

OPERATING MANUAL**Locating system
for horizontal directional drilling****SNS 300**

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The present manual is meant for reviewing the safety instructions, standard operating procedures, box contents and the configuration of the locating system for horizontal directional drilling - SNS 300 (system SNS 300).

The operating manual for SNS 300 system is the main document for training the operating staff who execute the work of horizontal directional drilling in accordance with the specified project with the use of SNS 300 locating system.

The technical information and recommendations outlined in the present manual fully comply with the current modification of SNS 300 system and its software version and apply neither to any other current modifications of the system configurations and its software implemented by the operator without any relevant approval of SENSE LLC nor to any work-piece executed by the third party.

None of the provisions of the present document constitute to the warranty obligations of SENSE LLC and cannot be regarded as the conditions for altering the terms of the existing limited warranty of SENSE LLC which applies to all the products of the company.

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Addressing the customer

Dear user!

We would like to thank you for the fact that you have chosen our SNS 300 locating system. We are very proud of our equipment and hope that you will fully evaluate its advantages.

Our main company mission is the creation of the unique highly qualified equipment and relevant service support from the customer service department, also training the staff to work with the equipment.

If any questions arise you are always welcome to contact our representatives by one of the phone numbers stated on the front page of the present manual.

We attentively take care of all scientific developments in the sphere of horizontal directional drilling with the purpose of creating new equipment which can assist in speeding and making the work easier. You can follow the new by yourselves on our website: www.sense-inc.ru or by calling us.

You are always welcome with questions, remarks and suggestions.

Safety instruction



Reviewing the safety instructions is obligatory for the staff of the drilling rig and following them guarantee avoidance of injuries and breakage of high-priced equipment and surrounding objects.

1. Avoid the contact of the underground drilling equipment with underground utilities, HV or gas pipelines.
2. The operators of the horizontal directional drilling shall meet the following requirements:
 - know the methods of safe and proper service of drilling and steering equipment including using insulating mats and relevant methods of equipment grounding;
 - before the start of drilling make sure that all the underground utilities and communication networks are allocated, identified and correctly specified;
 - use the relevant uniform - helmet and contrasting jackets;
 - precisely and correctly do the locating and following the probes which were installed in the boring head while drilling;
 - meet the requirements of national and local governmental regulations;
 - fulfill all the other corporate requirements of the safety instructions.
3. SNS 300 steering system can't be used for localizing utilities.
4. The continuous use in conditions of high temperatures which are caused by the heating of the boring head is unacceptable.
5. Steering equipment mustn't be operated near highly flammable and explosive materials.
6. In case of long distance transporting or long-term storage the batteries must be taken out from all the nodes of the system.
7. Before every drilling session in case of the precise and correct installation of the probe it is necessary to do the calibration of SNS 300 system in order to prove its correct work and passing precise information in respect of the location and guidance of the drill head.

8. To obtain accurate readings about the depth of the drill head while boring the main requirement shall be met: the receiver should be positioned above the transmitter, installed under the drill head underground.
9. After any breaks in the process of drilling calibration check of the equipment shall be performed every time.
10. To avoid obtaining inaccurate parameters or loss of information about the transmitter location it is necessary to do the check-up if there is electromagnetic interference:
 - traffic signal loops, invisible dog fences, cathodic protection, radio communication devices, high frequency installations, TV cables, digital utility networks, security systems, telephone cables, conductive earth, telephone cables, salty water, HF radiation and other interference sources;
 - interference sources in case of the use of the repeater can be other sources of radiation working on the same frequency near the display (E.g. system of distant car registering of other locating equipment of HDD));
 - On performing any location operations the interference level should be minimal.

Introduction

SNS 300 locating system is used in the process of horizontal directional drilling for spotting the location of the transmitter installed under the drill head underground.

The system consists of the receiver, transmitter, drill master's control (repeater) with cable and battery supply, the relay, set of batteries and antennae for all the devices of the system, USB-radio modem for the computer and software of the system.

SNS 300 locating system can be equipped by several transmitters of various use, depth and usage period.

SNS 300 locating system has a function of recording pieces of data of boring while sinking. Boring data can be uploaded on the computer with the software program that goes with the system.

The present manual has information about each component of the SNS 300 system: the receiver, the repeater, the transmitter, the relay and the software. In the following chapters there is a description of the preparing the components of the system before drilling and its proper use while drilling

Receiver



Appointment

- The receiver is intended for tracking the location of the drill bore head in horizontal directional drilling.
- The receiver gets parametric information from the transmitter and displays it on the indication panel: tilt angle, transmitter position according to a clock, temperature and the level of battery in the receiver and the transmitter.
- In the process of locating, the receiver calculates the depth of the transmitter, the position of the receiver and displays it on the display.
- The receiver sends the dubbing information to the remote display - the drill master's control (repeater).

Technical specifications

- Dimensional specifications:

- length – 310 mm;
 - width – 140 mm;
 - height – 285 mm.
- Net weight: not more than 4 kg.
 - Power supply: – 6 batteries LR14 type, size C, or NiMH accumulators of the same size, capacity - not less than 4500 mA*hour.
 - Duration of the constant work from one battery set - more than 10 hours.
 - Information indication: graphic LCD monitor.
 - Menu in English.
 - Possibility to save the current information in the process of drilling.
 - The distance of the radio coverage to the drill master's control (in direct visibility), not less than:
 - distance range 450 m without relay;
 - distance range 1000 m with one relay. If several relays are used the distance is getting bigger in proportion to their quantity at increment of 500m.
 - Range of working temperatures: from – 20 up to + 60°C, relative humidity up to 98 %.

Installing the set of batteries

Install completely charged rechargeable batteries or alkaline batteries (see fig.1) with the correct polarity into special cassette.

Put cassette with batteries to its place until you hear a click.



Fig. 1
Batteries installing

Main menu







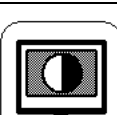
- The main menu of the receiver has a 'tile interface' style.
- On the front side under the indication panel there are control buttons.



Fig. 2 Button assignment:

1	switch to left Menu tile	- [←]
2	switch to upper Menu tile	- [↑]
3	switch to bottom Menu tile	- [↓]
4	switch to right Menu tile	- [→]
5	activate the selected Menu tile	- [↵]

Meaning of tiles/icons:

	switch to work mode
	turn off the receiver
	switch to radio modem settings, simultaneously shows that radio modem is on
	radio modem is off
	switch to calibration mode
	switch to receiver settings mode
	contrast settings

Main menu:

- [←], [↑], [↓], [→] – menu navigation;
- [↵] – select

Contrast menu:

- [←] – screen inversion;
- [↑] – contrast (lighter)(+);

- [↓] – contrast (darker)(-);
- [⇒] – on/off backlight

Location:

- [↑] – HD - Refinement of depth readings. Updating is used only in motionless position of the receiver and the transmitters.
- [↓] – DATA. - Sample-save the angle and the depth for the current drill bar in a protocol table.(Protocol table shall be made in advance)
- [⇒] – RLF -manual setting the location zone of the receiver regarding the transmitters: – R –in the rear area of the transmitter, L –above transmitter, F – in the front area of the transmitter.
- [↵] – exit the menu

Radio setup menu (see p.18):

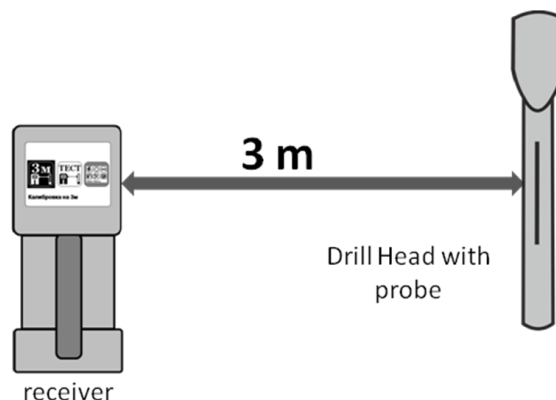
- Select the radio channel (0,1,2,3)
- Select the communication - without relay, with one or two relays, switch off the modem

