HDD LOCATING SYSTEMS

Sense

IT MAKES SENSE

SNS 1t NV

Entry Level Locating System for Horizontal Directional Drilling

User's manual

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HDD LOCATING SYSTEMS
Sense
IT MAKES SENSE

SENSE has been developing and manufacturing all types of locating systems for horizontal directional drilling since 1998.

A creative approach at all stages of the production process, careful selection of suppliers and close attention to the needs of the customer - these are the basic principles of the company's work.

Today, SENSE has extensive experience in cooperation with leading foreign and domestic manufacturers of electronic equipment and their components, providing production with reliable components for creating locating systems. This experience, combined with the creative, technical and labor potential of competent specialists, ensure high competitive performance of the company's products.

Congratulations on purchasing the locating system SNS 1t NV!

We would like to thank you for choosing the SNS 1 t NV locating system. We are rightfully proud of our advanced developments and hope that you will fully appreciate all the advantages of the purchased equipment. The mission of our company is not only to create unique high-quality equipment, but also to provide friendly service support, including training users to work with locating systems.

We are closely following scientific developments in the field of horizontal directional drilling technology, as well as listening to you to create new equipment that helps speed up and facilitate your work.

You can follow all the company's news yourself on our website on the Internet at: www.sense-hdd.ru.

If you have any questions about operation, you can always contact us by phone+7 (8422) 45-72-00, or by e-mail info@sense-inc.ru

CONTENTS

This Manual contains important safety information, as well as instructions on how to set up and operate the system.

More detailed safety instructions are available in the section **“ SAFETY MEASURES"**.

The manual serves as the main document for training personnel using the SNS 1t system when performing horizontal directional drilling operations in accordance with a given project.

The technical information and recommendations set out in this Manual relate to SENSE products in the supplied configuration and do not apply to any modifications of the system and its software made by the user without appropriate approval in the SENSE and to any third-party products.

Before using the products of the SENSE company, the user is obliged to check their suitability for use in solving the task.

Product identification

The model and factory serial number of your locating system are indicated on the instrument cases and in the warranty card.

Always have the warranty card or product numbers at hand when contacting the SENSE representative offices and services.

SAFETY MEASURES

Familiarization with the safety regulations is mandatory for the personnel of the drilling rig / complex, and their observance and implementation guarantees the avoidance of injury, damage to expensive equipment or damage to surrounding objects.

Operators of horizontal directional drilling equipment are required to comply with the following requirements:

Know the methods of proper and safe operation of drilling and location equipment, including the use of insulating mats and appropriate methods for grounding equipment. Do not allow underground drilling equipment to come into contact with underground utility and communication networks, high-voltage cable or pipelines. Contact of underground drilling equipment with similar objects can lead to serious injury to personnel, up to death, as well as significant material damage.

***The location equipment of the SNS system is not explosion-proof,** therefore, it should not be operated near flammable and explosive materials.*

When performing drilling and preparatory work on the site, production personnel are required to use appropriate overalls, hard helmets, and contrast vests.

Strictly comply with the requirements of state and local government regulations related to all stages of preparation and production of drilling operations. Strictly comply with all other corporate safety requirements.

To study this Manual, it is recommended to turn on the locating system and prepare it for operation.

Scope of application of this document

This manual refers to the system SNS 1t NV

Operation manual

Other documents

It contains all the necessary indications and instructions for working with the locating system at a basic level. In addition, this document provides an overview of the main functions of the devices, provides technical characteristics of the devices of the locating systems and safety instructions.

Instruction manual

Briefly describes the operating menus of the Receiver and applications for mobile devices when using the WiFi R-Box, the sequence of actions when preparing the system for operation.

Documentation format Symbold

In addition to the printed version, on the Internet at: www.sense-hdd.ru. in the electronic format.

The symbols used in this Manual have the following meanings:

Danger

It means a directly dangerous situation that can lead to serious injury or death.

Warning

Indicates a potentially dangerous situation or abnormal use of the device, which can lead to serious injury or death.

Careful

Means a potentially dangerous situation or abnormal use of the device that can cause minor or moderate injuries, or lead to significant material, financial or environmental damage.

Important instructions to ensure the effective use of the locating system.

2.1 Technical specifications of the SNS Sonde

Sonde description

The standard delivery of the SNS 1t NV system includes a probe of the SNS MSt2 brand on the "24+" protocol.

Fig.1. MSt2 Sonde

Dimensions (D x L)	22x205 mm
Radiation frequency	12 kHz
The error in measuring the angle of inclination relative to the horizontal plane	0,1%
Number of rotation angle positions “by hours”	12
Time interval for the data update:	— Inclination angle 1,2 second — positions by “hours” 0,3 second
Duration of uninterrupted operation	NLT 20 hours
Power supply	One element of typical SIZE AA

2.2 Technical specifications of the Receiver

Receiver description

The Receiver is a device for determining the location, tracking the movement and displaying the current parameters of the Sonde. The Receiver receives the following parameters from the Sonde: the angle of axial rotation of the Sonde relative to "12 o'clock", the angle of inclination (deviation from the horizontal), temperature, battery level and indicates them on the display.

Fig.2.SNS 1t Receiver

Overall dimensions (L x W x H)	310x140x285 mm
Weight in working condition	2 kg
Electric power supply	Built-in 3.4V lithium battery; 3.2Ah.
Charging device	power adapter 12V, 2A or 6 alkaline batteries of standard size C
Continuous operation time from a fully charged battery	Up to 50 hours
The operating frequency of the Sonde signal reception	12 kHz, protocol «24+»
The range of the radio telemetry transmission channel to the Repeater (available on request)	At least 200 m under the condition of line of sight and when using a standard antenna at least 450 m when using a remote antenna
The error in determining the depth of the Sonde	no more than 5% (at depths up to 9.99 m) in the absence of active and passive interference in the work area
The range of measured Sonde depressions relative to the bottom of the Receiver	0.5 – 9.99 m (in the absence of active and passive interference in the work area)
Minimum Sonde depth (distance from the Sonde to the bottom of the Receiver)	Not less than – 0,5 m
Environmental requirements	Temperature: – 20 °C to +50 °C, relative humidity – up to 98%

The Receiver is compatible with SNS series wireless Sondes "t", including with the SNS St Sonde on the "24/24+" protocol, frequency12 kHz and standard power. Before using the St Sonde, it is necessary to consult with the SENSE service center. When performing work, avoid prolonged exposure to direct sunlight on the Receiver display in extremely high temperature conditions.

Language selection

The 1t Receivers use icons with captions in English. Intuitive icons do not require translation into Russian.

2.3 Scope of supply

Fig.3. Example of the scope of supply

SNS MSt2 Sonde	1pc
MSt2 Sonde adapter for Sonde size 380 x 32 mm	1pc
Alkaline battery of standard size AA, 1,5V (option)	1pc
Location Receiver SNS 1t NV	1pc
Power unit (network adapter) AC 12V 2A with power cable	1pc
Car charger	1pc
Telemetry station (TS) with satellite	1pc
Power cable USB A – micro USB A	1pc
Power adapter plug 220V	1pc
Operational documentation	1pc
Wrist Repeater (**option**)	1pc
Portable bag	1pc

2.4 Telemetry station (TS)

The hardware and software complex of the TS is designed to duplicate information from the Receiver to the displays of devices running the operating system **Android version 4.4 and higher.**

Operation in the mode of **telemetry**: download SNS Vision App (snsvision) from Play Market or directly from our site, swtich the TS on. On the device with the OS Android switch Wi- Fi, select the access point – «SnsTS_xxxx». Open SNS Vision App.

Control, button:

1. Long press to turn on/off the device.
2. One short press to switch the channel.
3. Two short clicks to switch the mode. Indication, upper LED:
   1. Blue – mode of **telemetry**.
   2. Red is the Repeater mode.

Indication, lower LED:

1. Blue when the charger is connected – the station is charged.
2. Red when the charger is connected, charging is in progress.
3. Red blinks when the charger is turned off – the charge level is low.
4. Blue and red blink alternately – there is a problem with the battery.

2.5 Sonde adapter

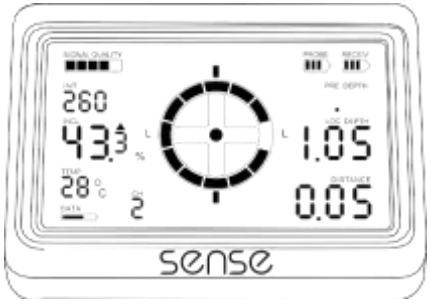
The Sonde adapter is designed for the use of the MSt2 probe in a drill head with a seat of 380x32 mm.

Wrist Repeater (optional)

The wrist Repeater is designed to display all information transmitted from the Receiver using the TS. It has a segment display. Built-in battery: 3.2V.

The WR detects telemetry channels automatically.

