



USER MANUAL

CABLES AND UNDERGROUND INFRASTRUCTURE LOCATOR

LKZ-2500

LKN-2500 • LKD-2500 • LKR-2500 • SONEL LKZ MOBILE

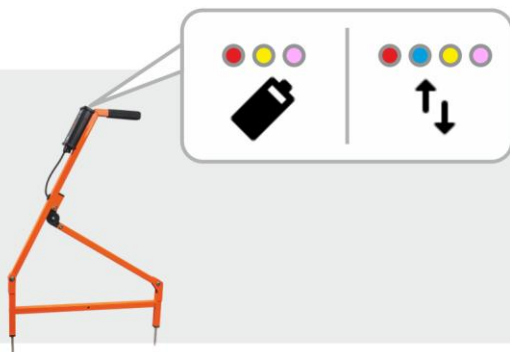
LKN-2500



LKD-2500



LKR-2500





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Version 2.00 16.04.2026

LKZ-2500 is a modern, high quality measuring system, easy and safe to use. Reading and using of this manual will help to avoid errors in measurements and prevent possible problems when operating the instrument.



This manual describes the firmware version:

- LKN-2500: >2.00,
- LKD-2500: >1.116,
- LKR-2500: >1.00.

The minimum version of the Sonel LKZ Mobile application compatible with the above-mentioned devices is 1.1.0.

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1 General information

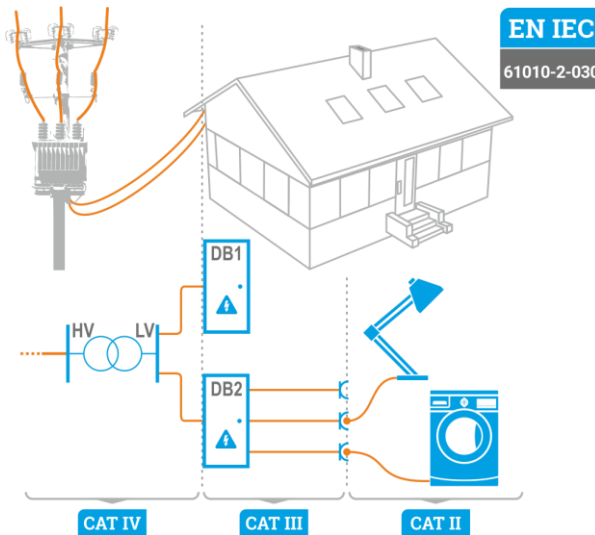
1.1 Safety symbols

The following international symbols are used in the device and/or in this manual:

	Warning. See explanation in the manual		Attention, risk of electric shock		Double insulation (protection class)
	Fuse		Declaration of Conformity with EU directives (Conformité Européenne)		Do not dispose of with other household waste

Measurement categories according to EN IEC 61010-2-030:

- **CAT II** – concerns measurements performed in circuits directly connected to low voltage installations,
- **CAT III** – concerns measurements performed in buildings installations,
- **CAT IV** – concerns measurements performed at the source of low voltage installation.



1.2 Behaviour of signalling LEDs



The LED is on continuously



The LED flashes slowly



The LED flashes rapidly

1.3 Safety

In order to provide conditions for correct operation and the correctness of the obtained results, the following recommendations must be observed:

- Before you proceed to operate the system, acquaint yourself thoroughly with the present manual and observe the safety regulations and specifications provided by the producer.
- Any application that differs from those specified in the present manual may result in a damage to the system and constitute a source of danger for the user.
- The LKZ-2500 system must be operated only by appropriately qualified personnel with relevant certificates authorising the personnel to perform works on electric systems. Unauthorized use of the system may result in its damage and may be a source of serious hazard to the user.
- Before connecting the system to power cables, they must be discharged.
- Using this manual does not exclude the need to comply with occupational health and safety regulations and with other relevant fire regulations required during the performance of a particular type of work. Before starting the work with the system in special environments, e.g. potentially fire-risk/explosive environment, it is necessary to consult it with the person responsible for health and safety.
- It is unacceptable to operate the device when:
 - ⇒ it is damaged and completely or partially out of order,
 - ⇒ its cords and cables have damaged insulation,
 - ⇒ it has been stored for an excessive period of time in disadvantageous conditions (e.g. excessive humidity). If the device has been transferred from a cool to a warm environment with a high level of relative humidity, do not start measurements until the device is warmed up to the ambient temperature (approximately 30 minutes).
- Do not leave unconnected conductor, while the other is connected to the tested network.
- Do not leave unattended device connected to the tested circuit.
- Do not operate the transmitter with open or incorrectly closed battery compartment and do not power it from other sources than those specified in this manual.
- Repairs may be performed only by an authorised service point.



WARNING

Disconnecting the protective conductor is a life hazard for the staff tracing the wires and also for bystanders. Wherever possible you must first disconnect the supply voltage and the phase cable(s). Be particularly careful when removing the protective conductor or the grounding of neutral wire from the system, which must be energized. Ensure that there are no bystanders in the danger area. When the tracing is completed, the connection of the protective conductor or grounding of the neutral conductor MUST be reconnected.



NOTE!

The LKN-2500 transmitter is not intended for direct operation under voltage.



Due to continuous development of the device, its features described in this manual may differ from the actual state.

2 Quick start

1

LKD / LKR



Attach the holder or the **LKR-2500** detector (A-Frame) to the **LKD-2500** detector.

2

LKD / LKR



Turn on the **LKD-2500** and/or **LKR-2500** (A-Frame).

3

LKZ Mobile



Pair the **Sonel LKZ Mobile** application with the detector (see **sec. 4**). Enter routing settings.

4

LKN



Turn on the **LKN-2500** transmitter. Enter the settings for the transmitted signal.

5

LKN



Pair the **LKN-2500** with the tested object. Start transmitting the signal.

6



Perform routing and/or fault detection. Observe the readings in the **Sonel LKZ Mobile** application.

7



Turn off all devices.



- Settings for the auto-off time in the LKN-2500 – see **sec. 3.3.3**.
- Enabling the transmission of dual-frequency signals in the LKN-2500 – see **sec. 7.2**

3 Description of the system

3.1 Main features of the system

- Working with energized or non-energized objects.
- Work in passive and active mode.
- 3 methods of active work.
- Detection of cables and infrastructure in the ground.
- Cable and infrastructure routing.
- Detection of cable faults and infrastructure detection.
- Recording the route of the routed object.
- Sharing route files with other users of the Sonel LKZ Mobile application.

3.2 Principle of system operation

LKZ-2500 is a system consisting of:

- LKN-2500 transmitter,
- LKD-2500 detector,
- LKR-2500 detector (A-Frame),
- Sonel LKZ Mobile application,
- other necessary accessories.

LKN-2500 transmitter injects a locating signal into an underground object. **LKD-2500 detector** placed along the object traces this signal along the object while **LKR-2500 detector** (A-Frame) enables the detection of underground groundings. The information about position of the traced object/fault is displayed on the **Sonel LKZ Mobile app** which is connected with the detector. Determination of the object's route and/or the location of the fault is possible based on observation of compass readings and the level of the detected signal.