Settings Menu (see p.19):

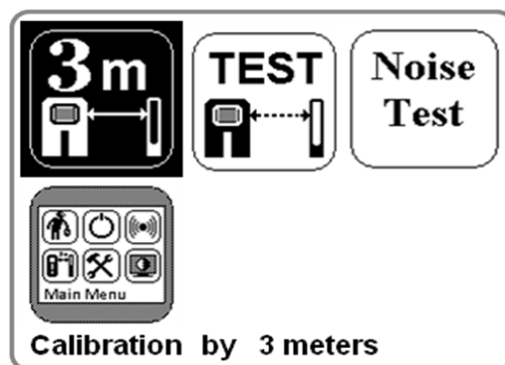
- Current drilling rod number.
- Managing protocol tables.
- Select units of display of the transmitter's angle inclination(°,%) .
- Correction on 12 o'clock.
- Receiver's height, and predicted depth mode.
- Frequency selection

Calibration

The mode is intended for calibration the readings of the receiver's distance regarding the transmitter. To do the calibration the transmitter shall be positioned at the distance of 3 m from the receiver's edge (as shown).



Activate the tile 3m with the help of button navigation to start calibration at 3 meters. At the end you shall see the sign 'ready'. Then press the key ([←] "USE") to save the calibration result and exit

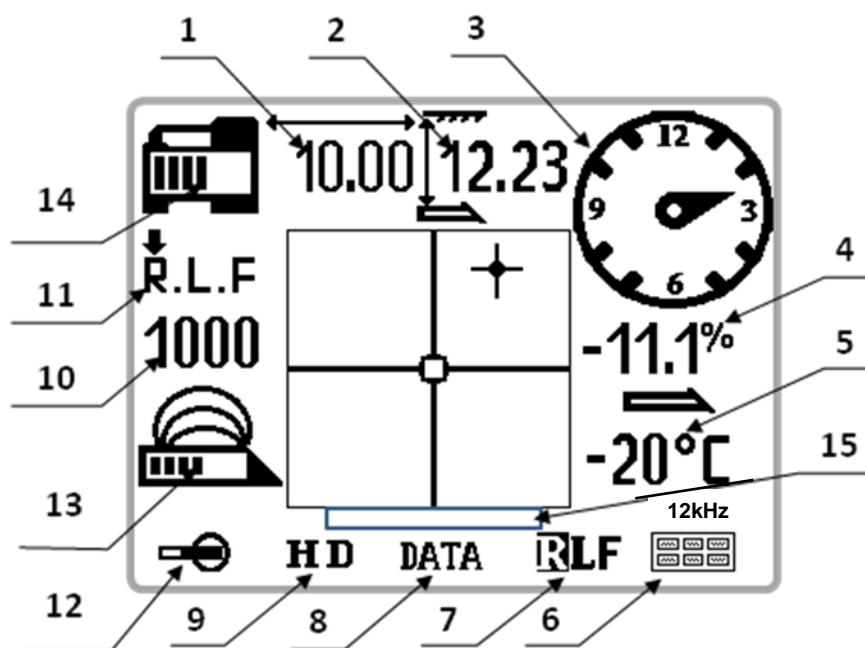


The tile 'Calibration test' is to check the distance readings at various distances.

Menu "Noise test " - displays the interference level for different frequencies: - a lower number represents a lower level of the interference. Evaluation of the interference level must be performed when the transmitter is off. Evaluation of noise level allows you to choose the preferred frequency of operation of the transmitter and receiver for a given environment, and to evaluate the depth of detection of the transmitter signal.

'Location' mode

The basic operation mode of the receiver - is location mode. While receiving a signal from the transmitter the screen displays real time data about the location of the transmitter, its temperature, longitudinal slope, 'clock' position and the signal level.



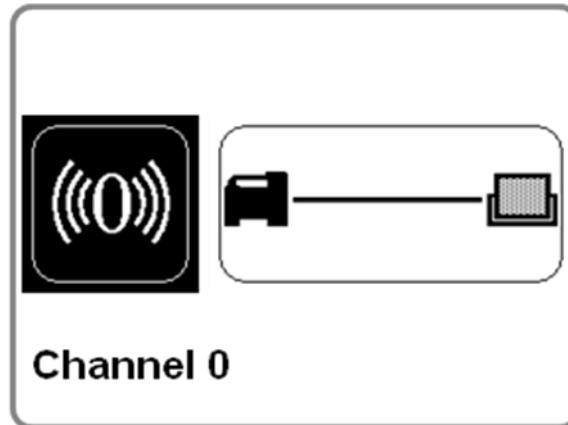
Indication in location mode

1	Distance between the transmitter and the receiver in drill directing. The receiver shall be positioned along the direction of the drilling route.
2	The depth of the transmitter regarding the receiver
3	'Clock' position of the transmitter
4	Inclination angle (regarding the horizon)
5	Transmitter's temperature (Celsius)
6	Switch to menu - switch to main menu
7	Manual setting the location zone of the receiver regarding the transmitter R – in the area of the rear location point, F – in the area of the front location point,

	L – in the area above the transmitter (location line).
8	Sample-save the angle (item 4) and the depth (item 3) for the current drill bar in the drilling protocol table (the protocol table shall be made in advance).
9	Refinement of depth readings. Updating is made by enlarging the length of averaging the readings. Quitting the mode - updating shall be used only at a motionless position of the receiver of the transmitter.
10	Signal level in nominal units. In the "TEST" mode the noise level is displayed
11	Location points: R – in the area of the rear location point, L – in the area above the transmitter (line location), F – in the area of the front location point
12	Enable/disable a more reliable reception of information (only 33 kHz). Used when stopped drilling.
13	Displaying of the battery charge level of the transmitter
14	Displaying of the battery charge level of the receiver
15	Displaying of the quality of the received signal

Radio setup

After switching on the tile main menu "RadioModem" the radio setup screen appears :



	Channel 0. Select the radio channel(0,1,2,3).
	No Relays. Select the communication- without relay, with one or two relays, switch off the modem.

Radio setup menu:

- [←],[→] – menu navigation;
- [↑],[↓] – value change;
- [↵] –select.

Select the radio channel:

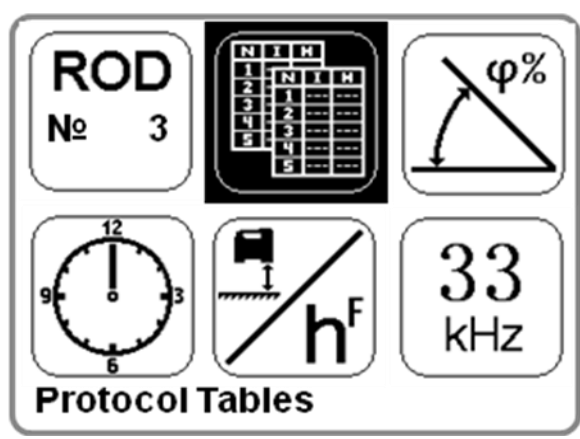
- [↑],[↓] – you can select the radio channel(0,1,2,3);
- [↵] –select.

Select the communication:

- [↑],[↓] – you can select the communication;
- [↵] –select.