On/backlight button.



2.6 Power supplies

Instruments

The Receiver, Sondes, wrist Repeater and TS can only be powered from an internal power source.

Internal battery of the Receiver

One built-in 3.4V lithium battery;3.2 Ah is the built–in battery of the Receiver.

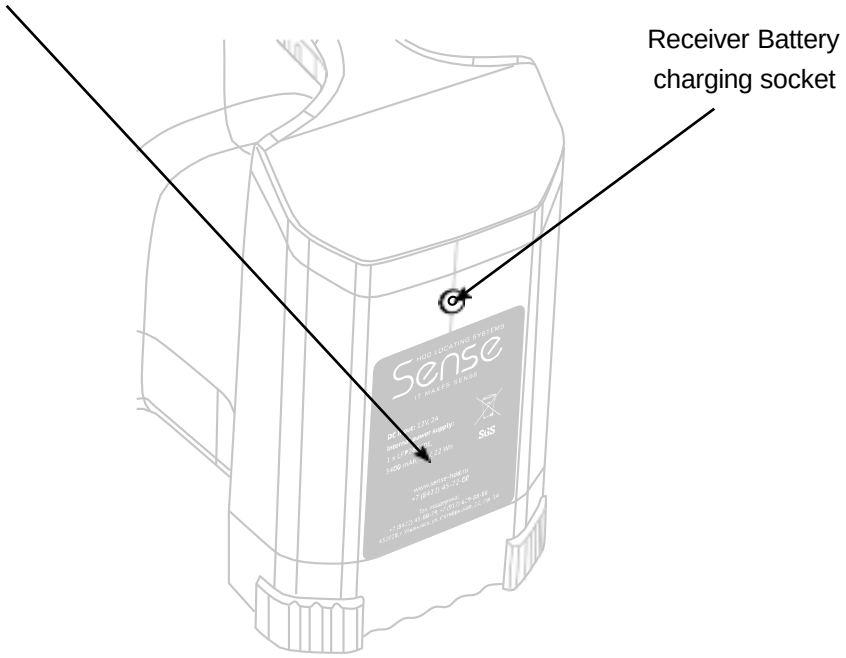


Fig.4. Battery pack, lithium

Sonde power supply

Sonde MSt2 – 1 replaceable element of standard size AA.

Internal TS charger

TS – Two built-in 3.4V lithium batteries;3.2 A/h.

Internal wrist Repeater charger

Wrist Repeater (optional) – one built-in 3.4V lithium battery; 3.2 A/h

To ensure the correct operation of the tool, always use rechargeable batteries, chargers and accessories manufactured by SENSE or accessories recommended by SENSE.

DANGER
It is forbidden to open the battery pack.

1. Combination of devices by drilling

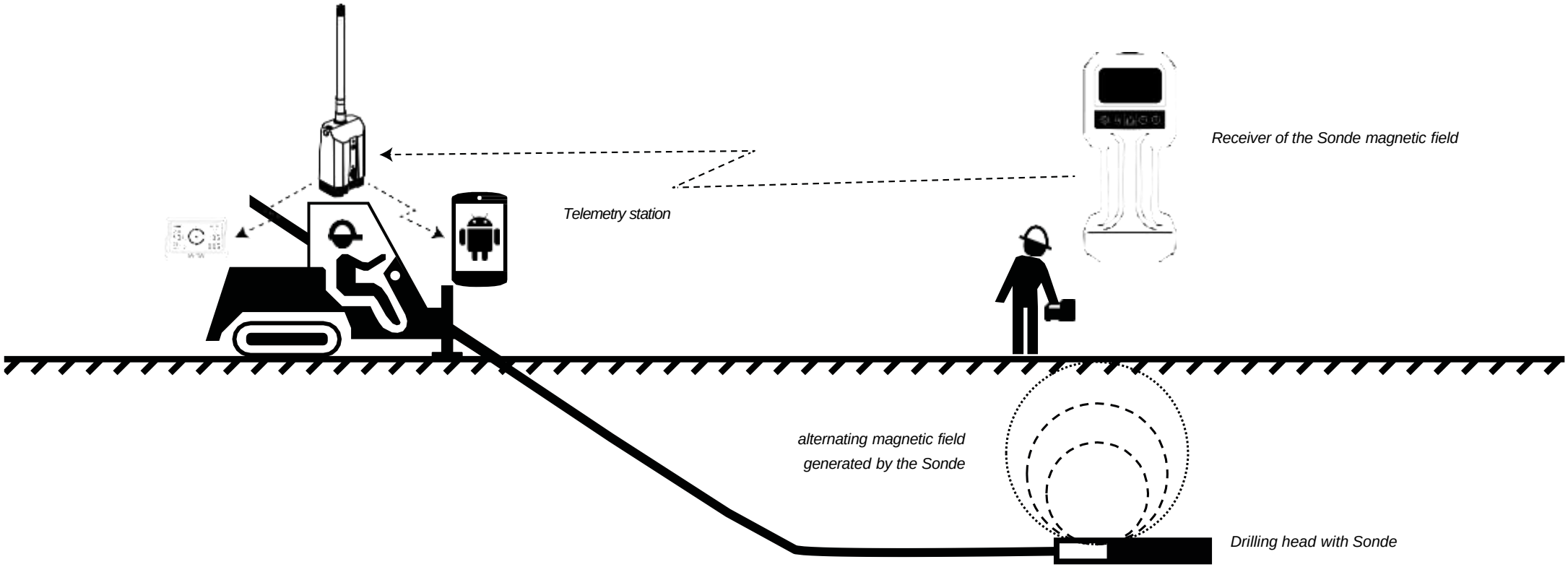


Fig.5. Combination of devices by drilling

Description

The above figure explains the purpose and interaction of the components of the system when accompanying the drilling of a pilot well. The measured magnitude and direction of the magnetic field lines generated by the Sonde make it possible to determine its location underground. At the same time, the Sonde transmits to the Receiver the parameters of the tilt angle, clock position, temperature, etc. These parameters are displayed on the Receiver display.

By means of the TS, drilling data is transferred to a device running Android OS and can be saved in it using the free SNS Vision program for further processing (saving, forwarding, preparing reports).

4.1 Keypad

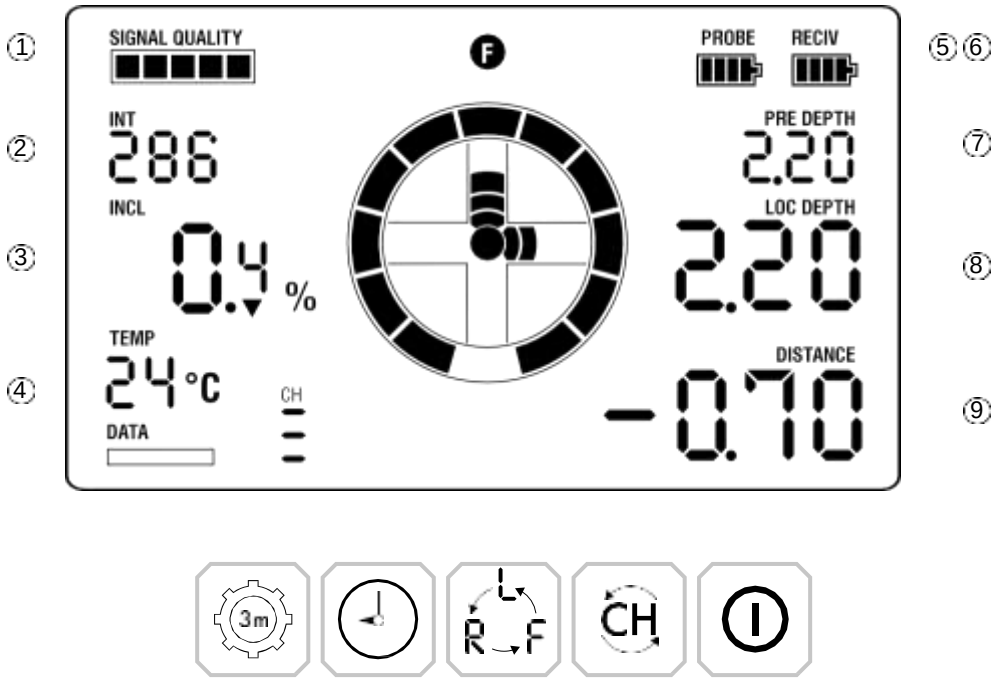
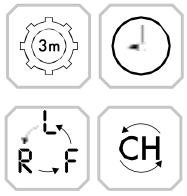


Fig.6. Keypad of the Receiver 1t



Buttons to change the parameters values.

The button for confirming / completing / fixing parameters / backlight / power.

4.2 Icons

All the parameter images shown are examples.

