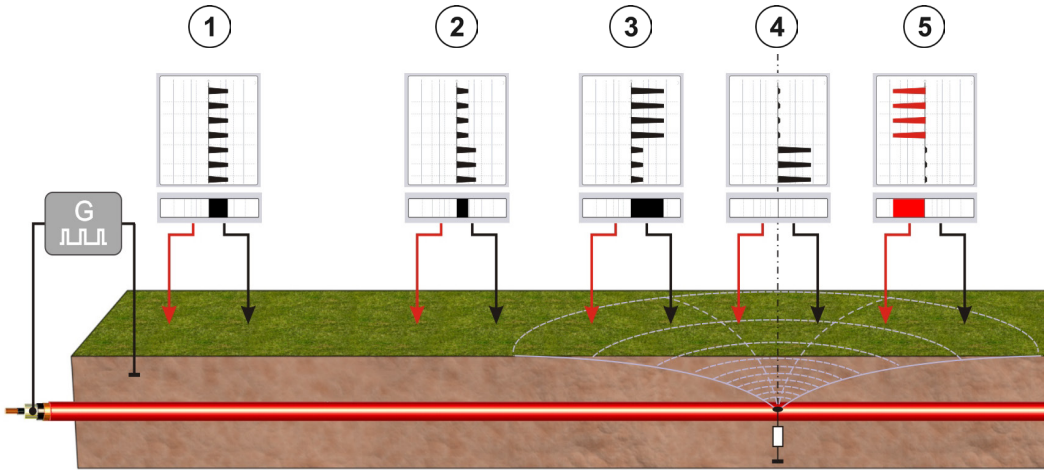
Dry asphalt ground acts as an insulator and does not provide sufficient earth contact for the earth spikes. In this case pinpointing can also be performed in parallel to the cable route on more suitable ground, as the voltage gradients do also spread to the side.

In densely built-up urban areas, the gaps between the ground and paving stones can also be used to attach the earth spikes.

If none of the above alternatives is feasible, the earth contact may be improved by means of the included sponge. For this, the sponge have to be moistened first and then sticked to the pointy end of the earth spikes.

5.2.2 Procedure

Diagram In the following picture you can see several points of an ideal signal route from the feeding point to the fault position and beyond:



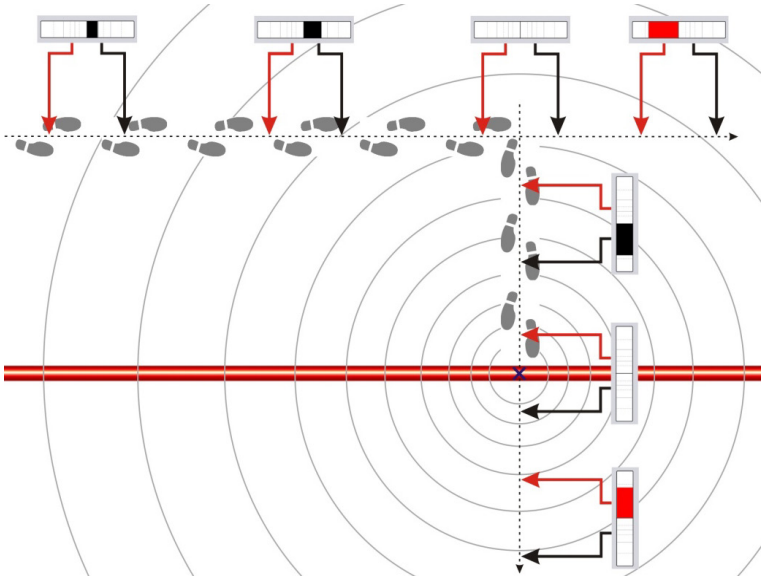
As voltage gradients induced by the current flowing back from the fault position exist around the earthing point of the generator, the measurement values near this point might be elevated (position 1). However, the deflection direction (polarity) also indicates the direction of the fault position at this point.