Settings

After switching on the tile main menu "Settings" the settings screen appears:



	<p>№ next rod. Shows the number of the rod, for which the measurement will be recorded in the current protocol table. (The table must be previously created. Check next paragraph).</p>
	<p>Protocol Tables. Protocols tables managing.</p>
	<p>Percents. Setting display mode of the transmitter angle: degrees or percentages.</p>
	<p>Correction on 12 o'clock. Installation transmitter position correction according to 12 o'clock. Used when the 12 o'clock mark on the transmitter does not coincide with the corresponding position of the blade in the drill head</p>
	<p>The height of the receiver and hF. When activated, the transition is executed in the operating menu (see description below tiles).</p>
	<p>Receiver height above the ground . This value will be subtracted with the measured height. This mode can be used when measuring above of the ground surface.</p>
	<p>Selecting the display depth transmitter. h - displaying of the actual depth. hF - displaying of the calculated depth (when the transmitter will be under the receiver if it will be moved with the current tilt). In this mode, near with indicating the depth will be displayed the letter "F".</p>

33 kHz	Frequency selection - 33 kHz
12 kHz	Frequency selection - 12 kHz
1.5 ^{kHz} X	Frequency selection - 1.5 kHz (receive data from the transmitter needs to be done at a frequency of 12 kHz. See Instructions for selecting the operating mode of the transmitter - paragraph 2.6)
1.5 kHz	Frequency selection - 1.5 kHz

Settings menu:

- [←], [→] – menu navigation;
- [↑], [↓] – value change;
- [↵] – select.

№ next rod:

- [↑], [↓] – you can change rod number;
- [↵] – select.

Protocol Tables:

- **New table** - create a new protocol table (up to 10 tables).
- **Delete the table** - delete the last table.
- **Clear all tables** - delete all tables.
- **Tables** - protocol table review.
- **Connect to PC** -reception/transmission protocols tables to computer.

Percents:

- [↑], [↓] – you can change display mode;
- [↵] – select.

Correction on 12 o'clock:

- [↑], [↓] – you can make required correction;
- [↵] – select.

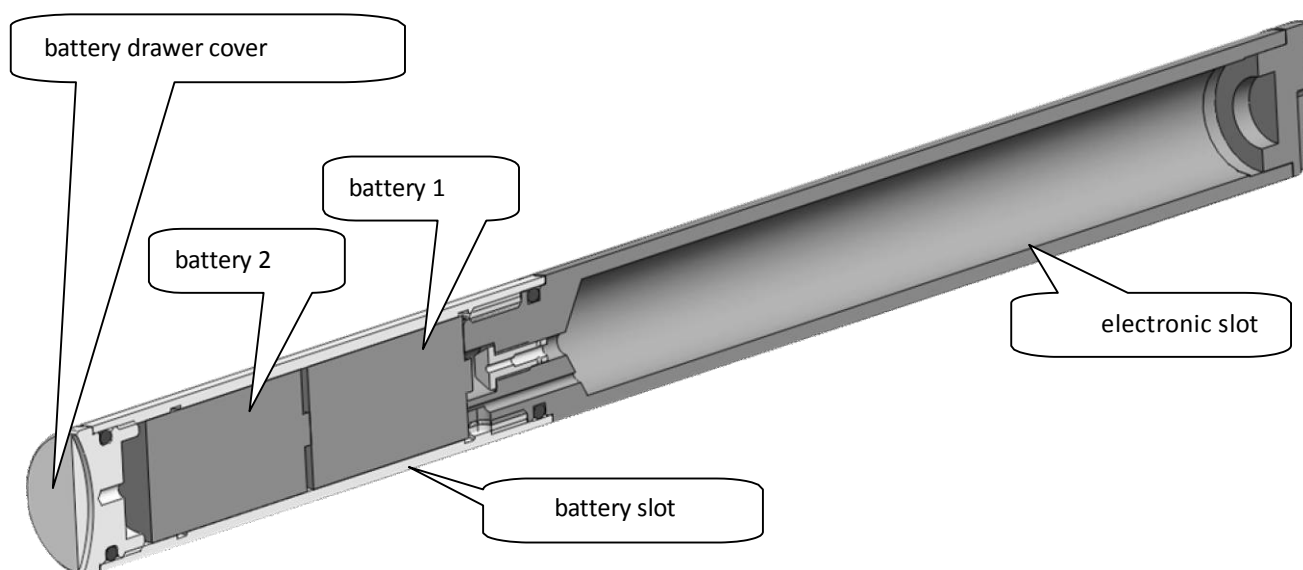
Height of receiver and hF:

- [↑], [↓] – you can make correction;
- [↵] – select.

Frequency selecton:

- [↑], [↓] – you can to set desired value;
- [↵] – select

Transmitters



Technical specifications

LLC SENSE produces several types of transmitters.

General:

- radiation frequency – 12 KHz;
- accuracy of fluctuation at longitude angle of inclination – 0,1 %;
- identification of turn angle – 24 positions

Transmitters of the standard radius of action SNS 300 15m and long-range actions PRO 20:

- length – 380 mm;
- diameter – 32 mm;

- operational depth- up to 20 m .

Transmitters long-range radius of action SNS 200 PRO 20 (4 battery), 30 (wired):

- length – 480 mm;
- diameter – 32 mm;
- operational depth - from 20 m up to 30 m - respectively transmitters.



Operational range of any transmitter used with the receiver SNS 300 mainly depends on the background interference range at drilling site. The operational range of the transmitter reduces as the interference range rises.

Batteries (on/off the transmitter power)

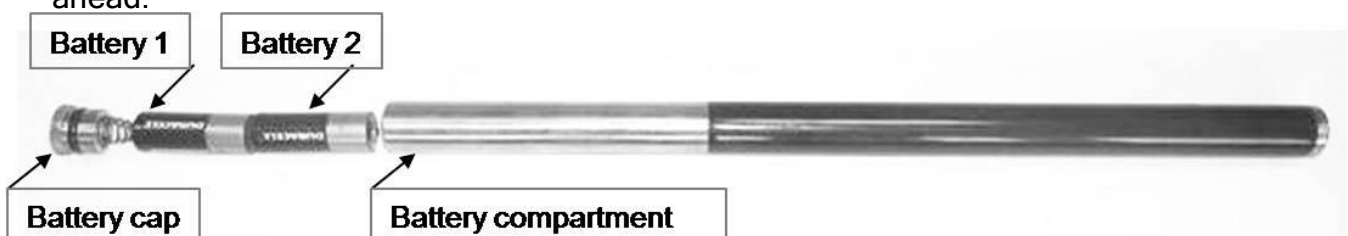
For a standard range (PRO 15) transmitter's operation two working alkaline batteries C or one lithium battery (Super Cell USA) are required.

It is forbidden to use damaged lithium batteries or lithium batteries manufactured by other companies. Use of damaged or poor-quality lithium batteries may damage the transmitter and / or the case and will invalidate the warranty of the manufacturer.

Setting batteries/switching on the transmitter

The transmitter is switched on after the batteries are set up correctly into it. To set up the batteries:

1. Using a screwdriver counter clockwise uncover the battery drawer.
2. Set up two Alkaline batteries into the transmitter by positioning positive contact ahead.



Check the signal of the transmitter with the help of the relevant receiver

Charge level of the transmitter's batteries

When using alkaline batteries their level of charge is shown at the bottom right part of the screen in locating receiver mode. In the case of using with transmitters PRO 15 a charge indication will remain at the maximum level until they discharge completely.



As the charge level indication will remain at the maximum level until the complete discharge you shall carry out the registration of the operational period of the transmitter with the lithium battery.

Standby mode (automatic on/off the transmitter)

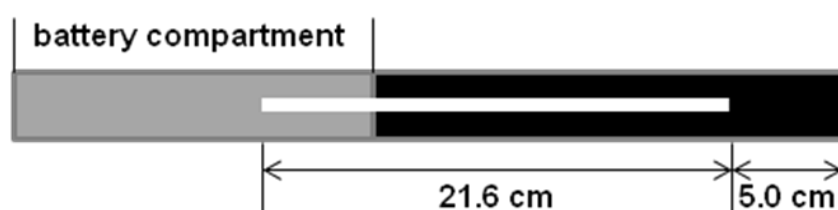
In order to save battery power, the transmitters PRO 15 automatically switch to standby mode and stop sending a signal if they are in a motionless position for more than 15 minutes. In order to bring the transmitter from the standby mode, you simply rotate the drill head.