① **Conditional quality of the received Sonde signal.**
The quality is considered sufficient if at least two segments are darkened. Receiving packets of information from the zones is accompanied *by "blinking" of all segments* of the quality scale.

② **The conditional intensity of the Sonde signal.** At a distance of 3 m after calibration, the value should be within 110.150 units, depending on the type of case of the drill head.

③ **The temperature of the Sonde is in degrees Celsius.**
It should be borne in mind that the readings of the temperature sensor located in the zone are delayed relative to the temperature of the drilling head by 15 seconds. **Therefore, when the temperature reaches 40 degrees and its further growth, it is necessary to stop drilling.**

④ **The angle of vertical inclination of the Sonde**, as a percentage, up or down relative to the horizon.

⑤ **Charge level of the Sonde battery.**

⑥ **Charge level of the Receiver battery.**

⑦ **Predicted depth at the front location point.**

⑧ **The depth of the Sonde relative to the bottom of the Receiver.**

⑨ **The horizontal distance between the Sonde and the Receiver. "-" means that the Sonde is located behind the Receiver.**

Enabling calibration mode at a distance of 3 m. Holding the button you need to press the button to confirm the start of the operation and before confirmation.

Clock correction – correction of the "clock" reading on the Receiver display.

To do this, press the button and, holding it, confirm pressing the button

A new correction value can be set only after the reset of the previous one, to do this repeat the action when *the Sonde is switched off* (the "clock" will be set to 12) and restart the system to update the data.

Initial setting of the location point type (R, L или F) depending on the position of the Receiver relative to the Sonde: behind - R; in front – F; above the Sonde – L.

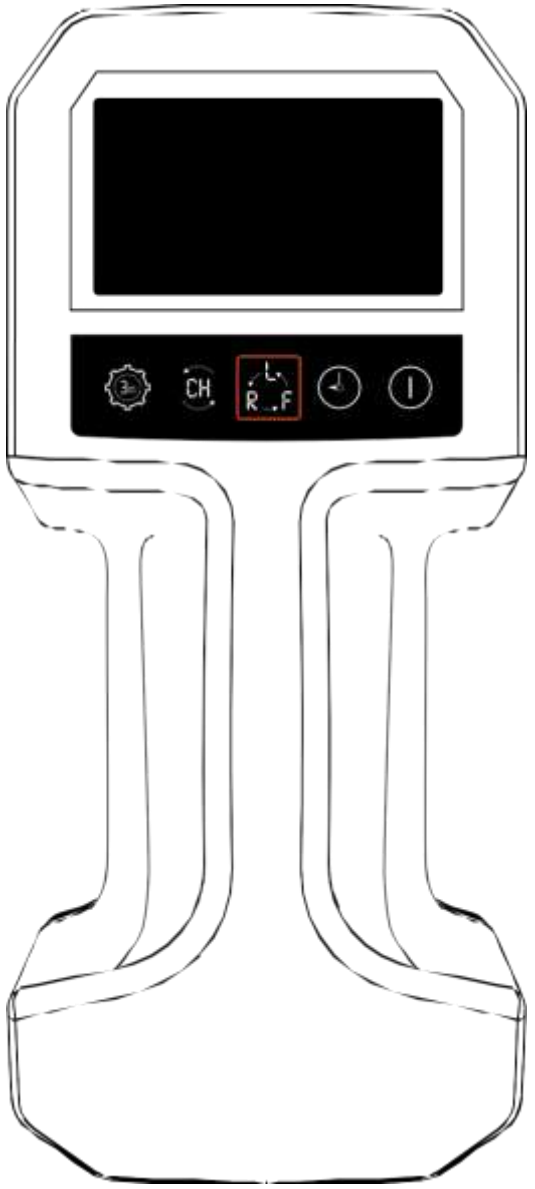
L and F are changed by pressing the button sequentially take into account the switching of drilling to the target.

In the future, R, L and F change automatically, provided that the Receiver is always correctly oriented relative to the drilling rig (always FROM).

Selecting the channel number of the radio modem (0…3) or disabling it "–". The change is made by pressing sequentially (enumeration)

Turning on/off the Receiver or the display backlight. A short press of the button turns ON/OFF the light, a long press (more than 3 seconds) turns ON/OFF the Receiver power supply.

An additional function is to confirm the operation when the buttons or are pressed.



5.1 Magnetic field of the Sonde

Description

Figure 7 gives an idea of how to determine the position of the Sonde. The magnetic field lines emanating from the Sonde cross the earth's surface strictly vertically at two points indicated by the symbols R (back) and F (front). Directly above the Sonde, the lines are positioned strictly horizontally (L, location line). Moreover, in the area of the line of location, the lines of force are not only parallel to the surface of the earth, but also to the axial direction of the Sonde. Therefore, in the area of the location line, it is impossible to determine the deviation of the Receiver from the Sonde in the transverse direction.

When the mutual direction of the Sonde and Receiver changes (to the drilling rig or from the drilling rig), the position of the location points changes to the opposite, therefore, the Receiver provides the possibility of forced installation of "R" or "F" with a known mutual direction.

The Receiver antenna reacts to both the magnitude and direction of the magnetic field lines, which allows the operator to find these points on the ground, as well as, focusing on the image displayed on the display, when they "beat off the points" to move in the right direction.

The diagram shown in Figure 7 illustrates only a special case – the horizontal arrangement of the Sonde and Receiver. In reality, the Sonde may be positioned at an angle to the horizon.

Description

Appendix 2 contains correction tables that allow you to determine the displacement of the Sonde in the forward or reverse direction relative to the point determined by the Receiver, depending on the angle of inclination of the Sonde. The effect of the tilt of the Receiver itself is compensated using the built-in horizon sensors.

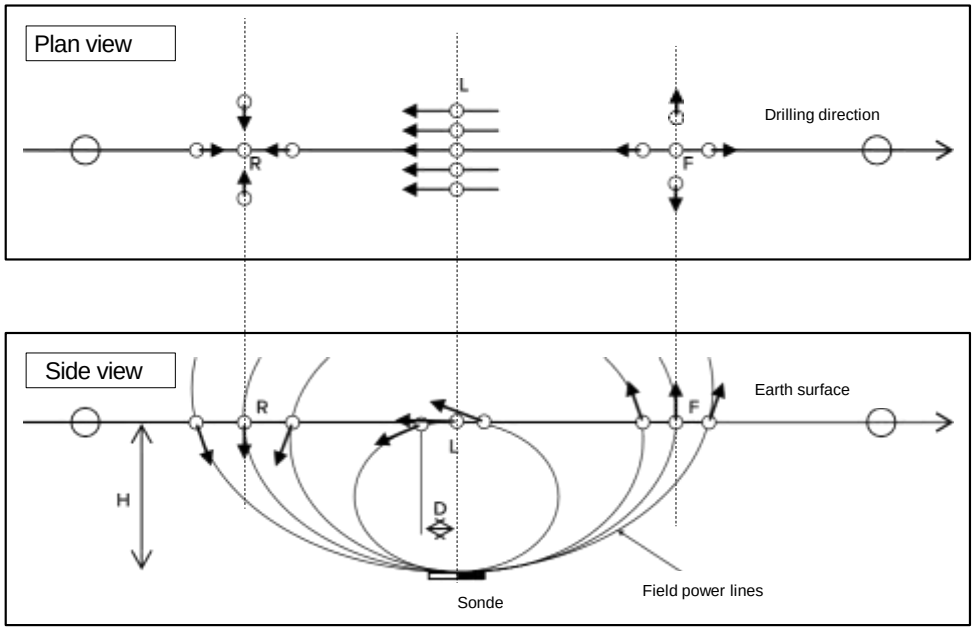


Fig. 7. Image of the Sonde's magnetic field vectors in the horizontal and vertical planes

5.2 Location screen on the Receiver Display

Description

The central area is occupied by an image of a "dial" showing the current angle of rotation of the drilling head around the axis of rotation ("clock"). There is a cross-shaped figure inside the dial, the darkened parts of which show the displacement of the Receiver relative to the location points or the location line in their vicinity. On the outside of the circle there are marks characterizing the horizontal angle between the axis of the Receiver and the axis of the Sonde (only in the vicinity of the location line).

Figure 8 shows the situation in the vicinity of the rear location point (the "R" symbol at the bottom of the screen). To move to the location point, you need to move in the direction of the darkened areas, eventually reducing them to zero.