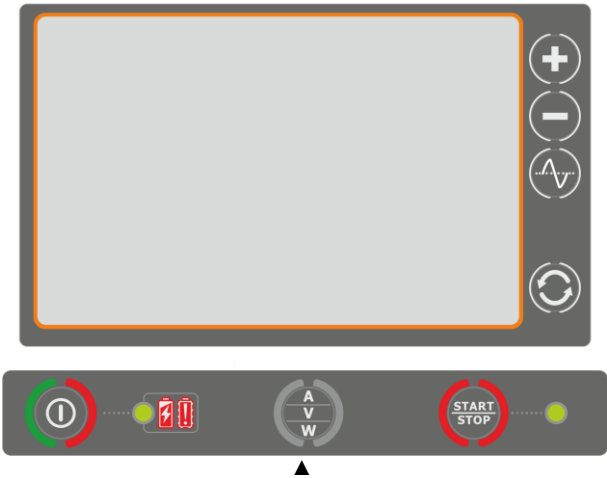
The system has the ability to trace cables and record routes and fault locations via the mobile application. Such files can be exported and shared with other users – including those who do not have the LKN-2500 / LKD-2500 / LKR-2500 device.

The system is capable of operating in passive mode (without the use of the LKN-2500 transmitter) and active mode (with the use of the LKN-2500 transmitter). The active mode allows to introduce the signal in three different methods:

- **galvanic** – injects tracing signal into the object directly, through crocodile clips and test leads,
- **clamp** – injects tracing signal into the object through an inductive clamp,
- **inductive** – injects tracing signal into the object inductively, using the instrument's internal antenna.

3.3 Transmitter LKN-2500

3.3.1 Buttons on the housing



- Turn on the device (press briefly)
- Turn off the device (press and hold)



Method of displaying parameters of the transmitted signal: amperes / volts / watts / resistance



Start/stop signal transmission



Increase the signal strength



Decrease the signal strength

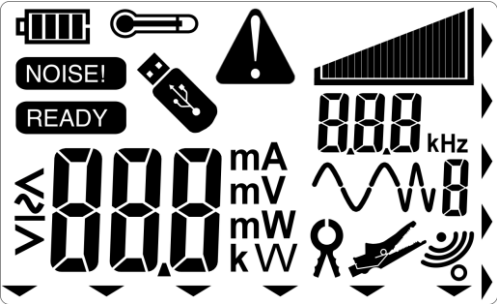


Select the signal frequency



Set the method of connecting the transmitter to the routed object

3.3.2 Display



	Charging the battery
NOISE!	Interference detected in the connected object
READY	The device is ready to transmit a signal
	Warning: the meter temperature is higher than permissible
	USB memory connected to the instrument
	Error/warning/information
	Strength of the transmitted signal.
	Strength of the transmitted signal.
	The frequency of the transmitted signal
	Shape and number of the transmitted signal.
	Inputting a signal into an object: clamp method
	Inputting a signal into an object: galvanic method
	Inputting a signal into an object: induction method
	Indicates a button on the instrument housing

3.3.3 Time settings for automatic shutdown (auto-off)

1



Press and hold down  button to turn on the meter. Release  only when the settings screen appears.

2



Enter the time after which the device will automatically turn off.

3



Confirm the settings with the **START/STOP** button.

3.4 LKD-2500 Detector

3.4.1 Buttons on the housing



- Turn on the device (press briefly)
- Turn off the device (press and hold)

3.4.2 Handles



LKD-2500 with a long handle installed



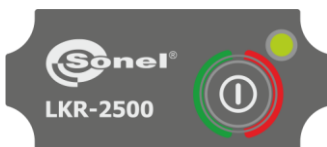
LKD-2500 with a short handle installed



LKD-2500 mounted on LKR-2500 (A-Frame)

3.5 LKR-2500 detector (A-Frame)

3.5.1 Buttons on the housing



- Turn on the device (press briefly)
- Turn off the device (press and hold)

3.6 Sonel LKZ Mobile application

The application works with Sonel LKD-2500 detector and Sonel LKR-2500 detector (A-Frame). It enables tracing of objects, grounding detection and recording of routes in the memory of the mobile device along with GPS positions of waypoints and additional readings.

The application additionally enables:

- live positioning preview,
- measuring the distance to a specific waypoint,
- export of routes to other mobile devices,
- reading routes from the mobile device's memory,
- preview of all recorded parameters,
- merging routes,
- adding notes and attachments to routes and measurement points.

3.6.1 Gestures



Drag your finger across the touchscreen



Touch an item on the touch screen

3.6.2 Menu icons

Expand your mobile device's settings menu



Expand the checkpoint menu

General



Go to the previous window



Go to the next window



Expand the item



Collapse the item



Return to the main menu



Close window / cancel the action



Save



Refresh



Information

Menu

<

Left/expand

>

Right/expand

Status menu

55

Battery charge level in LKD-2500

Checkpoint menu

Delete checkpoint

Save

Save the list of checkpoints

Memory

+

Add an object

Add a folder

Import a database from a file

Search

↑

Go to the parent folder

Function panel

Save the waypoint to the mobile application memory

Detector operating mode

Power

Radio

Signal

Frequency of the searched signal (different signals available depending on the operating mode)

Method of signal reception

Narrow

Wide

Selective

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3.6.3 Measurements



The icon is displayed when the application is paired with the LKD-2500 or LKR-2500 detector. It takes user to the routing / fault detection screen.

3.6.4 Bluetooth



Displays a list of available detectors.

3.6.5 Settings



Here you can configure the app to your needs.

3.6.5.1 Information



Here you can check information about the app.

3.6.5.2 App settings

Available settings:



- **ID auto increment** – creating new objects in the parent folder with a unique route ID within the existing numbering.
- **Name auto increment** – creating new names for memory elements according to previously entered names and types.
- **Imperial distance unit** – setting distance units.
- **Detector sound** – here you can turn on / off system sounds.
- **Signal chart** – here you can turn on / off RSSI characteristics.

3.6.6 Creating a memory structure

1



Select icon **Folders**.

2



Add a folder.

3



Enter the object details.

4



Save Changes.

5

Enter the created folder and:



add a lower-level folder (and enter its data)



import a database from a file



change view to: circuit



change view to: folders



show options



search among objects



show object details

3.6.7 Saved routes management

1



Select icon **Folders**.

2



Go to the folder with your saved routes and:



edit details of the folder



select all objects



delete selected objects



select the object, then move it to another folder



select several routes, then merge them

4 Pairing devices

- 1** **LKD / LKR**  Turn on **LKD-2500** detector or **LKR-2500** detector (A-Frame).
- 2**  Turn on **Sonel LKZ Mobile** application.
- 3**  Select the **Bluetooth** icon.
- 4**  Connect to the detector.
- 5**  Close the pairing window.



When communication between the detector and the Sonel LKZ Mobile application is lost and not restored within 5 minutes, the detector will automatically turn off.



Additional information displayed by the device

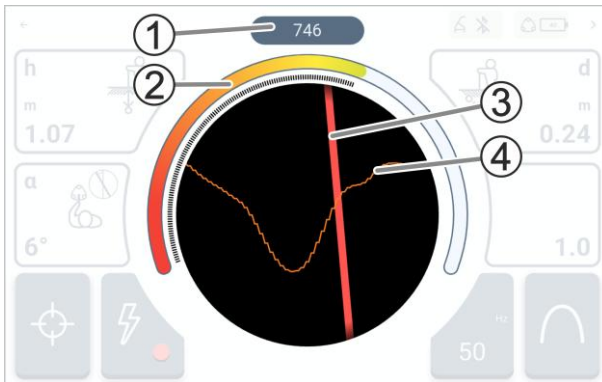
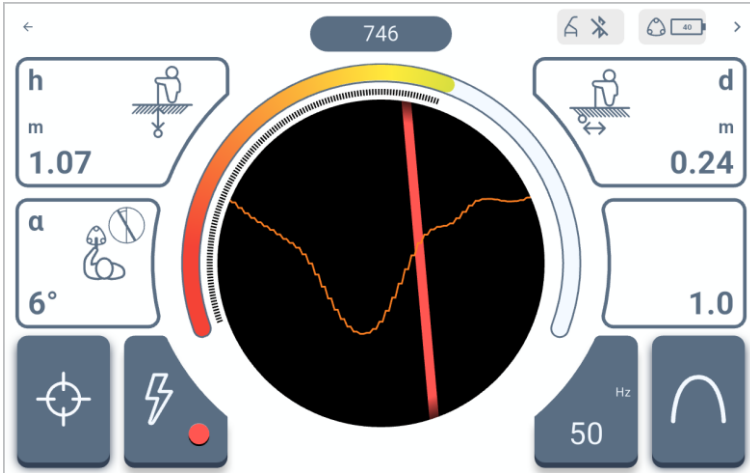


LKD / LKR without battery charging	LKD / LKR in battery charging mode	
		LKD / LKR switched off
 	 	LKD / LKR switched on
 	 	Synchronization with the Sonel LKZ Mobile application is in progress.
		Connection to the Sonel LKZ Mobile application established.