In standby mode, the transmitter continues to consume a small amount of battery power. To prevent battery discharge, do not leave batteries in the transmitter when they can be easily removed from it, and make sure to remove the batteries if you do not intend to use the transmitter.

Requirements to the drill head case

In the drill housing must be available slots that meet the requirements for the minimum length, width, and location on the drill housing to obtain the maximum range of the transmitter and extend the life of the batteries. SENCE LLC recommends the presence of at least three slots, which have a width of at least 1.6 mm and are spaced evenly around the circumference of the housing. The size of the slot should always be measured at the inner surface of the housing.

For the range of the standard transmitter PRO 15 (length 38 cm) length of the slots must be at least 21.6 cm and slots must begin at a distance of at least 5.0 cm but not more than 7.5 cm from the front end of the transmitter as shown below.



Both transmitters - PRO 15 and PRO 20 have a diameter of 32 mm, and should fit tightly into the internal housing cavity. To ensure the density of the transmitter into the body of the drill head can be covered with insulating tape or put on a sealing O-rings.

To ensure correct orientation of the transmitter in the drill housing, the control slot in the front cover of the transmitter should be inserted into the locking lug of the drill housing

Information about the transmitter condition

The transmitters of SNS 300 locating system are equipped with inbuilt digital thermometer. The transmitter's internal temperature readings are transmitted to the receiver and the remote display every 2 seconds. The temperature is indicated on the left side of the receiver's screen and the repeater near the temperature icon of the transmitter.



As the digital thermometer is installed inside the transmitter the temperature that goes up during the drilling process doesn't transmit to the transmitter immediately. To prevent damage it is necessary to take measures to cool the transmitter at any temperature increase.

The normal operating temperature of the transmitter during the drilling operation shall be in the range from -30°C to $+80^{\circ}\text{C}$. To prevent overheating of the transmitter it is necessary to slow down or stop the drilling process and/or increase the flow of drilling fluid.

Each transmitter is equipped with term seal for the temperature of 80°C , positioned at the end of the device. Appearing black dots on term seal means transmitter's overheating for more than 80°C . In this case, the warranty of SENSE LLC for the transmitter invalidates. Currently, SENSE LLC moves to release 3-frequency transmitters: 12kHz, 12kHz + 1.5kHz (the protocol is compatible with the system ECLIPSE) and 33kHz (protocol is compatible with the MARK III). Below is a guide for selecting the operating mode of the transmitter.

Instructions for selecting the operating mode of the transmitter

1. Selecting the current mode:
 - 1.1. Insert the batteries, Replace the battery cap and screw it in, while holding the transmitter in a horizontal position for 3 seconds.
2. Changing the operating mode of the transmitter
 - 2.1 Set the Receiver mode to 12 kHz (make sure that the tab "Settings" - "Correction on 12 hours" is set to 12 hours).
 - 2.2 Turn on the transmitter while holding it in vertical position at least 3 seconds
 - 2.3 Put the transmitter horizontally (within 1 min) and within 10 seconds, turn it to the desired position in accordance with the following table:

Work mode	Rotation value (h)
12 kHz	12
12 kHz strengthened	3
1,5 kHz + 12 kHz	6
33 kHz	9

- 2.4 Set the receiver to corresponding mode.
- 2.5 If within 1 min (2.3) transmitter was not put horizontally, changing of the mode will not happen, and it will run in old mode.
- 2.6 **Guide to the dual-frequency system mode**

On **Location screen** you can see at 12kHz mode in the lower right corner (transmitter is on):

“S 12KHz” - Single mode - transmitter operates on 12kHz

“D 12KHz” - Dual mode - transmitter operates on 12+1.5 kHz

Features of the dual mode (12+1.5 kHz):

- This mode is more power-consuming - 10 hours on batteries.

- This Mode should be used in those cases when you can not locate the points on 12kHz (transmitter data are present, but navigation is not possible, because of some noises - such as drilling under reinforced concrete structures).

The navigation can be implemented on 1.5 kHz and the data can be received at 12 kHz.

This mode is indicated in the **Frequency selected** menu as 1.5 kHz with crossed angle.

(on **Location screen** to switch to 12 kHz and back press the left button - left arrow).

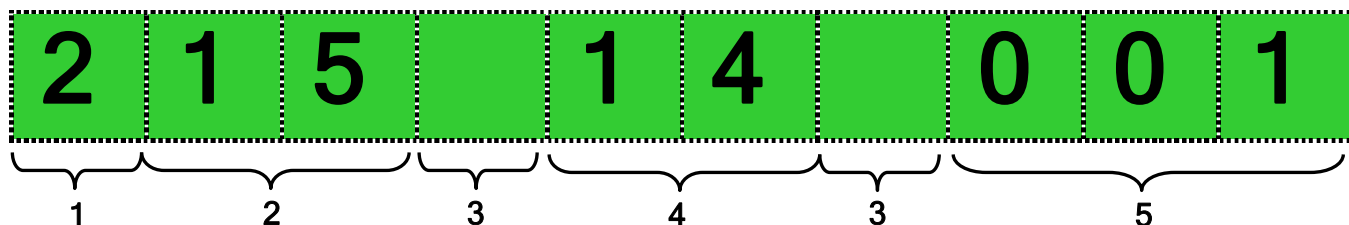
Calibration must be done separately for each frequency.

- It is possible to use only 1.5 kHz mode - in this case, navigation and data received will be on 1.5 kHz - but receiving of data at this frequency will be up to 8 m depth (depending on the external noises)).

This mode is indicated in the **Frequency selected** menu as the 1.5 kHz.

The calibration can be carried out only for 1.5 kHz.

Transmitter labeling

Code group:

- 1 – country
- 2 – year
- 3 – space

- 4 – code frequency
- 5 – serial number

Country:

- 1 – Russia
- 2 – Chine

Frequencies:

Code	Frequency(kHz)	Character	Characteristic	Depth(m)
1	12	S	standard	15
2	12+	D	deep	20
3	12/1.5	L	low-frequency	12
4	33	H	high-frequency	21

Remote display

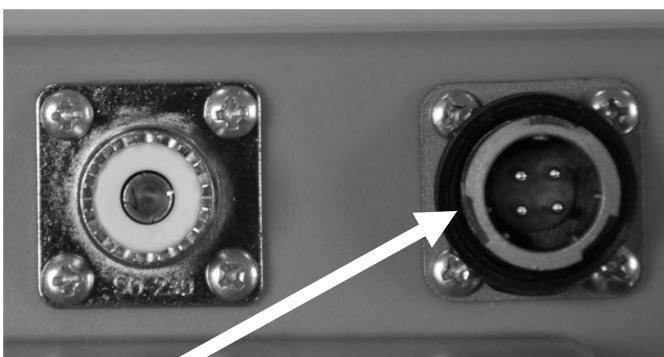


General description

- Remote display is intended to provide the drill master with information about the depth, direction and transmitter condition.

Power supply

Power for the repeater, can be delivered either from the inbuilt battery pack, similar to the receiver, or from the external DC source of 12-24 V and also from AC of 220 V.



Connecting the DC cable



To connect the DC cable, remove the protective cap from the DC power connector at the back of the display. After mating the four holes on the connector cable with four contacts in the connector of the display. Plug the cable into the connector and turn the connector clockwise so that the cable is securely fastened to the body. Connect the other end of the DC cable to the DC power supply.





Main menu

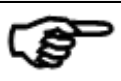


1	switch to upper tile menu
2	switch to right tile menu
3	switch to left tile menu
4	switch to low tile menu
5	activate the chosen tile of menu

The meaning of icons/tiles:

	switch to work mode
	turn off the remote display

	switch to radio modem settings menu (use[↑], [↓] – to change channel) (*)
	contrast settings
	switch to wire transmitter work mode
	go to the sub-menu to select the language or the software version: PYCC - selecting of the Russian language ENGL - selecting of the English language NEW Version OLD Version - selecting of the new or old version of the software

 (*) When you configure the radio modem, the selected number of channels in the repeater and the receiver must be the same.