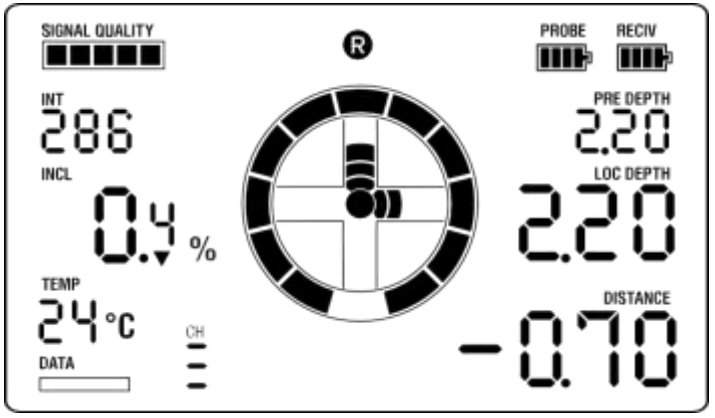


Fig. 8. Surroundings of the rear location point (R)

Description

In the vicinity of the location line (Fig. 9), the lateral segments disappear, since in this area it is impossible to determine the transverse deviation of the Receiver from the axial line of the Sonde (Fig. 7), but there are marks of the horizontal angle between the axis of the Sonde and the Receiver. The darkened segment shows the deviation from the location line in the direction of the front or rear location points.

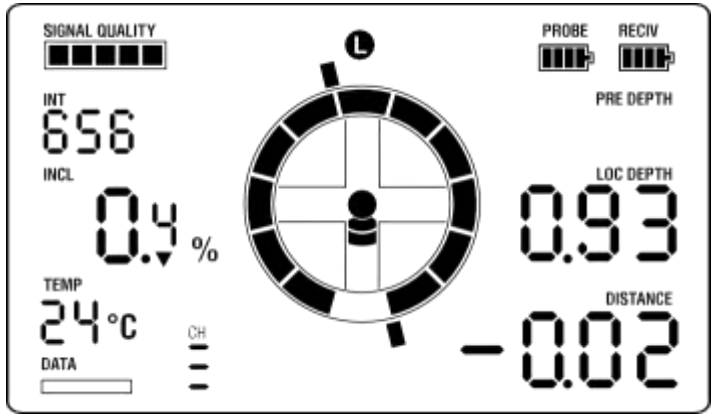


Fig.9. Surroundings of the location line

The example in Figure 10 shows the image options on the screen depending on the relative position of the Sonde and Receiver when moving from the rear to the front location point along an arbitrary trajectory.

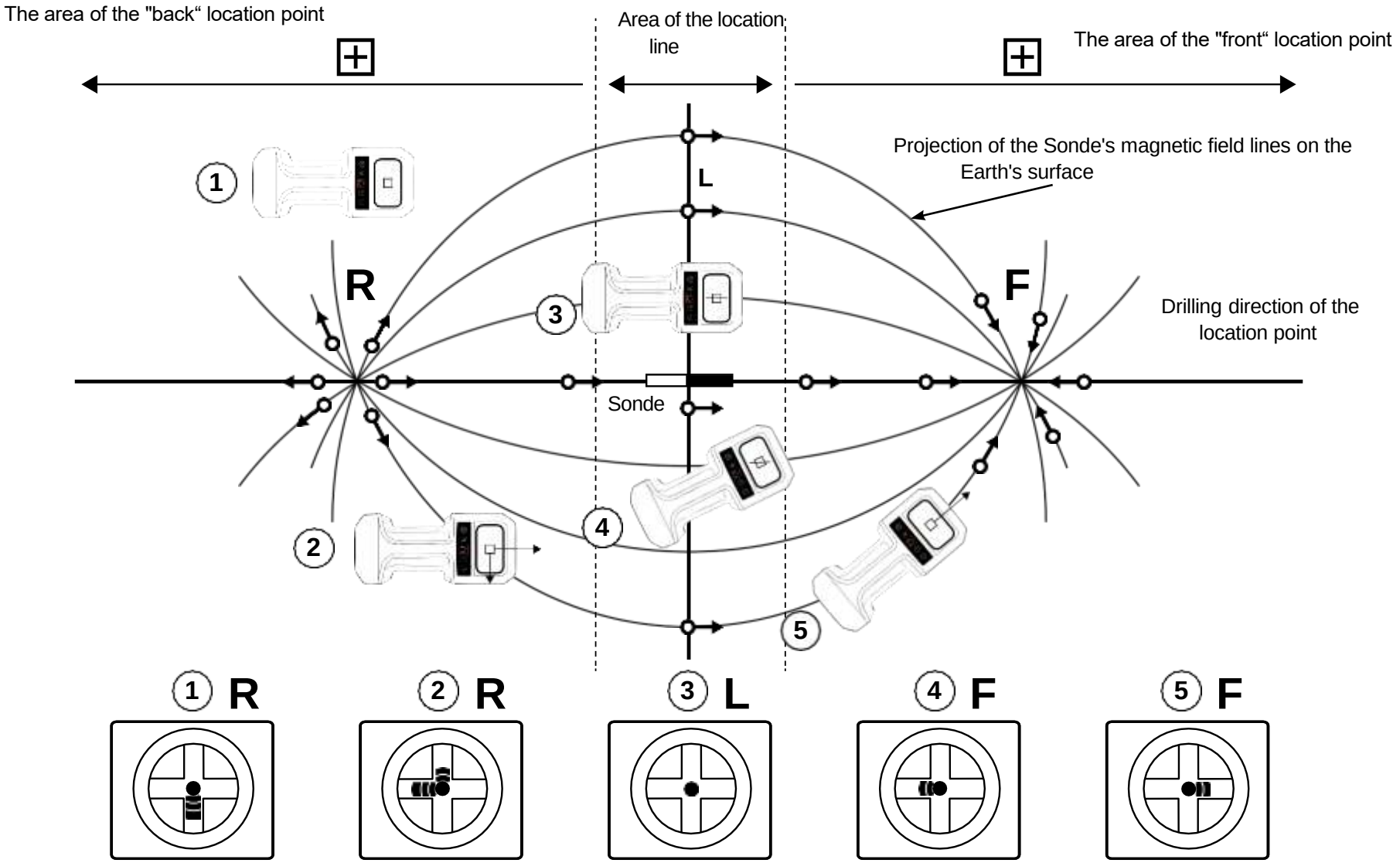


Fig.10. Displaying the relative positions of the Receiver and the Sonde on the display

6.1 Receiver power supply

Charging the Receiver power supply

1. The Receiver of the SNS 1 NV locating system has a built-in rechargeable power supply, which is charged using a 12V2A power adapter.

6.2 Preparation for work

Receiver

1. Make sure that the Receiver's power supply is fully charged.
2. Press and hold the button until the beep appears, after which the main menu will appear.

During the first two seconds, the following information is displayed on the display:

- **INT** Receiver serial Number;
- **DEP** Software version Number;

  DIST Data transfer protocol, where 0 is the "24" protocol, 2 is the "24+" protocol;
- The clock position is "12".

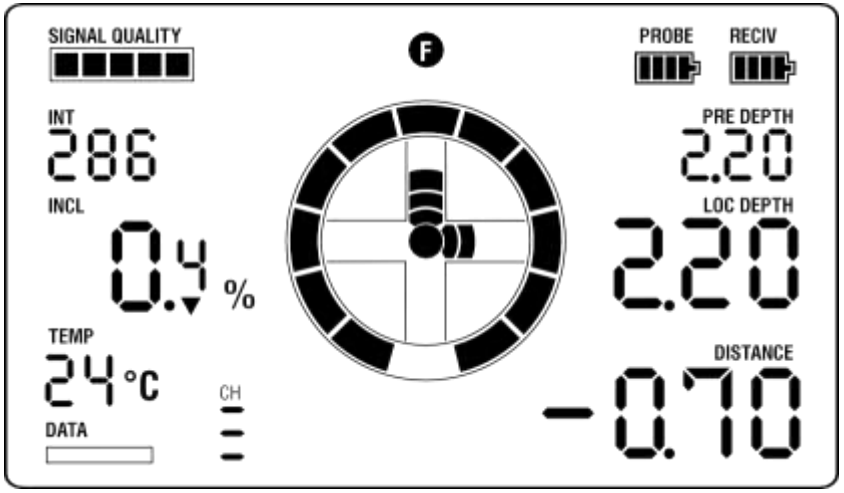


Fig 11. Displaying display information during power-on

Receiver

3. Reset the clock correction if it was set earlier. To do this, press the button and hold it down to confirm pressing the button .
4. Install 1 alkaline cell (for the SNS MSt2 Sonde) in the battery compartment.

5. After installing the battery or accumulator, tighten the plug tightly. Before installing the battery, make sure that the threads of the battery case and the probe plug are clean.

Sonde

6. Install the Mst2 Sonde into the case of the drill head oriented at "12 o'clock". The label of the Sonde must match the label of the case.

6.3 3 m Calibration

Calibration must be performed every time before drilling

Description

7. Position the drill head at a distance of 3 meters from the side surface of the Receiver, as shown in Figure 12.
8. Press a combination of buttons to start the calibration process.
9. Holding the button press the button until the flashing value of 3.00 meters appears, then release the buttons.

   CALIBRATION IS COMPLETED when the value 3.00 stops flashing.