5 Routing

5.1 Routing screen of the Sonel LKZ Mobile application

Routing screen of the Sonel LKZ Mobile application is shown below.



In the central part there is a compass with a route preview.

1 – received signal strength.

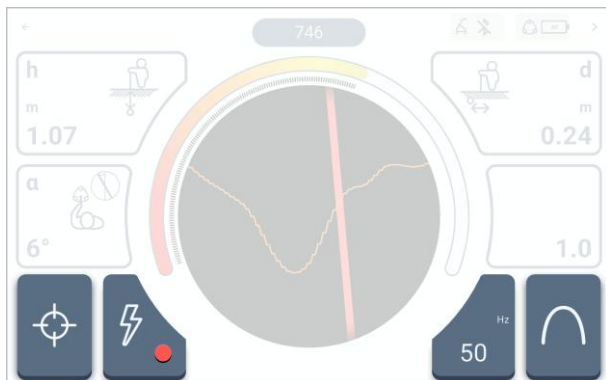
2 – graph of the received signal strength.

3 – course of the routed object relative to the detector axis.

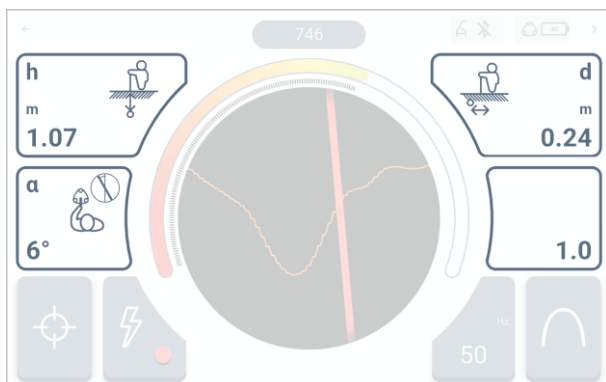
4 – RSSI characteristics (indication of the strength and stability of the received signal). The higher the amplitude, the closer the detector is to the object. Instability in the graph indicates an increased influence of disturbances on the readings.



- The area presented on the compass corresponds to the area around the LKD-2500 detector with a diameter of 2 meters.
- When the signal is strong enough, an arrow pointing towards it is displayed to direct the user to it.
- When line 3 turns grey, it means that the algorithm assesses that the signal does not meet the correctness conditions, which means that:
 - the displayed line is an approximation of the position of the traced object (the indications are stable) or
 - the detector has detected interference (indications are unstable).



In the upper and lower parts there are controls and settings icons described in **sec. 3.6.2** and **sec. 5.2**.



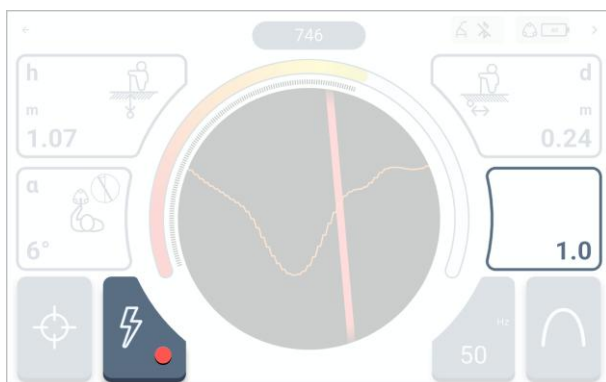
There is a set of indications on the sides.

h – depth of the routed object relative to the detector, expressed in meters.

α – angle of deviation of the routed object relative to the detector axis, expressed in degrees.

d – distance of the routed object from the detector, expressed in meters.

There is an **additional reading field** in the lower right corner.



The indications of this field depend on the active routing mode.

- **Power** mode – the number of the next harmonic of the base frequency is displayed.
- **Radio** mode – the currently detected leading frequency of the signal flowing through the routed object is displayed.
- **Signal** mode – the signal current flowing through the routed object is displayed.

5.2 Methods of signal reception

The LKZ-2500 system can receive the signal in three different ways.

Narrow. This characteristic is used to precisely determine the location of the signal and for **accurate routing of a single cable** once the signal has been located. The higher the reading, the closer you are to the signal source.

- Advantage: the highest tracing accuracy, insensitive to external sources of interference.
- Disadvantage: poor detection of signals from objects located deep underground.



When the characteristic is active, an algorithm determines whether the tracked signal meets the correctness conditions.

When it is active, an algorithm determines whether the conditions for the correctness of the tracked signal are met

- If the algorithm conditions are met, the line on the compass is coloured according to the set routing mode.
- If the algorithm conditions are not met, the received signals are still presented, but as a grey line.

Wide. This characteristic is used to find the signal and to fast map the area (it collects signals more widely than in narrow mode). The higher the reading, the closer you are to the signal source.

- Advantage: detects signals from objects located deep underground.
- Disadvantage: poor routing accuracy.



When this characteristic is active, an algorithm determines whether the conditions for the correctness of the tracked signal are met.

- If the algorithm conditions are met, the line on the compass is coloured according to the set routing mode.
- If the algorithm conditions are not met, the received signals are still presented, but as a grey line.

Selective. This characteristic is used to identify received signals and to route very low strength signals (the intensity of the audio signal decreases). The lower the reading, the closer to the signal source.



- Advantage: detects signals in places far away from their source.
- Disadvantage: external sources of interference distort the readings.

When this characteristic is active, the compass displays only signals that meet the criteria of the algorithm, which determines the fulfilment of the correctness of the tracked signal.



If the signal maximum is located in the same place for both narrow and selective modes, then the tracked object is actually there. In case of discrepancy, more reliable readings come from the narrow mode.

5.3 Routing modes

5.3.1 Operation in passive mode – Power

Operation in the **Power** passive mode involves locating of objects carrying own signals with a power frequency of 50 Hz or 60 Hz. This means that such routing can only take place over active powered facilities. In this mode, **using the LKN-2500 transmitter** to force a signal in the object **is not necessary**. This results in faster preparation for location and routing and no need to disconnect the facility from power supply or interfere with its structure.

1



Select **Power** mode.

2



Select the frequency of the signal searched in the routed object.

3



Select the method of signal reception.

4

Place the LKD-2500 detector over the object to be traced.

- When you start getting closer to the object, you will notice an increase in the strength of the received signal on the bargraph and numerical indicator.
- When you are directly above an object or in its immediate vicinity, you will see a line on the screen showing its course.

5



Now you just need to follow its route according to the indications.

6



If necessary, change the way of receiving the signal.