Relay



General description

The relay of SNS 300 locating system provides with the stable signal between the navigation receiver and the drill master's control in high complexity mode of drilling. The relay has a constructive similarity with a radiating transmitter. Dimensions: length 315 mm, diameter 32 mm. It has an inbuilt antenna for increasing the radio coverage.

Technical specifications

1. Dimensions: length 315 mm, diameter 32 mm;
2. Compact antenna – 115mm. You can connect an external antenna to increase the radio coverage;
3. Frequency range: – 433 MHz;
4. The antenna's power – 10 mW;
5. Power supply: – 2 batteries of LR14 type, size C;
6. Time of continuous work from one set of batteries – not less than 20 hours;

7. Indication: LED. Indicates the presence of data transmission (green LED) and the end of life of the battery power (red LED).



Please note that the standard supply goes without a tripod. Tripod can be ordered further if necessary

Warnings and Cautions

SENSE LLC is not responsible for any problems that may be used by any violation of these warnings, as well as the general recommendations in Warnings and Cautions in Safety Instructions chapter.

Warning: All the batteries for the system modules are designed with protection from shock and other hazards in case the operation of this device is carried out in accordance with the rules outlined in this manual. Violation of the operation rules for the batteries stated in this document may result in deteriorating the level of protection provided. Before using the battery, please, read the manual.

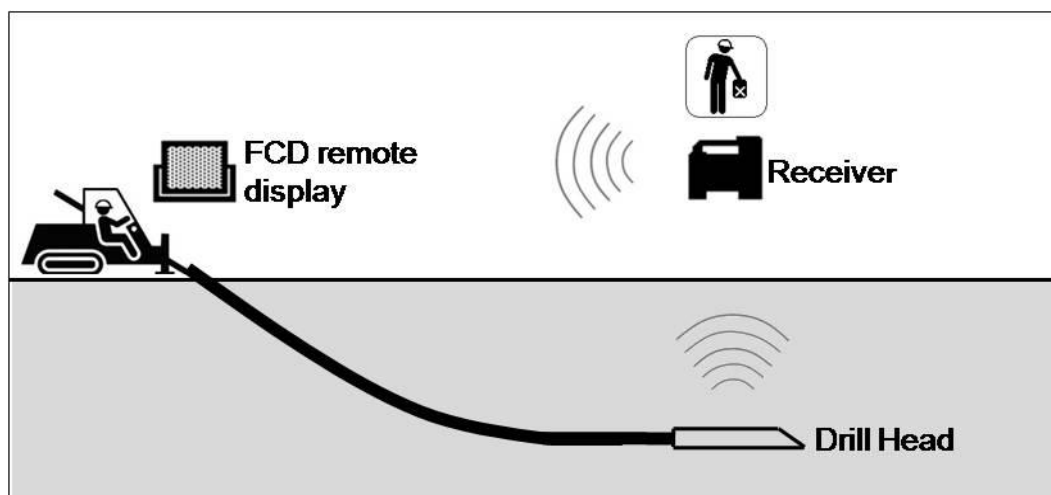
Warning: when transporting system modules it is highly recommended to remove the batteries from the receiver, transmitter and relay and disconnect the wires from the driller master's control to secure operating performance both of the equipment and batteries.

Locating

General description

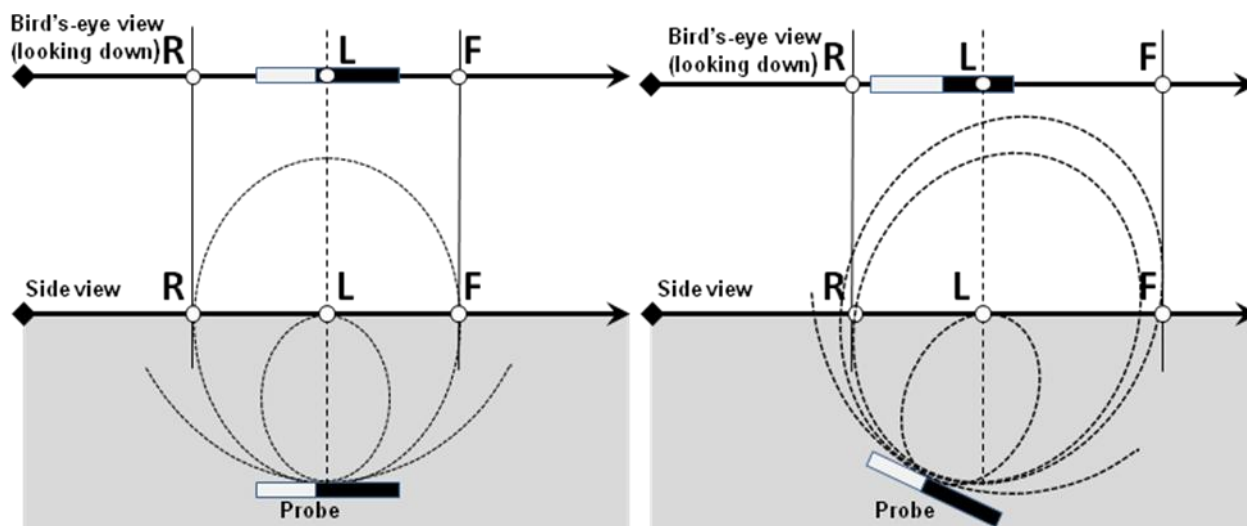
Locating with SNS 300 system is not a difficult and preparation-consuming operation. In the present chapter there is a description of the location points and location line, the geometrical layout of these elements regarding the transmitter that appear on the receiver's display while locating and relevant methods of marking location points after their identification. After that the standard rules of locating are given including an 'operational' method of tracking and the method of tracking the transmitter without access to the ground surface above the transmitter which is called 'remote location'.

Operating principle



The navigation receiver identifies the position (location) of the drill head by vector analysis of force lines of varying magnetic field that is formed by transmitting antenna of the immersion transmitter.

The character of the force lines distribution allows identifying two distinguished points called front point and back point of locating and one character line which provides the genuine location of the transmitter and its position with respect to the ground surface. The pictures given underneath show the method mentioned above.



F – front location point, L – location line, R – rear location point

On moving the navigation receiver above the drill head the current location of the points in reference to the receiver is displayed on the screen.

Thus, the sequence of actions for locating the transmitter is as follows:

- Guided by the marker's location on the monitor find the target location point adjust it with the central cross. Put a directing mark;
- Moving toward the drill head find the location line which is automatically marked on the screen. Put a directing mark;
- Similarly to item1 find the front location point. Put a directing mark;
- The intersection of line location and the line connecting the front and rear location points, gives the location of the transmitter. However, this will be true only if the position of the drill head is horizontal. When it is sloped the depiction of the field distribution changes as shown in the picture above;
- In this case while measuring on the location line at the location of measurement on the monitor will display the correction of the transmitter's distance (with a plus or minus sign) relative to the point of intersection of Item. Having measured this distance from the point of intersection, we obtain the genuine location of the drill head on the line connecting the location points.

Together with formation of varying magnetic field for determining the coordinates the transmitter passes the following information to the navigation receiver::

1. The inclination angle of the transmitter in vertical plane;
2. The angle of turn to the longitudinal axis of rotation;
3. The transmitter's temperature;
4. Residual capacity of the power batteries.

The information is constantly displayed on the receiver's screen and transmitted via the radio to the drill master's control.

Interference - description and ways of their withdrawal

Before starting drilling you need to evaluate the potential interference value at the construction site. Interference can reduce the transmitter range or can show inaccurate transmitter position measurements and can cause a reduction the velocity of work. Interference may arise from different sources.

Sources of interference include, among other things, traffic signal loops, buried dog fences, cathodic protection, high frequency system, TV and power cables, fiber-optic cables, metal structures, telephone lines, cell phones, relay masts, conductor soil, salt water, rebar, radiation and other sources of interference.