Important note! The drilling head must be installed with a minimum deviation from the horizontal. When measuring the distance from the Receiver to the drill head, do not use a metal measuring device.

It is important to calibrate in place without active interference!

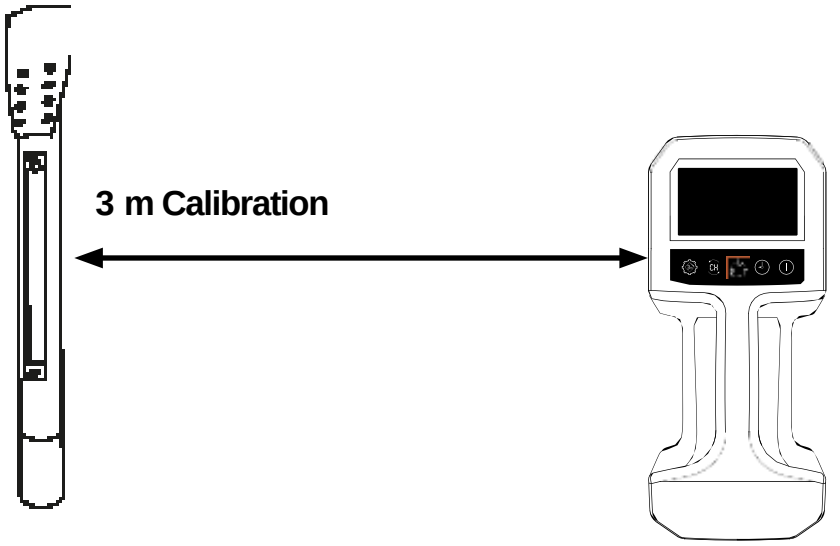


Fig.12. The location of the Receiver relative to the drilling head

Calibration is considered to have been successfully performed with the following depth detection parameters:

- The conditional signal intensity is about 130 by 3 m;
- tolerance ±5%;
- The conditional quality of the received Sonde signal is high.

If the conditional quality of the received Sonde signal is not high, then it is necessary to ensure that the drill head meets the requirements specified in Appendix 3.

6.4 Correction for the "clock"

Description

The "clock" correction is required to set the drilling head at 12 o'clock so that the drilling rig operator can set the required drilling direction during the drilling process.

Order of works

10. After calibrating the Sonde, set the drill head for "12 o'clock" at the calibration site or on the spindle of the drilling rig.
11. Adjust the reading of the "clock" on the Receiver display.

To do this press the button and, holding it, conform pressing the button
The new correction value can be set only after resetting the previous one, for which you can repeat the steps with the probe turned off and the next reboot of the Receiver.

It is recommended to calibrate each time before drilling.

6.5 Determining the location of the Sonde during drilling

Description

The location of the Sonde underground is reliably determined by the location of two characteristic points (R and F), as well as the line (L) of the location on the earth's surface, which were mentioned in paragraph 5.2 (see Fig. 10).The process of determining the location (localization) of the Sonde consists in searching for these points and the location line. The direction of movement during the search is indicated on the screen by darkened "cross" sectors in the center of the display, which decrease when moving in the right direction.

The task of the search is to reduce the number of darkened sectors to zero. When the location points are reached, a darkened round mark appears in the center of the cross.

Thus, the sequence of actions of the operator when tracking the position of the Sonde is as follows:

1. Moving from the drilling rig in the direction of the drilling head, find the rear location point, focusing on the state of the darkened sectors. The darkening in all directions disappears, a dark circle appears in the center and the "R" symbol appears in the bottom row of the display symbols.

Fig. 13. Display of the Receiver dial SNS 1t

Fig. 14. Display of the dial when the Receiver SNS 1t is located on location line.

2. Mark this point with a marker;
3. Moving forward in the direction of the drill head, find the location line. There is also a darkened circle in the center and an "L" symbol in the bottom row of symbols.
4. Mark this point with a marker;
5. Moving further along the location line in the direction of drilling, find the front point of the location, focusing on the state of the darkened sectors. The darkening in all directions disappears, there is a dark circle in the center and the "F" symbol in the bottom row of the display symbols.
6. Mark with a marker.

The intersection of the location line and the line connecting the front and rear location points will give the location of the Sonde. However, this will be true if the angle of inclination of the drilling head is close to zero (horizon). When it is tilted, the field distribution pattern will change, as illustrated in Figure 15.

As it can be seen from the Sonde, **with a negative tilt of the Sonde, its true position will be shifted to the rear location point (R) and, accordingly, to the front point with a positive tilt. The Receiver software takes this offset into account when displaying the distance value "Dist".**

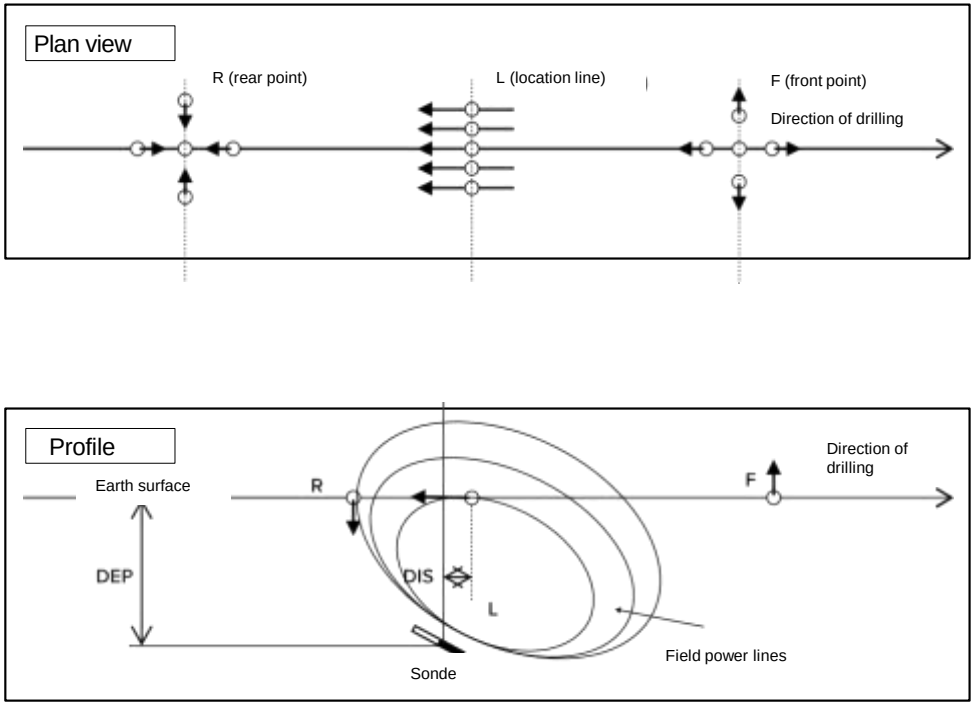


Fig.15. Distribution of the magnetic field at the tilt of the drilling head

Along with this, there is a way to determine the depth by the distance between the front and back points of the location. In the case of a zero angle of inclination of the probe and a horizontal surface, the depth is defined as the distance between between the points R and L, divided by 2. When the probe is tilted, it is necessary to use the table given in Appendix 2.

Following these rules will allow you to achieve the planned performance in the production of works using the HDD method, as well as avoid the negative consequences of damage to closely located underground utilities, and failure of location equipment.

When performing preparatory and drilling operations using SNS locating systems, operators must take into account:

1.To avoid receiving distorted parameters or loss of information about the position of the Sonde, be sure to verify that the range of receiving Sonde signals corresponds to the design values along the entire drilling route.

The decrease in range is most likely due to an excessive level of electromagnetic interference in the work area.

2. In order to ensure the accuracy of information about the removal of the Sonde from the Receiver, **before each drilling, it is necessary to calibrate the Receiver** with the Sonde properly installed inside the drilling head.

3. It must be remembered that the depth of the Sonde in the SNS 1 t NV system is measured not relative to the surface of the earth, but relative to the bottom of the Receiver. Automatic correction of readings depending on the height of the Receiver above the ground **is not provided.**

4. Important information about the temperature mode of the Sonde.

With prolonged drilling, or a lack of drilling fluid, an unacceptable increase in the temperature of the drilling head and, as a result, overheating of the Sonde is possible. At the same time

it is necessary to take into account the significant inertia, that is, the delay in the readings of the temperature sensor of the Sonde relative to the rapid increase in the temperature of the drilling tool. In order to avoid damage to the Sonde, if there is a visible tendency to increase (more than 60 ° C) the temperature, it is necessary to immediately take measures to cool it: slow down or stop the drilling process and/or increase the flow of drilling fluid. Each SNS st/1t Sonde is equipped with a thermal seal located in its end part, which reacts to an increase in temperature above 40°C. The appearance of a black mark on the thermal seal means that the Sonde is overheating above 88 °C. The MSt2 Sondes supplied by the 1 t NV Receiver in the kit do not have thermal seals, it is necessary to carefully monitor the temperature mode displayed on the Receiver display. It is possible to check the overheating of the Sonde only from the manufacturer.