5.3.2 Operation in passive mode – Radio

Operation in the **Radio** passive mode involves locating of objects carrying own signals or signals induced at frequencies from 2.5 kHz to 52 kHz. This means that such routing can take place over all active or inactive objects that carry signals with a frequency within the measurement range. In this mode, **using the LKN-2500 transmitter** to force a signal in the object **is not necessary**. This results in faster preparation for location and routing and enables the location of various types of infrastructure, not necessarily electricity - also telecommunications or simply conductive.

1



Select **Radio** mode.

2



Select the frequency of the signal searched in the routed object.

3



Select the method of signal reception.

4

Place the LKD-2500 detector over the object to be traced.

- When you start getting closer to the object, you will notice an increase in the strength of the received signal on the bargraph and numerical indicator.
- When you are directly above an object or in its immediate vicinity, you will see a line on the screen showing its course.

5



Follow the route of the object as indicated.

6



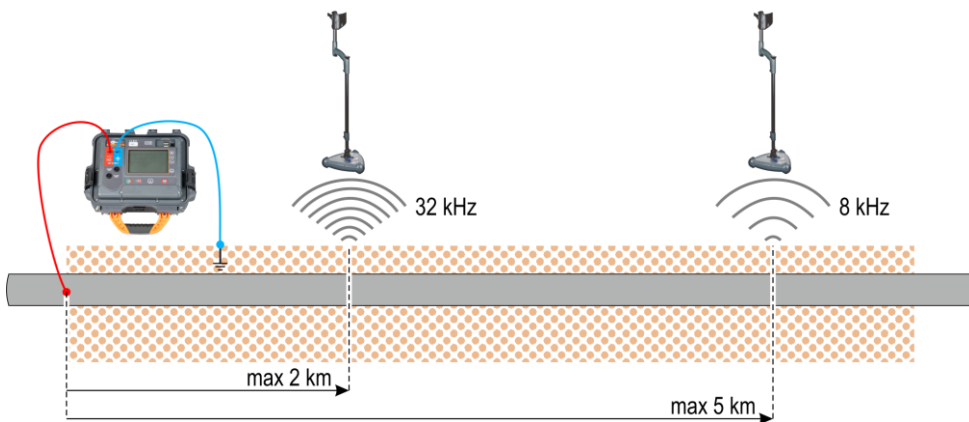
If necessary, change the way of receiving the signal.

5.3.3 Working in active mode – Signal (with signal input)

Working in the **Signal** active mode involves precise locating of objects capable of transmitting signals. This means that such routing can take place over all active or inactive objects capable of carrying signals. In this mode **using the LKN-2500 transmitter** to force a signal in the object **is necessary**.

The location signal fades with distance from the transmitter due to leakage into the ground, so it is crucial to **select the right frequency**. The basic rule is to start with the lowest available frequency and increase it only when terrain conditions or line conditions hinder the flow of the signal current.

- **The lowest possible frequency** is to be used **under optimal conditions**: with a good transmitter connection, a continuous metallic line, low resistance and favourable ground conditions. A lower frequency allows for a longer tracking range, slower signal decay, and less signal leakage to neighbouring cables and objects, which translates into more accurate route identification and less risk of error in developed areas. For the LKN-2500, this is a frequency of **8 kHz**.
- **Select a higher frequency** when the **signal current flow is impeded**. For example, this occurs with poor contact, corroded connectors, components with increased resistance, cables with a small cross-section, discontinuous screens, insulated connections (seals, sleeves, O-rings) or when a direct connection cannot be obtained (galvanic method), i.e. when a clamp or inductive signal input method is used. It is easier to introduce a higher frequency into the line, but it results in a shorter location range and a greater tendency to transfer the signal to parallel objects, so it should be used consciously, mainly on shorter sections or in difficult conduction conditions. For the LKN-2500, this is a frequency of **32 kHz**.

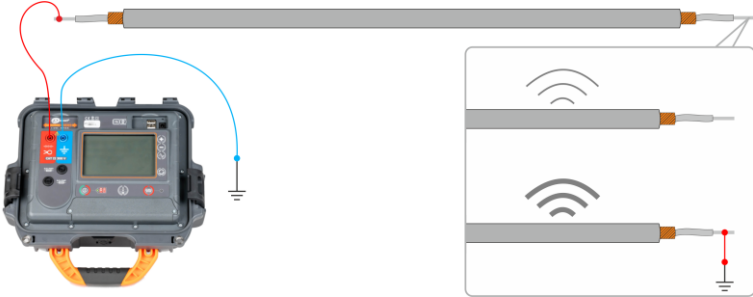


5.3.3.1 Methods of introducing a signal to the routed object

- **Galvanic method** – involves introducing a signal into the object galvanically, i.e. via wires. The wires are connected to the transmitter, the ground electrode and the object being routed. The galvanic method ensures the best introduction of the generated signal to the object and, consequently, the most effective location and routing.



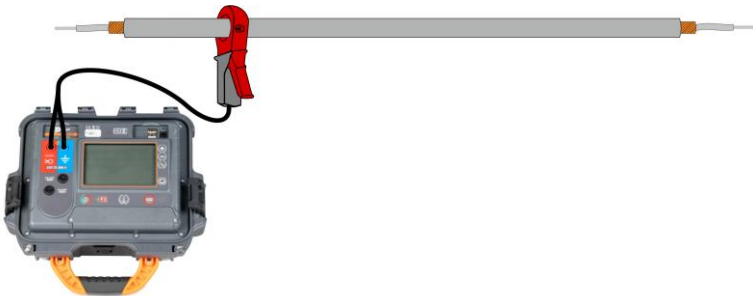
- The routed object **must be out inactive**, i.e. de-energized.
- To improve the strength of the transmitted signal, ground the end of the routed object.



- **Clamp method** – involves introducing a signal to the object inductively using clamps. The clamps are connected to the transmitter and attached to the routed object.



The tested object **can be live**.



- **Inductive method** – involves introducing a signal to the object inductively using internal antenna of the transmitter. The device is placed over the object **as directed by the arrow on the housing**. The signal is induced in all objects located under the transmitter, so it will be possible to locate more objects located underground. The strength of the signal generated in the object depends in this case on the depth at which the object is located, as well as on the type of ground and the presence of other conductive infrastructure.



The tested object **can be live**.



5.3.3.2 Introducing signal

1



In the **LKN-2500** set the method of introducing the signal (galvanic / clamp / inductive) to the routed object.

2



Connect the signal forcing circuit.

3



Select the frequency of the transmitted signal

Set the signal strength.

4



In the induction method, the signal strength is locked at the maximum level.

5



Press **START/STOP** to start transmitting the signal.

6



When necessary, change the method of displaying parameters of the transmitted signal: amperes / volts / watts / resistance



Additional information displayed by the device



Voltage on the object ≥ 5 V. Signal transmission is blocked. Disconnect the voltage from the object.



1

Voltage on the object ≥ 50 V. Signal transmission is blocked. Disconnect the voltage from the object.



-t-

The temperature of the device is higher than permissible.



Aut

The device was previously turned off because the Auto OFF time elapsed.



bAt

The previous shutdown of the device occurred due to battery discharge.

5.3.3.3 Routing

1



In **Sonel LKZ Mobile** app, select **Signal** operating mode.

2



Select the frequency of the signal that the LKN-2500 introduces to the routed object.



When using both the LKD-2500 and LKR-2500 simultaneously, you must use the combined menu to set the frequency to be detected for each detector. The frequency reading should be close to the frequency transmitted by the LKN-2500.

3



Select the method of signal reception.

4

Place the LKD-2500 detector over the object to be traced.

- When you start getting closer to the object, you will notice an increase in the strength of the received signal on the bargraph and numerical indicator.
- When you are directly above an object or in its immediate vicinity, you will see a line on the screen showing its course.

5



Follow the route of the object as indicated.