The first step is to check the route to the presence of potential sources of interference. The next step is to check for the presence of electromagnetic interference of noise background.

To verify the presence and value of the background noise is proposed to take the transmitter and receiver and pass along the drilling route. One operator walks along the route of drilling with the receiver and the other with the transmitter in parallel to first one at the distance of the maximum depth of the project. The presence of the background noise can be valued by stability received signal.

Correction of the probe inclination angle

When routing communications requiring high accuracy of the angle inclination one should make correction of the angle inclination readings depending on the rotation angle of the device.

This correction is caused by the transmitter itself, its installation under the drill head and of the drilling string.

To compensate these errors the following method is suggested.

1. The drill head with the transmitter installed should be rotated all-around, at the same time one should take the readings of the angle inclination every 30 degrees or 1 hour mark.
2. Insert the readings onto the following table.

Sample table:

Clock reading	Indication of the angle inclination(%)	Notes
12	-1.6	Minimal angle
1	-1.9	
2	-2.3	
3	-2.6	
4	-3.0	
5	-3.4	
6	-3.8	Maximal angle
7	-3.5	
8	-3.1	
9	-2.8	
10	-2.4	
11	-2.0	

3. Choose in the table the lines with the minimum and maximum reading of the angle inclination (in the example lines 12 and 6 hours)
4. Find the average angle of these two readings (sum two readings and divide by two: $-1.6+(-3.8)=-5.4$; $-5.4/2= -2.7\%$). This very angle (-2.7%) is an updated inclination angle.

5. There are two ways to use the present calculation in consideration of the angle inclination in drilling:
- To determine using the table the clock position which gives the closest reading to the updated angle (in our example it's 3 and 9 o'clock). Furthermore take the readings of the angle inclination in this position of the device. Put the device in this position and make sure that the reading of the angle inclination is equal to the updated angle.
 - Another way is to determine the correction for 12 o'clock. To do this you need to deduct the updated angle from the angle reading at 12 o'clock. (in our example $-1.6 - (-2.7) = 1.1\%$). Furthermore take the angle readings at 12 o'clock and deduct the correction. E.g. while drilling we took the angle reading 1.5 % ($1.5 - 1.1 = 0.4$) - the updated reading will be 0.4%.

The rotation of the drill head for correction evaluation can be done at the beginning when the head drill is installed into the machine with the first drill bar. Also you can determine the correction at control points of the borehole. To make the evaluation more precise it is necessary to take readings at the angle close to zero.

SNS 300 program package

Software and driver COM-USB installation

Contents of the installation CD.

- DOC - documentation (Program description, Operating manual of SNS300).
- PROG - program catalogue **Sns-Reader**.

Program installation

Run the installation program SNS-Reader_Installer_EN.exe from directory PROG on the installation CD.

Summary

SNS-Reader program is intended for uploading, editing and saving the tables of the protocols which were obtained while working with SNS 300 system.

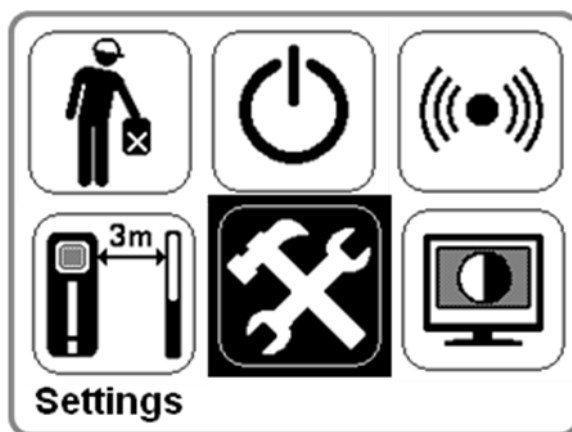
1. Preparation for work.

Before commencing connect the radio modem to the computer. If it is the first time that the radio modem has been connected to the computer wait until the drivers have been installed.

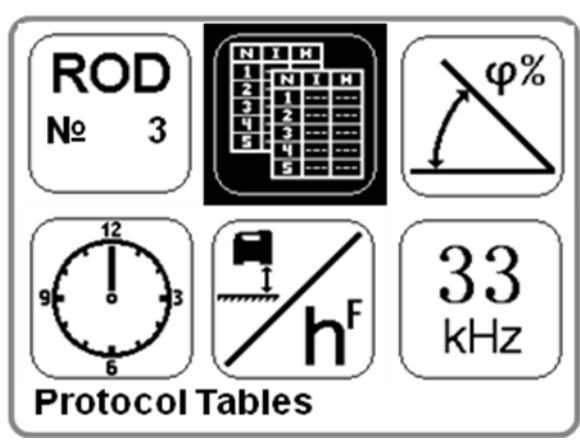
1.1. Preparing the receiver for work with the program.

The work with the program is carried out in 'Work with PC' receiver's mode. In order to change for this mode, switch on the receiver, wait until the display on the receiver will show the main menu and do the following:

(1)Go to 'Settings' submenu:



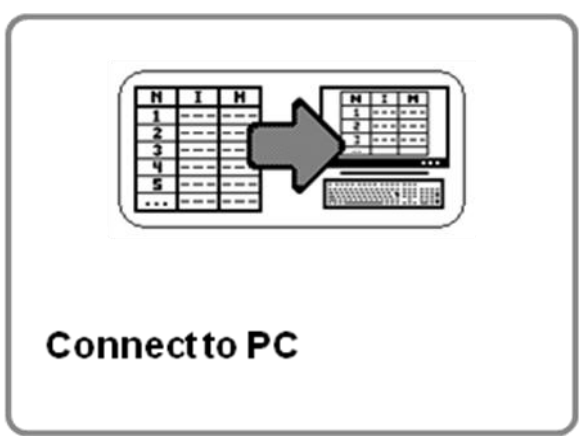
(2) Choose Tables of protocols' option:



(3) Choose the option 'Connect to PC':



(4) Wait for the change to the 'Connect to PC' mode. At the end of the mode change session, you will see the following picture:

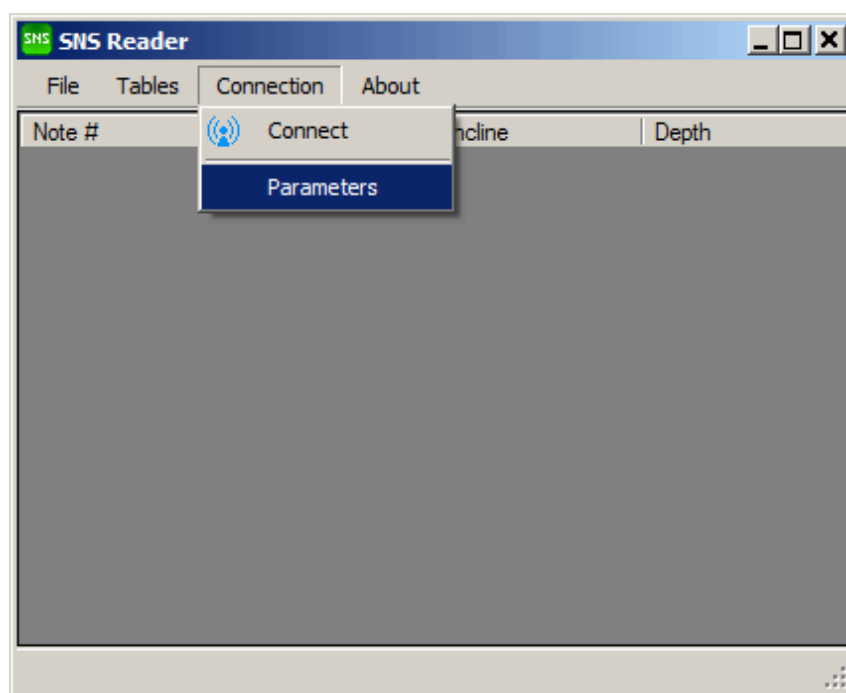


The receiver is ready for work with the program.