In such a case, the warranty obligations of the SENSE for this probe are canceled.

5. Features of battery operation and storage.

- It is forbidden to store and transport the Sonde with an installed battery. In between use, the equipment must be stored in the supplied carry-on bag with the power supplies removed.
- It is forbidden to operate the system, including battery modules, at air temperatures below -20°C and above 40°C.
- The battery capacity at significant negative temperatures is usually significantly reduced, which leads to a reduction in the continuous operation time of the Receiver. This circumstance must be taken into account when planning work in the cold season.
- When transferring the SNS 1t NV Receiver from frost to a warm room, moisture condenses both on the surface and inside the devices, which can disrupt their operation. To avoid this, it is necessary to keep the devices warm for at least one hour before switching on.

- **It is forbidden to use batteries and accumulators with damage, or from an unknown manufacturer**. The use of such batteries may cause damage to the equipment and void the warranty
- Do not attempt to replace the battery of the **SNS 1t NV** location Receiver yourself. The battery of the **SNS 1t NV** location Receiver must be replaced only by SENSE or an authorized dealer. Improper replacement or repair can lead to battery damage, overheating and injury. Recycling or disposal of the battery must be carried out separately from household waste.

DO NOT BURN THE BATTERY

- Charge the **SNS 1 t NV** location Receiver using the supplied USB cable and power adapter. It is also allowed to charge the **SNS 1t NV** location Receiver using third-party cables and power adapters that meet the technical characteristics of the original kit, the requirements of local laws and meet international and regional safety standards. Other adapters may not meet current safety standards, and charging using them may involve a risk of injury or death.
- The use of damaged cables and chargers, as well as charging in humid conditions, can lead to fire, electric shock, injury or damage to the equipment of SENSE or other company. If the original power adapter is used to charge SENSE devices, make sure that the cable is securely inserted into the adapter before plugging it into a power outlet. It is important to ensure that chargers and power adapters are in a well-ventilated place during use or charging.

This symbol indicates that this equipment and/or battery cannot be disposed of with household waste. The disposal of SENSE equipment and batteries must be carried out

in accordance with local laws and regulations. After the service life of the SENSE equipment has expired, contact the local official authorities to find out about the possibilities of recycling and disposal, or transfer the equipment to the office of SENSE HDD LLC. Batteries must be removed and disposed of in a manner that does not harm the environment. Separate collection and disposal of waste contributes to the conservation of natural resources, protection of human health and the environment.

6. Recommendations for the maintenance of equipment.

- Clean the Receiver and Sonde housings with a soft cloth moistened with a mild soap solution.
- Clean the front surface of the display only with special moistened wipes to avoid scratches and loss of transparency of the glass.
- Periodically clean the contact springs of the Sonde to ensure reliable electrical contact with the batteries, as well as the threaded connection of the lid, through which electrical contact is also carried out.
- Periodically check the integrity of the rubber ring gasket on the battery cover of the Sonde, as its damage may cause water to penetrate into the Sonde and, as a result, the Sonde to fail.

WARNING!

It is forbidden to disassemble, repair, or make changes to the operation of the equipment. In this case, the buyer loses the right to warranty service, the supplier is not responsible for the accuracy of drilling data obtained using the SNS 1t system in the future.

DANGER!

The power supply modules contain lithium batteries. The storage, transportation by various modes of transport and disposal of lithium batteries are regulated by law.

8.1 Transportation

Carrying equipment in the field

When carrying the SNS 1t NV system in the field, make sure that it is carried:— in a portable bag

Fig.16. Portable bag

—or by the operator in hands

Transportation by car

When transported in a car, the carry-on bag with the components of the SNS 1t NV locating system must be securely fixed in order to avoid the effects of shock or vibration. Be sure to use a carry-on bag for transportation and secure it on board.

Transportation by cargo

When transporting by rail, on ships or airplanes, be sure to use an impact-resistant case (optional) for packaging and transportation, or similar means to protect the devices from shock and vibration.

Transportation and carriage of batteries

When transporting or carrying the batteries, the person responsible for the SNS locating system must ensure that all national and international requirements for such operations are met. Before transportation, it is recommended to contact representatives of the company that will do this.

Calibration in the filed

After transporting or carriage of the instruments, or before each drilling, it is necessary to perform the calibration described in this Manual in the field before starting work. If the instrument is stored for a long time, remove the alkaline batteries from the Sonde to avoid leakage.

8.2 Storage

Tools and instruments

Observe the temperature conditions for storing the equipment, especially in the summer when storing it in the car. Refer to the section for information about the temperature mode.

Calibration in the field

After long-term storage, it is necessary to perform the calibration described in this Manual in the field before starting work.

Li-Ion And alkaline batteries

- Refer to the section for more information about the storage temperature range.
- It is recommended to store the batteries at temperatures from 0°C to +20°C / +32°F to +68°F in a dry place to minimize their self-discharge.
- If these conditions are met, batteries with a charging level from 10% to 50% of their capacity can be stored for a year. After this period, the batteries should be fully charged.
- Before storing, it is recommended to remove the batteries from the tool or charger.
- Before using rechargeable batteries (Li-Ion) that have been in storage, they should be recharged.
- Ensure that the batteries are protected from humidity and dampness. Wet batteries must be thoroughly wiped before storing or using them.

8.3 Drying and cleaning

Description

Use only clean, soft and non-fibrous pieces of cloth for wiping. If necessary, they can be moistened with water, in no case do not use any other liquids, as they can damage the polymer components. It is unacceptable to use pure alcohol to clean the Receiver screen. It is recommended to dry the components of the SNS 1t locating system, bag or container (optional), packaging seals at a temperature not exceeding 40°C mandatory subsequent wiping. Do not pack the components of the locating system until everything is completely dried. Keep the cables and plugs in a dry and clean condition. Check for dust and dirt on the connectors of the connecting cables.

9 LIMITED INTERNATIONAL WARRANTY, SOFTWARE LICENSE AGREEMENT

Main provisions

LLC SENSE HDD, legal address: Russia, 432028, Ulyanovsk, Oktyabrskaya str. 22, build. 14 (SENSE) guarantees to the original end customer (Buyer) that both the SNS locating system as a whole (the "System") and the SENSE brand, its components comply with the technical specifications declared by SENSE Company published at the time of delivery, free from defects in materials and quality of manufacture of Products stamps of the SENSE (further –The "Product") for a period of TWO (2) YEARS from the confirmed date of initial purchase (or, if applicable, from the date of delivery, or from the date of acceptance) of the Product at the central office of the SENSE and dealer network (the "Warranty Period"), subject to strict observance of operating conditions and technical maintenance in accordance with the operating instructions provided by the SENSE company.

In accordance with this warranty, you can file a claim directly with SENSE, even if the SENSE Product was purchased from third parties. If a defect in the Product is detected during the Warranty Period, SENSE, at its discretion, will repair the Product free of charge using new or equivalent new parts in terms of performance and reliability, replace the Product with another functionally equivalent product assembled from new or used spare parts equivalent to new ones in terms of performance and reliability, or, with your consent, a product that is at least functionally equivalent to the replaced Product (in this case, all replaced products or parts thereof become the property of the SENSE), or reimburse the cost of the originally purchased Product. This warranty does not apply to normal wear of consumable parts, such as batteries, except in cases where the causes of the malfunction are defects in materials or workmanship, and damage resulting from improper use, accident, unauthorized repairs and other causes that are not defects in materials and poor workmanship. SENSE does not guarantee the absolute accuracy or completeness of the data or information displayed or calculated by the System. The accuracy and completeness of such information may depend on a number of factors, including (without limitation): active or passive interference (including interference from salt water), as well as other environmental conditions. Incorrect or incomplete calibration; improper operation of the device, as well as other factors. SENSE does not guarantee or accept any responsibility for the accuracy or completeness of the data received from any external devices, which were calculated based on any data received from any external devices and shown on the SENSE device, including (without limitation) all data received from any HDD drilling rigs.

Within the framework of this warranty, SENSE undertakes to carry out maintenance of the equipment sold to the consumer and support for the software product, which consists in making free repairs or, at its discretion, replacing defective components during the warranty period. In addition to the above, SENSE guarantees to provide free consulting services remotely via available means of communication during the same period, and, if reasonably necessary, to carry out free testing of the supplied equipment.

Within the framework of this warranty, SENSE undertakes to provide technical maintenance services even after the end of the warranty period (SERVICE PERIOD) on a commercial basis, as well as on a commercial basis in cases not covered by these warranty obligations. SENSE reserves the right to make design changes and improve SENSE products from time to time, and the User understands that SENSE is not obligated to improve previously manufactured SENSE products in order to make such changes.