6



If necessary, change the way of receiving the signal.

5.4 Route registration

- 1



Pair the **Soneil LKZ Mobile** application with LKD-2500 detector.
- 2



In the main menu, select **Measurements**.
- 3



Select operation mode.
- 4



Select the frequency of the signal that the LKN-2500 introduces to the routed object.
- 5



Follow the route of the object as indicated.

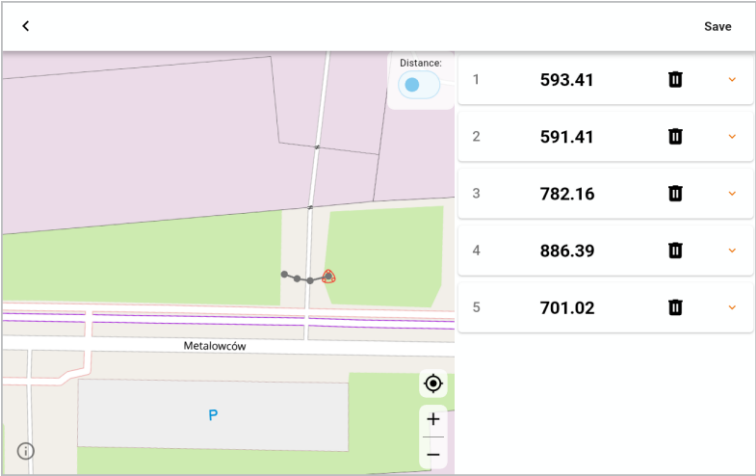


This icon will save the GPS location of the route point along with all its data to the application memory.

After expanding the **checkpoint menu**, a route map and list of saved points will appear.

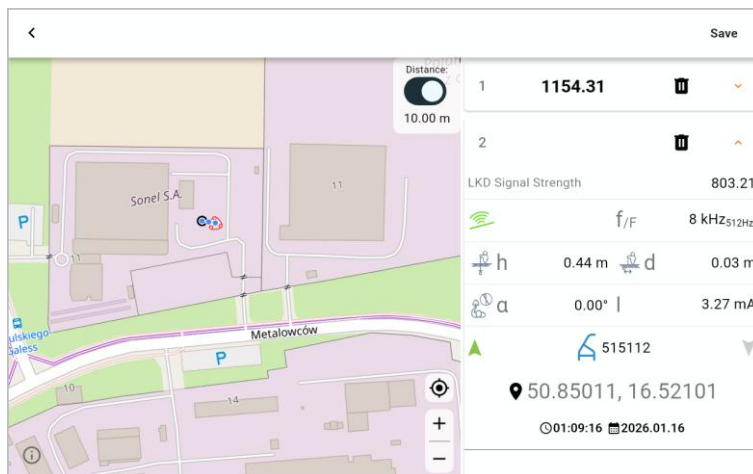


- Like any other map, you can zoom in, zoom out, and position it on the touch screen.
 - You can delete () or expand/collapse ( ) each point.





The expanded checkpoint has the following form.



1 – checkpoint number in the series

– detector operating mode: Power / Radio / Signal.

h – depth of the routed object relative to the detector, expressed in meters.

α – angle of deviation of the routed object relative to the detector axis, expressed in degrees.

d – distance of the routed object from the detector, expressed in meters.

f – frequency:

⇒ frequency of the signal sought (only in Signal mode),

⇒ leading frequency of the signal sought (only in Radio mode),

I – signal current flowing through the routed object, expressed in milliamps (only in Signal mode).

– the signal strength received by A-Frame (only with A-Frame connected).

– the position of A-Frame relative to the location of the damage (only with A-Frame connected).

– GPS location of the checkpoint

– time of saving the checkpoint

– date of saving the checkpoint

Comment – adding a comment as an attachment

Add comment – field for adding a comment

Photo – add photos as attachments

Videos – add videos as attachments



In the upper right corner of the map, there is a switch. Once activated, it will display the distance between your device with the app and the selected checkpoint.



Finally, expand the **checkpoint menu** and save the results to an object in the app memory – the **Save** command in the top bar.

5.5 Restoring the route

1

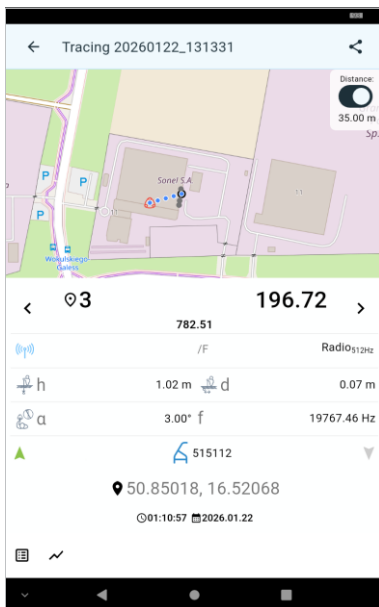


In the main menu, select **Folders**.

2



Go to the routed object. A map will appear with a route marked by the saved checkpoints.



📍 1 – checkpoint number in the series

⚡ / 📶 / 📶 – detector operating mode: Power / Radio / Signal.

f – frequency of the signal sought (only in Signal mode).

h – depth of the routed object relative to the detector, expressed in meters.

α – angle of deviation of the routed object relative to the detector axis, expressed in degrees.

d – distance of the routed object from the LKD detector, expressed in meters.

f – frequency:

⇒ frequency of the signal sought (only in Signal mode),

⇒ leading frequency of the signal sought (only in Radio mode),

I – signal current flowing through the routed object, expressed in milliamps (only in Signal mode).

📶 – the signal strength received by A-Frame (only with A-Frame connected).

▲▼ – the position of A-Frame relative to the location of the damage (only with A-Frame connected).

📍 – GPS location of the checkpoint.

🕒 – time of saving the checkpoint.

📅 – date of saving the checkpoint.

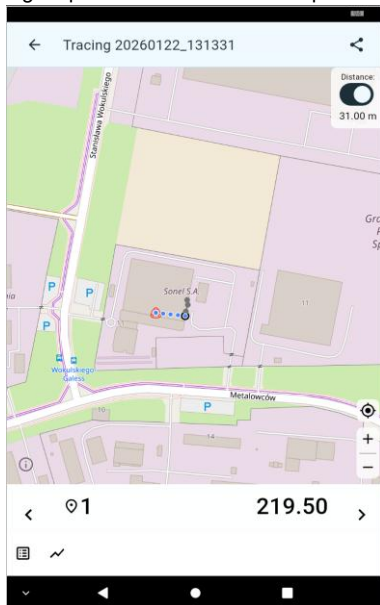
📋 – the icon expands the list of all saved route points. Each item on the list can be expanded to view its parameters and, if necessary, add a note, comment, or attachments.

📈 – displays a graph for the measured route points. Using the list on the top bar, select the data set to be presented.

3



Swipe from top to bottom (bottom to top) of the values area to collapse (expand) the signal parameters at the control point.



4



When necessary, use the icon in the upper right corner of the screen to export the route to a file.

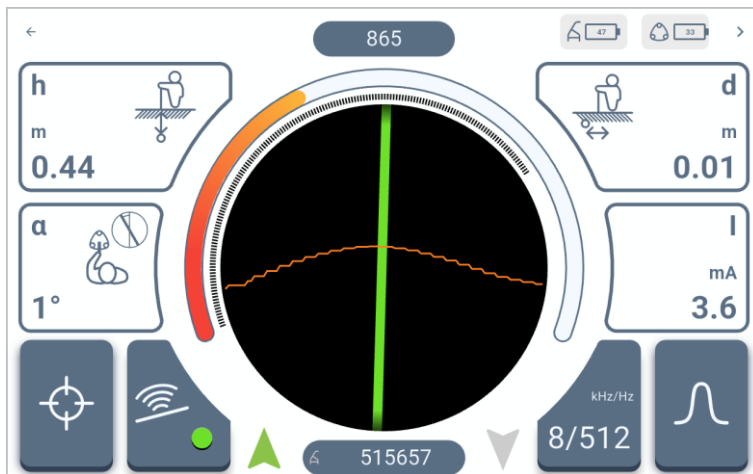


In order for the map of the route area to be loaded, the mobile device must have Internet access.