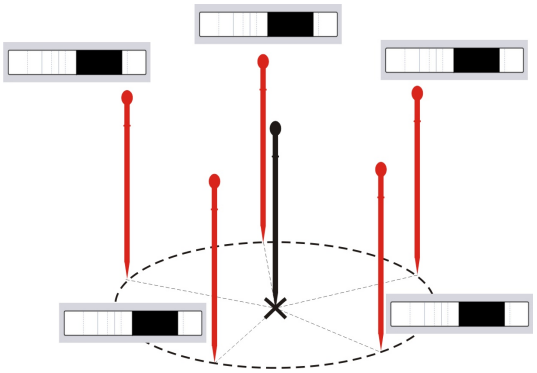
At half-way point between the generator and the fault position, the signal strength reaches a minimum (position 2). On moving nearer to the fault (position 3), the signal strength increases again. The maximum signal strength is measured when one of the earth spikes is directly above the fault.

If the fault is exactly between the two earth spikes or exactly to the side (position 4), the indicator unit does not display a reading.

If the fault position is passed by, the polarity changes (position 5). The signal on the indicator unit points to the other direction.

Procedure This is what to do when approaching the fault:

Step	Action
1	Find a suitable place to start on the ground directly above the traced cable route or to the side. Insert the two earth spikes in the correct alignment positions (see page 38) into the ground.
2	Observe the signals on the indicator unit and try to identify the impulse signal of the generator. • Adjust the scale of the display to the signal level by turning the knob or activate the automatic scaling (see page 36). • If necessary, increase the distance between the earth spikes to receive a stronger signal level. • If the DC impulse of the generator is masked by interference, try to counter the interference by using some of the available filter functions (see page 37). • Switching to the alternative view which shows the voltage curve over the last 16 seconds (see page 36) could make identifying the periodical DC voltage impulses easier.
3	Follow the cable route in the direction of the signal without changing your orientation. Take some more measurements every few metres. When approaching the fault position, the distance between the earth spikes can be gradually decreased by up to about one metre with increasing signal levels. Continue approaching until the signal suddenly changes its polarity and indicates the opposite direction.
4	Go back slightly and measure the signal level at smaller intervals. Determine the position at which the opposing currents compensate each other and at which there is no signal level indicated.
5	To correct any possible lateral offset, insert the two earth spikes at an angle of 90° to the cable route and determine the zero point for the second coordinate by further measurements. 

Step	Action
6	Place the black earth spike on the suspected position of the fault and the red earth spike about one metre away. The signal must now point in the direction of the black earth spike. Repeat this control measurement at several other positions in a circle around the black earth spike.  If the signal level indicates towards the black earth spike at each control measurement, the fault position has been successfully verified.
7	Repair the damaged section and test the sheath again for any further damage.

5.3 Completing the Work

After the sheath fault has been successfully pinpointed, the indicator unit can be turned off by pressing the button **for 3 seconds**.

Afterwards, the DC impulse generator can be switched off and disconnected from the cable under test while making sure that all applicable safety regulations are followed.

6 Storage and Transport

Long periods out of use and storage

If you do not expect to use the unit for over a month, you must remove the batteries and store them separately.

You should store the device in a dry and sheltered environment which provides adequate protection against mechanical damage and dirt. The storage temperatures shown in the technical data must be adhered to.

Transport

Only use the carry-bag supplied to transport the device. Please note that the ambient conditions along the entire transport route must comply with the technical data.

During transport, never hold the device by the connection cables only!

7 Maintenance and Care

Changing the batteries

To change the 6 x 1.5 V AA batteries, you must undo the two screws on the underside of the indicator unit by a quarter of a turn (e.g. using a coin) and then take off the battery compartment cover.

NiMH rechargeable batteries (AA type) can also be placed in the battery compartment. However, they must be charged using an external charger.

Caring for the display

Do not clean the display with aggressive products such as solvents or spirits.

Instead, use lukewarm water and a soft, lint-free cloth for wet wiping, or a microfibre cloth for dry wiping.

Lock of the telescopic handle

After a few years of intensive use, the quarter turn lock of the telescopic handle can show signs of wear and tear which will lead to a worsening of the support for the sensor.

If this is the case, you can either send the telescopic handle to an authorised service centre, or you could order a quarter turn lock as a replacement part (article number: 128309580) and carry out the replacement yourself.

If you choose to carry out the repair independently, you must first loosen the union nut (1) at the lower end of the handle by using a spanner with a rim width of 22 mm. After that has been done, the quarter turn lock (2) may be removed and replaced.

Before being re-assembled, the thread (3) of the telescopic handle should be moistened with a liquid thread locker (medium strength; e.g. Loctite 243). To align the lock correctly and to secure it against rotation, the slit at the head of the quarter turn lock must engage with the guide link (4).