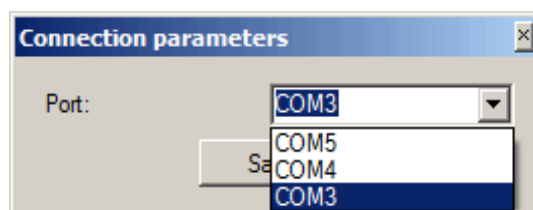
1.2. Preparing program for work with the receiver.

Launch SNS-Reader program and do the following:

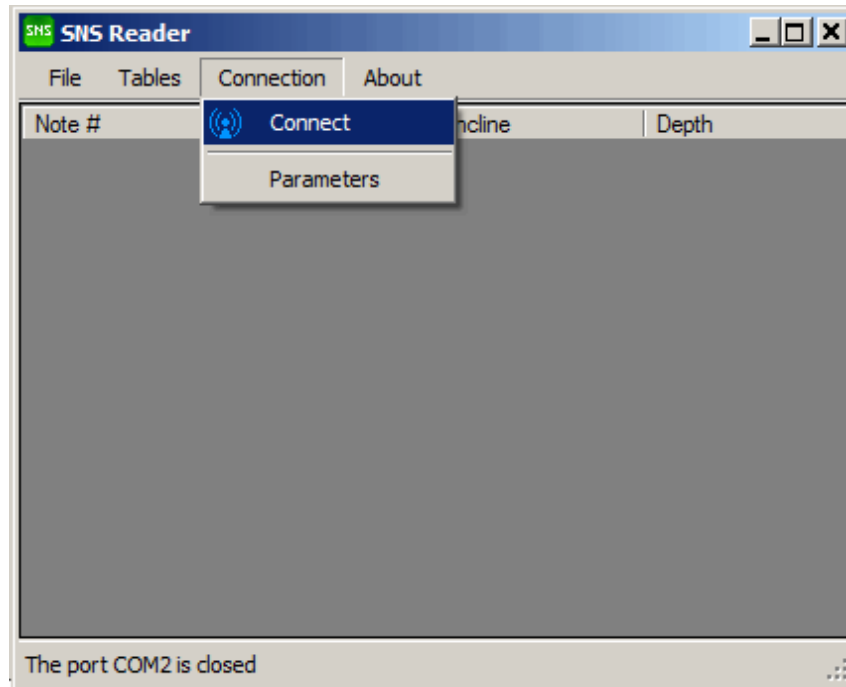
(1)Go to 'Connection' menu and choose 'Parameters' option:



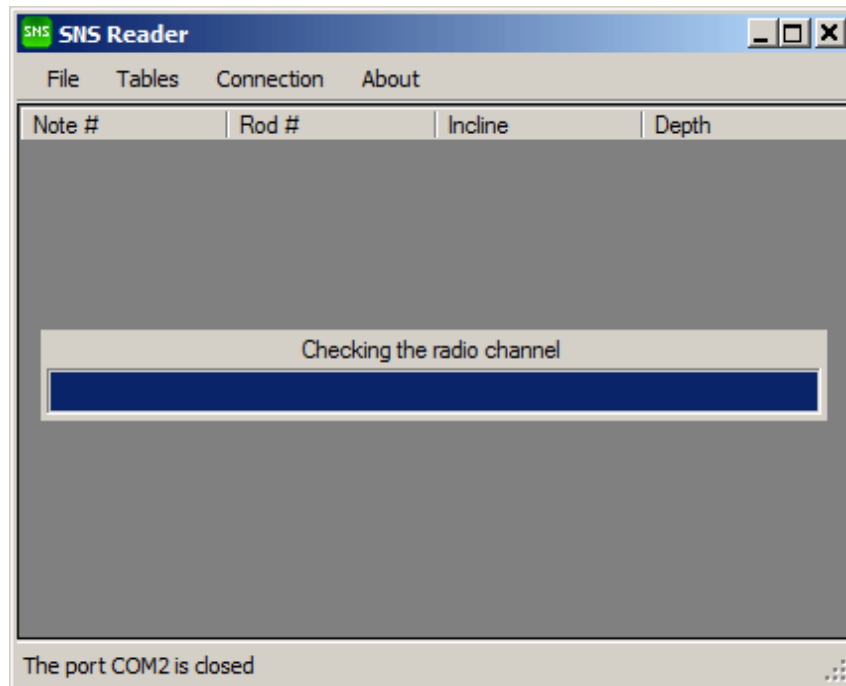
(2)In the window displayed choose the radio modem's COM-port and press 'Save' button:



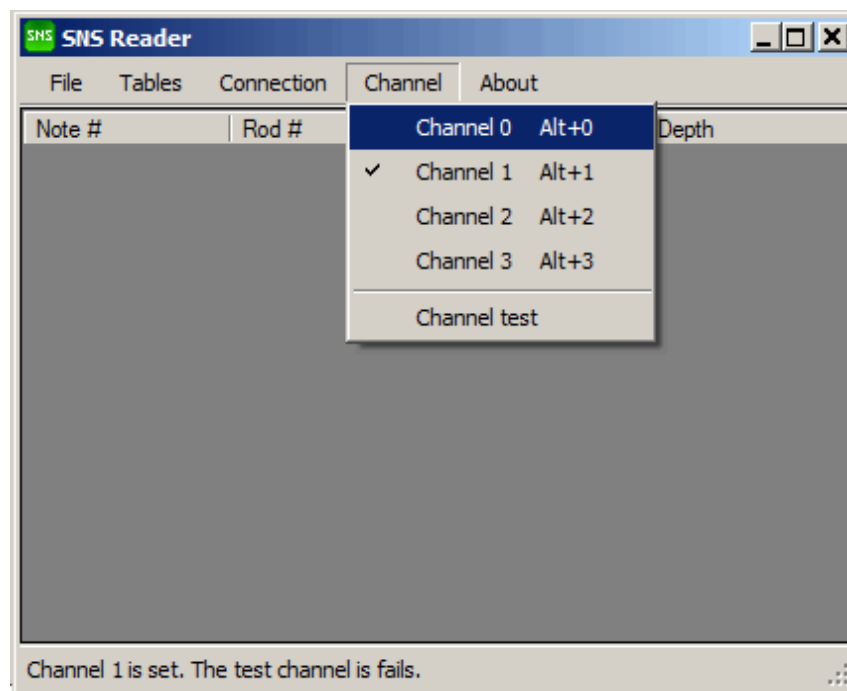
(3) In 'Connection' menu choose the option 'Connect';



After connecting to the Radio Modem there will be a link test:



If the parameters of the port and the link are accurately chosen there will be the sign 'Port COMx is open, the link test is completed. Channel 'y', where x- the radio modem's port number, y - the radio-channel's number. If the link test failed change the channel for another one accordingly in the link program. To do this, go to 'Channel' Menu and choose the necessary channel.