6 Grounding detection (A-Frame)

6.1 Screen for tracing and locating grounding in the Sonel LKZ Mobile application

Screen for tracing and locating faults in the Sonel LKZ Mobile application is shown below.



The central part features a compass with a signal strength indicator.

1 – bar graph of the received signal strength (displays readings from the LKD-2500).

2 – signal strength received by the LKR-2500.

3, 4 – indication of the direction during the determination of the grounding location using the LKR-2500.

6.2 Methodology for locating grounding

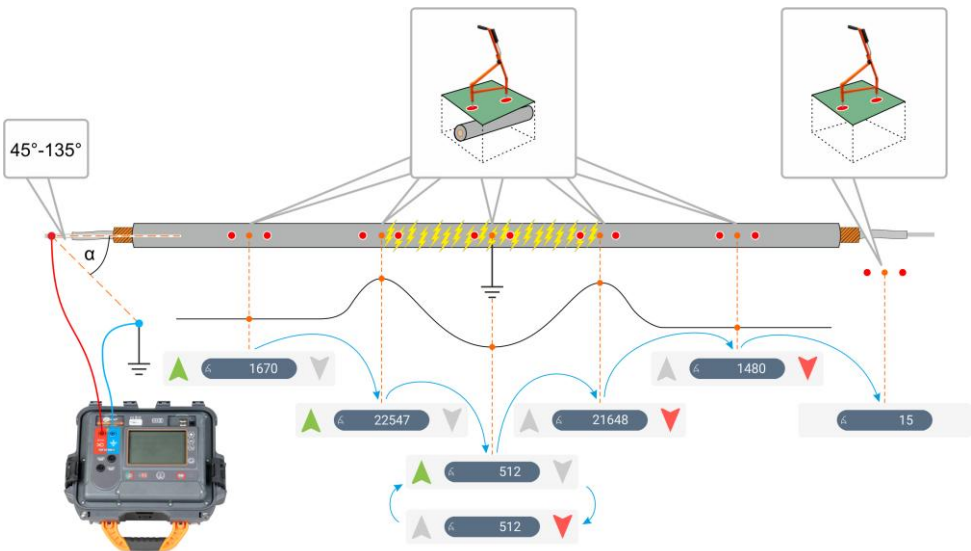
6.2.1 Detecting insulation damage using the signal drop method

Both A-Frame electrodes should be inserted into the ground along the route of the object being tested. It is possible to determine the start of the insulation damage:

- by an increase in the signal when one electrode/operator is directly above the fault location,
- by a minimum signal when the fault being located is between the A-Frame electrodes/operators.

If, on the basis of the readings, it is suspected that we are approaching the location of the damage, the control points should be made more frequent. Please note that in the case of extensive damage, there is an area with a minimum signal level between the maximum signal readings, which may be the location of a potential defect.

For more precise and easy detection of insulation damage, the signal polarity measurement function can be used. To do this, the transmitter must be set to dual-frequency signal generation mode, while the application must be set to receive this signal. Once the dual-frequency signal reception is at the appropriate level, the signal polarity indication is automatically activated.



Connection diagram and signal strength during insulation fault location
by detecting signal drop when polarity changes

While changing position along undamaged parts of the communication route, as well as directly at the fault location, due to the low level of the received signal, there may be no indication or chaotic changes in signal polarity. When approaching the fault zone and the signal level increases, the polarity is displayed continuously (▲ or ▼, depending on the direction of the current). **After the insulation fault point is passed, the polarity will be reversed** (from ▲ to ▼ or vice versa). In the case of insulation damage at a single point, the signal level at the damage site will have a distinct minimum. Keep in mind that a change in polarity without a significant change in signal level cannot be used as a basis for unambiguously determining the location of the damage.

6.2.2 Signal introduction

1

Enable dual-frequency signal transmission on the transmitter. To do this:



- Press and hold the button to turn on the transmitter. Release the button only when the settings screen appears.
- Go to the **A.Fr A.** menu.
- Here you can enable (**On**) or disable (**OFF**) additional signals.
- Confirm the settings with the **START/STOP** button. The settings will be saved.

2



Connect the signal forcing circuit according to the galvanic method (**sec. 5.3.3.1**).

3



Enable dual-frequency signal transmission.

263 Hz

263 Hz + 526 Hz signal. If the test results are ambiguous, switch to the next signal.

512 Hz

512 Hz + 1024 Hz signal. If the test results are ambiguous, switch to the previous signal.



- Each of the dual-frequency signals can be transmitted separately or with an additional signal background (8 kHz and 32 kHz to choose from). This makes it possible to search for grounding and trace the object at the same time.
- To enable/switch/disable the background signal for the desired dual-frequency signal, press and hold .
- When the dual-frequency signal and background signal are being transmitted, the transmitter does not measure the effective voltage and current of the background signal.
- The following are examples of dual-frequency signal.

263 Hz

263 Hz

263 Hz

263 Hz + 526 Hz signal without background noise.

263 Hz + 526 Hz signal with 8 kHz background noise.

263 Hz + 526 Hz signal with 32 kHz background noise.

4



Set the signal strength.

6.2.3 Grounding location

- 1



In the **Sonel LKZ Mobile** application, select the **Signal** operating mode.
- 2



Select the frequency of the signal that the LKN-2500 introduces into the traced object.

When using both the LKD-2500 and LKR-2500 simultaneously, you must use the combined menu to set the frequency to be detected for each detector.
- 3

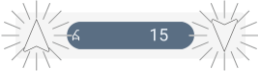


Select the signal reception method.
- 4

Perform tests using the **LKR-2500** (A-Frame). To avoid switching to an adjacent object, it is recommended to monitor the depth of the object and the value of the current induced in the line and its direction (direction determination only after selecting a dual-frequency signal).

 15

No arrows – no signal



Arrows flashing momentarily – uncertain signal.

 21648 

The signal is detected, but there is a problem with its identification. Potential causes: high noise level, possible capacitive nature of the object being tested.

 22547 

Signal phase consistent, detector approaching the fault (the fault is ahead of us).

 21648 

Opposite phase, detector has passed the fault (the fault is behind us).

5



Change the signal reception mode if necessary.
- ## 6.3 Registering checkpoints
- Saving checkpoints and operating the map are identical to **sec. 5.4**.
- ## 6.4 Reading checkpoints from memory
- The procedure for reading checkpoints from memory is identical to **sec. 5.5**.
- 36
- LKZ-2500 – USER MANUAL

7 Software update

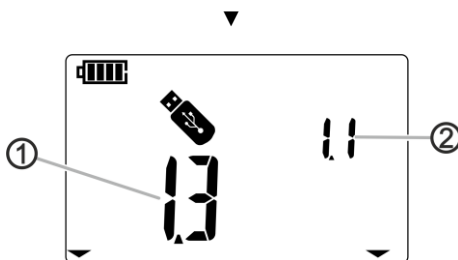
7.1 LKN-2500 transmitter

1 Download the update file from the manufacturer's website.

2 Save the update file to a USB stick. The memory must have the FAT32 file system.

3  Turn on the LKN-2500.

4  Insert the USB stick into the upper USB port of the LKN-2500. The installed and latest available software version will be displayed on the screen.