9 LIMITED INTERNATIONAL WARRANTY, SOFTWARE LICENSE AGREEMENT

Warranty period

The calculation of the warranty period begins from the moment the final buyer signs documents on the acceptance of the System or its components from SENSE or from a dealer authorized by SENSE to sell SENSE products.

The warranty period is set separately for different SENSE products:

— the warranty period is 24 (twenty-four) months for all SENSE equipment included in the delivery package;

— the warranty period of 3 (three) months is set for the batteries supplied with the System, for all services provided by SENSE, including control tests, as well as for products repaired outside the warranty period, as well as products not subject to warranty repair by SENSE.

Service period

The term "Service period" means the period of time from the moment the buyer signs the acceptance documents for the System or its components until the end of any obligations of the SENSE company to carry out repairs, software product support, testing and consulting services. The service period established by SENSE is 20 years.

Warranty for the software

The system software (defined as operating software and/or proprietary software that is necessary for the activation and operation of the equipment) is subject to the terms of the warranty provided by SENSE for the equipment. The terms of this warranty clearly cannot be applied to application programs (defined as pre-installed or downloadable embedded programs and/or PC-supported programs for special use of devices and/or data). Information on the amount of the warranty for the application software is contained in the corresponding software license agreement.

What is covered by the warranty?

The warranty period applies to the following new SENSE products: Receivers, Repeaters, battery chargers and the batteries themselves. The warranty period of ninety (90) days applies to all other new SENSE products, including Sondes, accessories, and software. Unless otherwise agreed by SENSE, the warranty period of ninety (90) days applies to:

a) a used SENSE product sold by SENSE or an authorized SENSE dealer who has explicitly obtained from SENSE the authority to sell such a used SENSE Product;

b) services provided by the SENSE company, including testing, maintenance and repair of an unguaranteed SENSE product. The warranty period starts from the date of shipment of the SENSE product or from the date of shipment (or other delivery) The products are SENSED by an authorized dealer to the user.

The warranty period also applies to all SENSE software products.

What isn’t covered by the warranty?

This warranty does not apply to any hardware devices and software not manufactured under the SENSE brand, even if they were packaged and sold with SENSE products. Products and products not manufactured under the SENSE brand may have their own manufacturer's guarantees, which provide advantages in addition to the rights provided for by consumer protection legislation.

This warranty doesn’t cover:

a) wear of consumable parts, such as a battery or protective coatings, except in cases where damage is caused by defects in materials or workmanship;

b) cosmetic damage, including, but not limited to, scratches, dents or plastic damage in the area of ports, except in cases where the damage is caused by defects in materials or workmanship;

c) damage caused by use together with third-party components or products that do not meet the specifications of the SENSE product;

d) accidental damage and damage caused by violation of the rules, improper use, contact with liquid, fire, earthquake and other external causes;

e) damage caused by the use of the SENSE Product not in accordance with its technical specifications or other published by SENSE instructions;

f) damage caused as a result of maintenance (including updates and extensions) by persons who are not representatives of SENSE or authorized service centers of SENSE;

g) SENSE products, the functions and capabilities of which have been modified without the written permission of SENSE;

h) defects caused by natural wear or aging of the SENSE device;

I) SENSE products on which the serial number has been removed or damaged

Provision of warranty services

If the functioning of SENSE's products, including software, does not comply with the technical specifications declared by SENSE during the warranty period, then, upon written request from the Buyer, SENSE will perform a control check of the product. In case of confirmation of the defect, such a product will either be repaired free of charge (software updated), or replaced at the independent choice of SENSE. The Buyer's written statements of complaints must contain a detailed description of the external manifestations of the alleged malfunction. All complaints must be submitted by the Buyer complete with documents confirming the purchase of SENSE products, including confirmation of the date of purchase, and must also include the serial number of the product. Complaints must be submitted no later than the expiration date of the warranty period.

The above-mentioned measures represent the sole and exclusive measures of compensation to the Buyer for violation of the aforementioned warranty statements by SENSE. A repaired device or a replacement device is sent to the "Buyer" within the time required for this. SENSE takes care of the costs of sending repaired or replaced devices or their parts. SENSE is not responsible for damage received during transportation. SENSE determines the locations of warranty work at its discretion.

The procedure for applying for warranty repairs

If you have any questions about the operation of the System, you must first contact the authorized SENSE dealer from whom the System was purchased (if any). If the authorized dealer cannot resolve the issues that have arisen, or the System was purchased directly from the SENSE company, then you need to contact the SENSE company directly by phone. +7 (8422) 45-72-00. The telephone line is open from 07:00 to 16:30 Moscow time.

As experience shows, many problems arise not because of a malfunction of the equipment, but because of improper operation, due to lack of experience in using equipment of this type or due to inappropriate environmental conditions, in particular, high intensity of active interference. In this case, the problem is usually solved by telephone consultation directly during the work. To achieve the maximum effect of such consultations, it is necessary to prepare the required equipment in advance.

If, as a result of operational inspections and discussion of issues with a representative of the customer service of the SENSE company, a malfunction of the SENSE product is confirmed, the Buyer will be asked to send the defective equipment for repair to the SENSE company. When sending, you must attach a cover letter with a description of the problems encountered, as well as contact details to the product.

Payment for transportation, including all insurance costs, is made by the Buyer. If, after receiving the company's SENSE of the product and performing the appropriate

diagnostic checks, it will be established that the problem that has arisen falls under the warranty, the company will perform the required repair and/or adjustment of the product, after which a fully functional product will be immediately sent to the Buyer. The return delivery is carried out at the expense of the SENSE company.

If the identified fault does not fall within the scope of the warranty, the Buyer will be informed of the reasons for the cancellation of the warranty and an estimate of repair costs will be provided to him. After obtaining the Buyer's consent for the production of commercial repairs, all work will be performed immediately, and the repaired product will be sent to the Buyer. In this case, the Buyer will be billed for all expenses not covered by warranty obligations, including transportation costs and insurance. In most cases, the repair period does not exceed 1-2 weeks.

At the time of repair, the SENSE company can provide similar equipment under repair for short-term rent. If such equipment is urgently needed and is available, then the company will try to send it with an urgent delivery. SENSE will make every reasonable effort to reduce the downtime of the Buyer's equipment caused by the warranty claim. If the company provides the equipment for the duration of repair, the unused equipment must be received for repair later than on the second business day after the Buyer receives the equipment for rent. After receiving the repaired equipment from SENSE, the leased equipment must be returned to SENSE using urgent delivery so that SENSE receives it no later than the second business day after you receive the repaired SENSE product. If these deadlines are not met, the rental fee for the use of the leased equipment will be charged for every day of delay in its return. In case of elimination of defects, the warranty period is extended for the period during which the Product was not used. The warranty period for the replacement Product is calculated anew, starting from the date of delivery of the Product to the consumer.

IMPORTANT!

Do not attempt to open the case of SENSE Products unless the operating instructions describe how to open it or remove the protective covers from SENSE Products. Opening the cases of SENSE Products or removing the protective covers may cause damage that is not covered by this warranty. SENSE Products should only be serviced by SENSE or authorized SENSE service representatives.

Exclusivity of the warranty obligation

Upon the occurrence of a warranty event, the Buyer's right to warranty repair follows solely from the above warranty obligation. The above-mentioned warranty has exclusive effect and replaces all other agreed or tacit warranties, conditions and definitions of an actual or legal nature, including those related to quality accepted on the market, suitability for a certain type of use, satisfactory quality or compliance with the rights of third parties; any warranties that arise in the ordinary case, during handling or execution, any warranty that the software is compatible with any specific hardware or software, that the software will work properly on the customer's equipment and will not cause malfunction of the customer's equipment or damage to its data, as well as any warranty that the software will work continuously or without errors, all of them are unequivocally considered invalid.

These warranty obligations do not apply to all cases of damage, the causes of which may be, but are not limited to, the following:

— non-compliance with the provisions of the Operating Instructions for the System or its individual parts;

— operation of SENSE products in conditions beyond the performance characteristics for this product (including, but not limited to, temperature conditions);

— abuse, misuse, negligence, negligence, accidents, fire, flood, natural disasters, improper use, connection to the mains of incorrect voltage, as well as to improper power sources, use of incorrect fuses, overheating, contact with high voltage sources or aggressive chemicals, use of batteries and other products that were not supplied or recommended by SENSE, as well as other events beyond the control of SENSE.

These warranty obligations do not apply to any damage that occurred during the transportation of the SENSE product to or from SENSE.

In addition to the above, the warranty obligations are canceled in the following cases:

— in case of alteration, destruction or forgery of any factory or serial number, identification, instructing or sealing labels on the product, or;

— in case of any unauthorized dismantling, repair or modification of the product outside the SENSE company.