1 – software version on the USB memory stick
2 – software version installed in the device

5  If the version on the USB stick is higher than the installed version, press **START/STOP** to update.

6 After a successful update, the instrument will return to the transmitting screen.

7.2 LKD-2500 and LKR-2500 detector

1 Download the update file from the manufacturer's website to the mobile device.

2 Turn on **Sonel LKZ Mobile** application.

3  Turn on the detector.

4 Using the mobile application, pair it with the device.

5 


 Go to **Settings ► Update** and select the update file. A message verifying the correctness of the file will be displayed on the screen. Then confirm the update.

6 A progress bar will appear on the screen. After successful update, the application will display the main menu.

8 Troubleshooting

Before sending the instrument for repairs, contact our service department. It maybe possible that the meter is not damaged, and the problem has been caused by some other reasons.

The meter can only be repaired at outlets authorized by the manufacturer.

Troubleshooting of typical problems during the use of the instrument is described in the table below.

8.1 LKN-2500 transmitter

8.1.1 Error codes

Error code	Cause	Action
	Voltage present on tested object ≥ 5 V.	Disconnect the voltage from the object.
 1	Too high or too low supply voltage to the galvanic actuator – damaged internal power module.	
 2	Reference voltage error.	
 3	Relay switching error.	Contact the customer service centre and provide the error code to get help.
 4	Relay switching error.	
 5	Relay switching error.	
 6	Calibration coefficients checksum error.	
 7	Galvanic transmitter on/off error.	
 8	Inductive transmitter on/off error.	
 9	Relay switching error.	
 10	Relay switching error.	
 11	Relay switching error.	

Error code	Cause	Action
	▪ Charging error. ▪ The temperature of the device is higher than permissible.	Turn off the device, wait 10 minutes, turn the device on and check if the error persists. If yes, contact the customer service centre and provide the error code to get help.
 FUS	Blown fuse.	Replace the fuse.
 Aut	The device was previously turned off because the Auto OFF time elapsed.	Turn the meter off and on.
 bAt	The previous shutdown of the device occurred from battery discharge.	Charge the battery

8.1.2 Fuse replacement

The device is protected by two fast-acting fuses 5 x 20 mm 0.5 A / 250 V AC. To replace the fuse, unscrew the socket head, place a working fuse in place of the damaged fuse, and then screw on the socket head.



NOTE!

Do not use fuses other than those listed in this manual.

9 Power supply



NOTE!

Before operating the meter, discharge the battery and then fully charge it, so that the indication of its charged status is correct.

9.1 Battery power

The meter is powered by a lithium-ion battery. The meter is charged by a USB power supply. It can be also charged from the car 12 V accessory socket, using an optional converter.

The charge level of the rechargeable battery is indicated by the symbol in the display on a permanent basis

9.1.1 LKN-2500 transmitter



Battery charge $<100\%$.



Battery charge $\leq 37\%$.



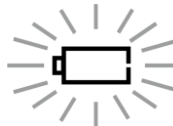
Battery charge $\leq 87\%$.



Battery charge $\leq 12\%$.



Battery charge $\leq 62\%$.



Battery charge $\leq 5\%$.



Additional information displayed by the device



Aut

The device was previously turned off because the Auto OFF time elapsed.



bAt

The previous shutdown of the device occurred from battery discharge.

9.1.2 LKD-2500 and LKR-2500 detector

The battery charge level of the device is indicated in the Sonel LKZ Mobile application.



Battery charge in %.



When communication between the detector and the Sonel LKZ Mobile application is lost and not restored within 5 minutes, the detector will automatically turn off.

9.2 Charging rechargeable battery

9.2.1 LKN-2500 transmitter



NOTE!

Do not power the device from sources other than those listed in this manual.

Connecting the power source to the charging socket turns off the device. Charging starts immediately. The charging status is indicated by active LED.

Charging with:

- a charger,
- the car cigarette lighter socket, using an optional converter.

Indication of completed charging: the LED is inactive.

9.2.2 LKD-2500 and LKR-2500 detector



NOTE!

Do not power the device from sources other than those listed in this manual.

Charging starts once the power supply has been connected to the device, regardless of the fact whether the device is on or off and whether it operates or not. The charging status is indicated by active LED.

Charging with:

- a charger
- power bank,
- the car cigarette lighter socket, using an optional converter.
- computer USB port,
- via the USB-A / USB-C adapter.

When the device is turned off by  button, the charging process is not stopped.

Signalling of completed charging:  (signalling in the Sonel LKZ Mobile application).

9.3 Power supply from mains

It is possible to charge the battery of LKD-2500 and LKR-2500 when carrying out the measurements. To do this, simply connect the power supply to the device.

9.4 General rules for using Li-Ion rechargeable batteries

- Store the meter with batteries charged at least to 50%. The battery pack may be damaged if stored when fully discharged. The ambient temperature for prolonged storage should be maintained within the range of 5°C...25°C. The environment should be dry and well ventilated. Protect the device from direct sunlight.
- Charge the batteries in a cool, well-ventilated place at a temperature of 10°C ... 28°C. Modern fast chargers detect both too low and too high temperature of rechargeable batteries and react to the situation adequately. When the temperature is too low, charging is prevented as it may irreparably damage the batteries.
- Do not charge or use the batteries in extreme temperatures. Extreme temperatures reduce the lifetime of rechargeable batteries. Always observe the rated operating temperature. Do not dispose of the battery pack into fire.
- Li-Ion cells are sensitive to mechanical damage. This kind of damage may cause its permanent damage and thus cause ignition or explosion. Any interference in the structure of Li-Ion battery pack may cause its damage. This may result in its ignition or explosion. A short-circuit of the battery poles "+" and "-" may permanently damage the battery pack or even cause its fire or explosion.
- Do not immerse Li-Ion battery in liquids and do not store in humid conditions.
- If the electrolyte contained in the Lithium-Ion battery pack comes into contact with eyes or skin, immediately rinse the affected area with plenty of water and consult with a doctor. Protect the battery against unauthorised persons and children.
- When you notice any changes in the Lithium-Ion battery pack (e.g. changes in colour, swelling, excessive temperature), stop using the battery pack. Li-Ion batteries that are mechanically damaged, overcharged or excessively discharged are not suitable for use.
- Any misuse of the battery may cause its permanent damage. This may result in its ignition. The seller and the manufacturer shall not be liable for any damages resulting from improper handling of the Li-Ion battery pack.

10 Status signalling

10.1 LKN-2500 transmitter



-  LKN-2500 turned off.
-  LKN-2500 turned off, battery is charging.
- 
 - Charging error.
 - The temperature of the device is higher than permissible.
-  LKN-2500 turned on.

10.2 LKD-2500 detector



-  LKD turned off, the charger disconnected.
-  LKD turned off, battery is charging.
-  LKD turned on, the charger disconnected.
-  LKD turned on, the charger disconnected. (Synchronization with the Sonel LKZ Mobile application is in progress.)
-  LKD turned on, battery is charging. (Synchronization with the Sonel LKZ Mobile application is in progress.)
-  LKD turned on, the charger disconnected, connection to the Sonel LKZ Mobile application established.
-  LKD turned on, battery is charging, connection to the Sonel LKZ Mobile application established.

10.3 LKR-2500 detector



-  LKR turned off, battery is charging.
-  LKR turned on, the charger disconnected.
-  LKR turned on, the charger disconnected. (Synchronization with the Sonel LKZ Mobile application is in progress.)
-  LKR turned on, battery is charging. (Synchronization with the Sonel LKZ Mobile application is in progress.)
-  LKR turned on, the charger disconnected, connection to the Sonel LKZ Mobile application established.
-  LKR turned on, battery is charging, connection to the Sonel LKZ Mobile application established.
-  LKR turned off, battery is charging.