— In no event shall SENSE is liable for costs or any damage caused by any changes, modifications or repairs to the SENSE product made without the express written permission of SENSE;

— In addition, SENSE is not responsible for damage and damage to the SENSE product or any other equipment in the possession of any service department that does not have the appropriate permission from SENSE.

Restriction of responsibility

The warranty obligations set out above are the sole obligation of Sense and are given in lieu of all other obligations, express or implied, including, but not limited to, implied warranties of merchantability and fitness for a particular application, implied warranties of non-infringement, and any implied warranties arising during operation, during commercial activity or in the course of intended use. This statement is a disclaimer and an exception to the obligations of all the above-mentioned cases.

To the extent permitted by applicable law, sense disclaims all liability arising from a contract, quasi-contract or tort (including mild and moderate negligence) for extraordinary, indirect and special damages, fines of any kind, the customer's expenses for the purchase of replacement products, any loss of income or profits- whether the company, disruption of transactions, loss of information or data, or other financial damage resulting from the sale, installation, maintenance, use, operation, failures or downtime of products or in connection with them, and limits its liability at its sole discretion to replacement, repair or reimbursement of the cost of the purchased device. This is valid even if the company or its authorized distributors have been informed of the possibility of this damage. This exclusion of liability for damage does not apply if any of the tools listed here do not perform their basic functions. Some powers do not allow the limitation of accidental or consequential damages, so this limitation does not apply. In the event that applicable law does not allow for the complete exclusion or limitation of liability for claims and damages, as mentioned above, liability is largely limited to the scope of applicable law. Within the limits established by the current legislation, responsibility for support personnel is also excluded.

If Sense performs all the actions described above to ensure warranty procedures, these actions will constitute the only and exclusive compensation measures for the buyer for violation of the aforementioned warranty statements of Sense. These limitations of liability are subject to interpretation in accordance with the laws of the Russian Federation.

Exclusion

If the court does not allow the complete exclusion or limitation of tacit guarantees or liability for indirect or consequential damage for certain Products supplied to consumers, or limitation of liability for personal injury, then these tacit guarantees and liability are limited by the warranty period.

Separability

If any provision of this warranty is found by any official authority to be void, invalid or non-enforceable, then such provision shall be deleted from the warranty, and the remaining provisions shall remain in full force and effect. In such a case, the warranty is subject to interpretation and, if necessary, correction in such a way as to ensure the achievement of such or approximately such a result, which would be as close as possible within the framework of legislation to the result, which was provided for by a provision recognized as null, illegal or non-enforceable.

General provisions

No SENSE dealer, agent or employee is authorized to amend, extend or supplement this warranty. This warranty is governed by and construed in accordance with the laws of the country in which the Systems and/or SENSE Products were purchased.

Sample of the warranty card

APPENDIX 1

Corrections for the angle of inclination of the Sonde

Description

When laying communications that require increased accuracy to the angles of inclination, the error of the angle of inclination readings should be taken into account, depending on the angle of rotation of the instrument (clock).This error is formed from the error of the Sonde itself, its installation in the drilling head and the error of the drilling column (different lengths of rods).

To compensate for this error, the following method is offered.

1. It is necessary to rotate the drilling head with the installed Sonde around its axis, taking readings of the angle of inclination every "hour" (corresponds to 30 degrees).
2. Enter the readings in the following table.

Clock indications	Readings of the inclination angle (%)	Remark
12	-1.6	The smallest angle
1	-1.9	
2	-2.3	
3	-2.6	
4	-3.0	
5	-3.4	
6	-3.8	The largest angle
7	-3.5	
8	-3.1	
9	-2.8	
10	-2.4	
11	-2.0	

3. Select the rows with the smallest and largest tilt angle readings in the table (in the example, rows 12 and 6 o'clock).
4. From these two values, find the average angle (add up the readings and divide by 2):

Example: –1.6 + (-3.8) = –5.4;
–5.4 / 2 = –2.7%.

The resulting angle (-2.7%) is the specified angle of inclination. To apply this calculation in accounting for the angle of inclination during drilling, two methods can be used:

- Use the table to determine the value of the "clock" closest to the specified angle (in our example, it is 3 or 9 o'clock). In the future, take the readings of the angle of inclination at this position of the tool. To check, place the tool in this position and make sure that the tilt angle readings match the specified angle.
- Another way of accounting is to determine the correction of readings for 12 hours. To do this, subtract the calculated specified angle from the angle reading at 12 o'clock (in our example -1.6 – (-2.7) = 1.1%). In the future, take readings of the angles at the 12 o'clock position and subtract the correction.

Example: We got the angle readings 1.5% (1.5 – 1.1 = 0.4) – the specified reading will be 0.4%.The rotation of the drilling head to calculate the correction can be done when installing the drilling head in the machine together with the first rod. You can also make refinements at the control points of the well. For the most accurate calculation, it is necessary to take readings at angles of inclination close to zero.

Depth calculation based on the distance between the FLP and RLP location points

The depth of the drill head can be calculated by the distance between the location points. The calculation is possible if the angle of inclination of the drilling head is determined and the location points are located approximately on the same horizon. To calculate, it is necessary to measure the distance between the location points and use the formula:

$$\text{depth} = \frac{\text{distance between the location points}}{\text{divider}}$$

where "divider" is a parameter depending on the angle of inclination of the drilling head.

Sonde inclination angle %	Divider	Sonde inclination angle %	Divider	Sonde inclination angle %	Divider	Sonde inclination angle %	Divider
0	1,41	26	1,47	52	1,62	78	1,84
2	1,41	28	1,48	54	1,63	80	1,85
4	1,42	30	1,48	56	1,64	82	1,87
6	1,42	32	1,49	58	1,66	84	1,89
8	1,42	34	1,50	60	1,68	86	1,91
10	1,42	36	1,51	62	1,69	88	1,93
12	1,43	38	1,52	64	1,71	90	1,96
14	1,43	40	1,54	66	1,73	92	1,98
16	1,43	42	1,55	68	1,74	94	2,00
18	1,44	44	1,56	70	1,76	96	2,02
20	1,45	46	1,57	72	1,78	98	2,04
22	1,45	48	1,59	74	1,80	100	2,06
24	1,46	50	1,60	76	1,82		

Requirements to the case of the drilling head

Description

In order to obtain the maximum range of the Sonde and extend the life of the batteries, there must be slots in the body of the drill head that meet the requirements for the minimum length, width and location on the case.

WARNING!

SENSE recommends the presence of at least three slots, which should be at least 1.6 mm wide and evenly spaced around the circumference of the case. The size of the slot should always be measured on the inner surface of the case.

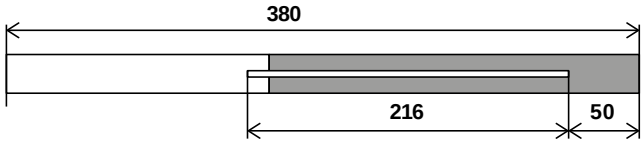


Fig.16. Slots for the MSt2 wireless Sonde assembly with adapter for size 380x32mm

WARNING!

The size of the slots is specified not for the outer, but for the inner seating surface of the case. If a disc cutter is used when cutting through the cracks, these sizes will vary significantly.

The Sonde models assembled with the adapter have a diameter of 32 mm and must fit tightly into the inner cavity of the case. To ensure the tightness of the probe installation in the body of the drilling head, it can be fitted with O-ring gaskets. To ensure the correct orientation of the Sonde in the drill head, the control groove in the front cover of the Sonde must be inserted into the fixing protrusion of the case.

Active interference

Description

Sources of active interference include (among others): traffic light circuits, underground communications, dog fences, cathodic protection systems, high-voltage installations, television cables, electrical cables, high-voltage power lines, fiber optic cables, telephone cables, cellular telephones, relay masts, other sources interference. In addition to these active interferences, there are other types of interference that also affect the range of the Sonde signal and its localization errors. Such interference is classified as "passive", the effect of which can either weaken the electromagnetic field of the Sonde or distort its spatial distribution. Typical representatives of such interference are: reinforced concrete structures saturated with metal reinforcement, massive metal structures near the drilling route. In addition, conductive media such as salt water, moist saline soils, etc. significantly weaken the signal.

Due to the fact that the magnitude and nature of active interference affect the operation of the locating system, it is ALWAYS necessary to walk with the Receiver and Sonde along the entire route before drilling to ensure the reliability of their interaction. In this case, the Receiver should be moved along the design route, and the Sonde should be carried at a distance equal to or greater than the design depth.

Certification

CE certification — registration number: CE: BOKE-221201302C, 219.05-SENSE-SNC it-EU

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Dealers and partners:

You can always find up-to-date information about dealers and partners of the company "Sense HDD" LLC at **https://sense-hdd.com/dealers/**

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