11 Cleaning and maintenance



NOTE!

Use only the maintenance methods specified by the manufacturer in this manual.

The casing of the device may be cleaned with a soft, damp cloth using all-purpose detergents. Do not use any solvents or cleaning agents which might damage the casing (powders, pastes, etc.).

Clean the probe with water and dry it.

The test leads should be cleaned with water and detergents, and then dried.

The electronic system of the meter does not require maintenance.

12 Storage

In the case of storage of the device, the following recommendations must be observed:

- disconnect all the test leads from the meter,
- clean the meter and all its accessories thoroughly,
- wind the test leads.

13 Dismantling and utilisation

Worn-out electric and electronic equipment should be gathered selectively, i.e. it must not be placed with waste of another kind.

Worn-out electronic equipment should be sent to a collection point in accordance with the regulations valid in a given region.

Before the equipment is sent to a collection point, do not dismantle any elements.

Observe local regulations concerning disposal of packages, waste batteries and rechargeable batteries.

14 Technical data

14.1 LKN-2500 transmitter

The device does not have the character of a standard and therefore is not subject to calibration. The proper form of control for this type of instrument is checking.

Features

- Voltage measurement
- Resistance measurement
- Power measurement
- Current measurement
- The ability to work with live cables (clamp and inductive method)
- Battery level indication

Adjustable frequencies of the transmitted signal

- 263 Hz + 526 Hz (dual-frequency signal)
- 512 Hz + 1024 Hz (dual-frequency signal)
- 8000 Hz
- 32768 Hz

Operating data

- | | | |
|----|---|--|
| a) | type of insulation acc. to EN 61010-1 and EN IEC 61557 | double |
| b) | measurement category acc. to EN IEC 61557 | CAT II 300 V |
| c) | ingress protection acc. to EN 60529 | |
| | ▪ with open housing | IP40 |
| | ▪ with closed housing | IP67 |
| d) | power supply | |
| | ▪ rechargeable battery | Li-Ion 7.2 V 9.8 Ah |
| | ▪ operating time when powered by a battery | max. 16 h |
| | ▪ charging temperature | 0°C...45°C |
| e) | transmission power | |
| | ▪ galvanic method | max. 3.6 W |
| | ▪ induction method | max. 84 VA |
| f) | dimensions | 318 x 257 x 152 mm |
| g) | weight | 3.4 kg |
| h) | operating temperature | -10...+50°C |
| i) | storage temperature | -20...+60°C |
| j) | reference temperature | +23 ± 2°C |
| k) | altitude a.s.l. | ≤2000 m |
| l) | auto-off function | 0.5 h...9.5 h |
| m) | quality standard | development, design and manufacturing are ISO 9001 compliant |
| n) | the product meets EMC requirements (immunity for industrial environment) according to the following standards | EN IEC 61326-1, EN IEC 61326-2-2 |

14.2 LKD-2500 detector

The device does not have the character of a standard and therefore is not subject to calibration. The proper form of control for this type of instrument is checking.

Features

- 4-stage signal filtering
- Signal detection at the indicated azimuth
- Offset measurement (the compass covers area of 2-metre diameter around the LKD-2500)
- Measurement of angle of deviation of the routed object relative to the detector axis
- Measurement of the signal current flowing through the routed object
- Battery level indication
- With Sonel LKZ Mobile – indication of the currently detected signal leading frequency
- With Sonel LKZ Mobile – acoustic and visual detection indication (360° line direction indicator)
- With Sonel LKZ Mobile – RSSI characteristics
- With Sonel LKZ Mobile – indication of the received signal strength (bar graph and numerical value)
- With Sonel LKZ Mobile – metric or imperial units

Depth measurement accuracy

⇒ The abbreviation "m.v." used in the specification of accuracy denotes a measured value

Mode Depth	Power	Radio	Signal (8 kHz)	Signal (32 kHz)
≤1 m	10% m.v.	10% m.v.	5% m.v.	2.5% m.v.
≤4 m			10% m.v.	10% m.v.
≤6 m	unspecified			

- The depth of the cable should be measured parallel to and directly above the cable route.
- Accuracy is correlated with the current that can be forced in the object (defined reference conditions).

Operating data

- a) type of insulation acc. to EN 60529.....IP65
- b) power supply
 - rechargeable battery Li-Ion 3.6 V 6.7 Ah
 - operating time when powered by a battery max. 13 h
 - charging interface USB-C 5 V / 3 A
 - charging time max 4 hours
 - charging temperature +2.5°C...+45°C
- a) dimensions 290 x 275 x 100 mm
- b) weight 1.2 kg
- c) operating temperature -10°C...+50°C
- d) storage temperature -20°C...+60°C
- e) reference temperature +23°C±2°C
- f) operating humidity 20%...90%
- g) reference humidity 40%...60%
- h) data transmission
 - wireless communication standard Bluetooth 5.0 BLE
 - communication range up to 50 m in open space
- i) Auto-Off when communication between the LKD-2500 and the Sonel LKZ Mobile application is lost 5 min
- j) altitude a.s.l. ≤2000 m
- k) quality standard development, design and manufacturing are ISO 9001 compliant
- l) the product meets EMC requirements (immunity for industrial environment) according to the following standards EN IEC 61326-1, EN IEC 61326-2-2

14.3 LKR-2500 detector

The device does not have the character of a standard and therefore is not subject to calibration. The proper form of control for this type of instrument is checking.

Features

- Location of cable grounding point
- Signal detection and damage detection at the indicated azimuth
- Battery level indication
- With Sonel LKZ Mobile – visual detection indication
- With Sonel LKZ Mobile – indication of the received signal strength (numerical value)

Operating data

a)	ingress protection acc. to EN 60529	IP65
b)	power supply	
	▪ rechargeable battery	Li-Ion 3.6 V 3.5 Ah
	▪ operating time when powered by a battery	max 15 h
	▪ charging interface	USB-C, 5 V / 3 A
	▪ charging time	max 2 h
	▪ charging temperature	+2.5°C...45°C
c)	dimensions	
	▪ folded	655 x 70 x 305 mm
	▪ unfolded	530 x 70 x 800 mm
	▪ folded with LKD-2500 installed	655 x 250 x 305 mm
	▪ unfolded with LKD-2500 installed	530 x 300 x 800 mm
d)	weight	
	▪ the device itself	2.9 kg
	▪ the device with LKD-2500 installed	4.0 kg
e)	operating temperature	-10°C...+50°C
f)	storage temperature	-20°C...+60°C
g)	reference temperature	+23°C±2°C
h)	operating humidity	20%...90%
i)	reference humidity	40%...60%
j)	data transmission	
	▪ wireless communication standard	Bluetooth 5.0 BLE
	▪ communication range	up to 50 m in open space
k)	Auto-Off when communication between the LKR-2500 and the Sonel LKZ Mobile application is lost	5 min
l)	altitude a.s.l.	≤2000 m
m)	quality standard	development, design and manufacturing are ISO 9001 compliant
n)	the product meets EMC requirements (immunity for industrial environment) according to the following standards	EN IEC 61326-1, EN IEC 61326-2-2

15 Manufacturer

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

SONEL S.A.

Wokulskiego 11

58-100 Świdnica

Poland

tel. +48 74 884 10 53 (Customer Service)

e-mail: customerservice@sonel.com

web page: www.sonel.com



NOTE!

Service repairs must be performed only by the manufacturer.

NOTES

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NOTES



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