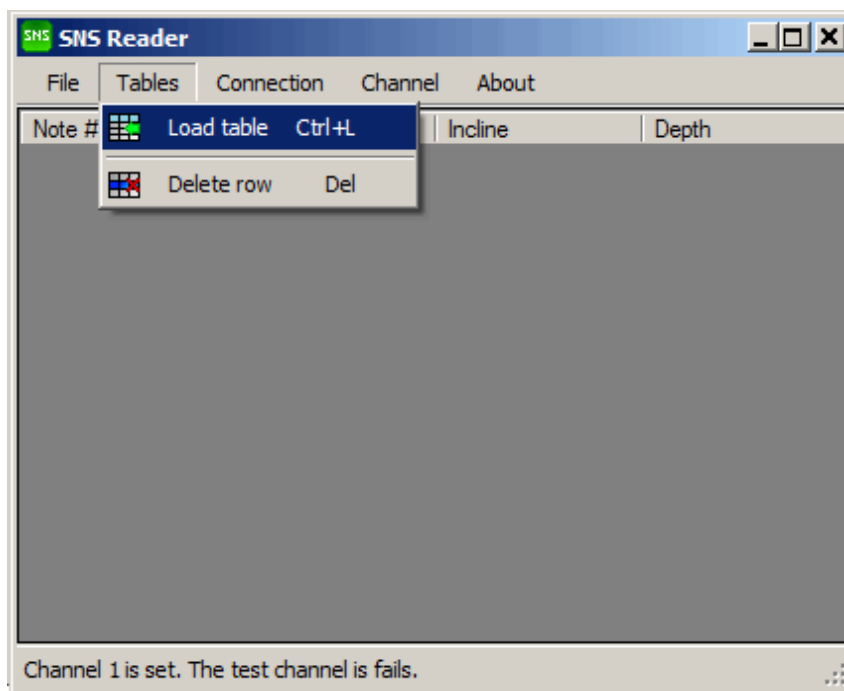


After every change of the channel the link test is done once again. If the channel is chosen accurately, there will be a sign 'The channel X is set. The link test is completed' in the status bar, where X - the radio-channel number

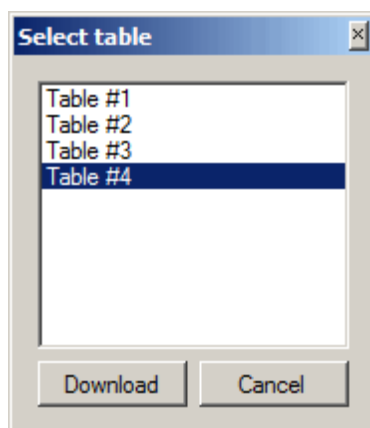
After the successful link test, the program is ready for work.

2. Downloading tables of protocols from the receiver, their editing and saving tables into the file.

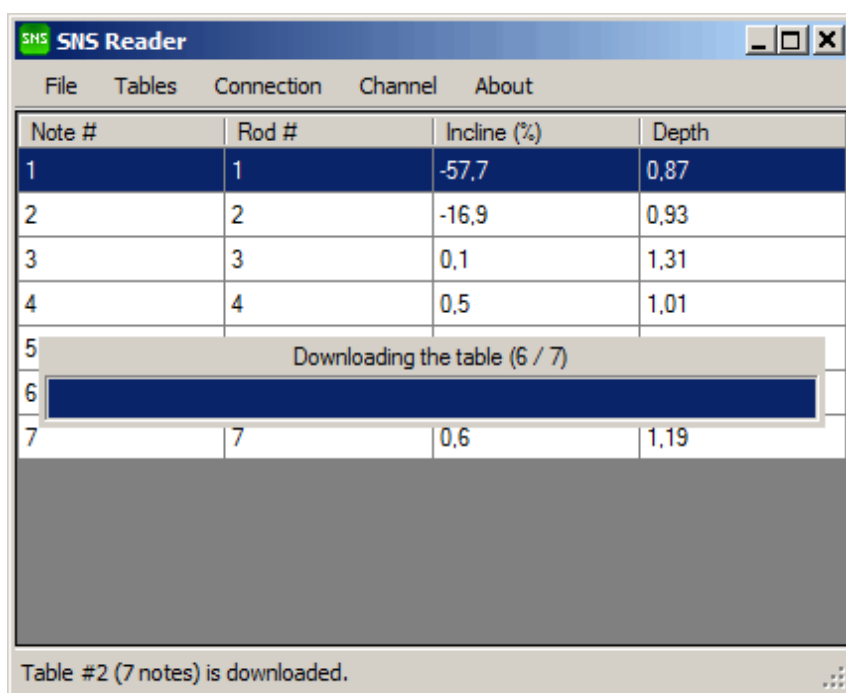
(1) To download the table go to 'Tables' menu and choose the option 'Download a table'



(2) In the window appeared choose the table that you want to download from the receiver and press 'Download':

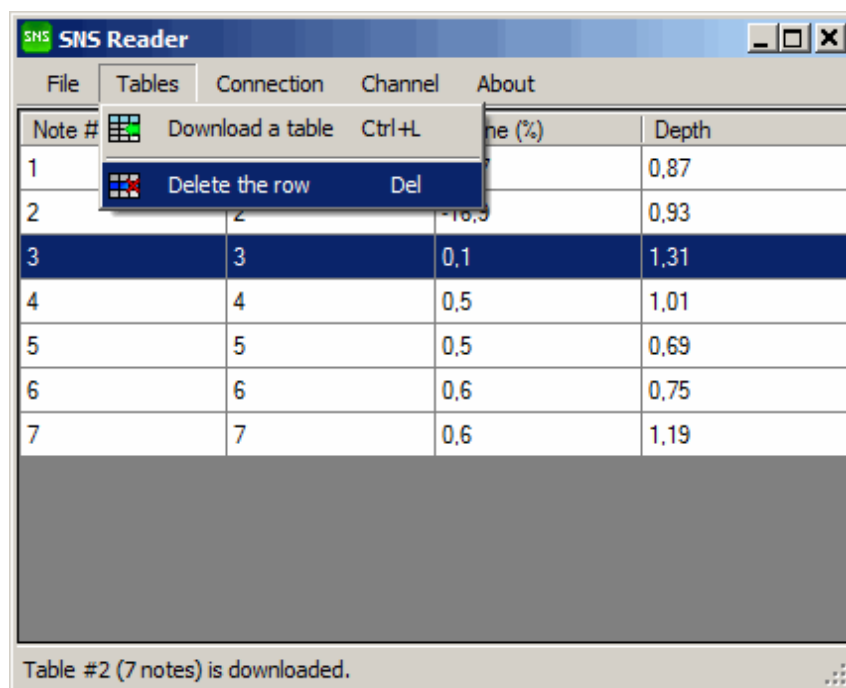


Wait until the table is downloaded:

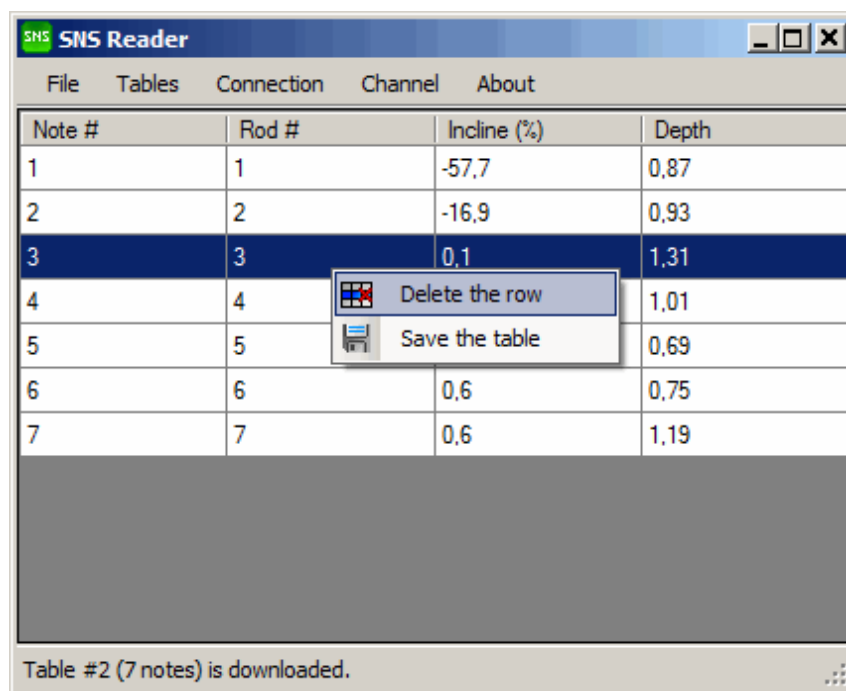


2.1. Editing a table.

In case wrong recordings were made during taking protocols they can be deleted. To do this choose the recording or recordings that you need to delete and in 'Tables' menu choose 'Delete the row':

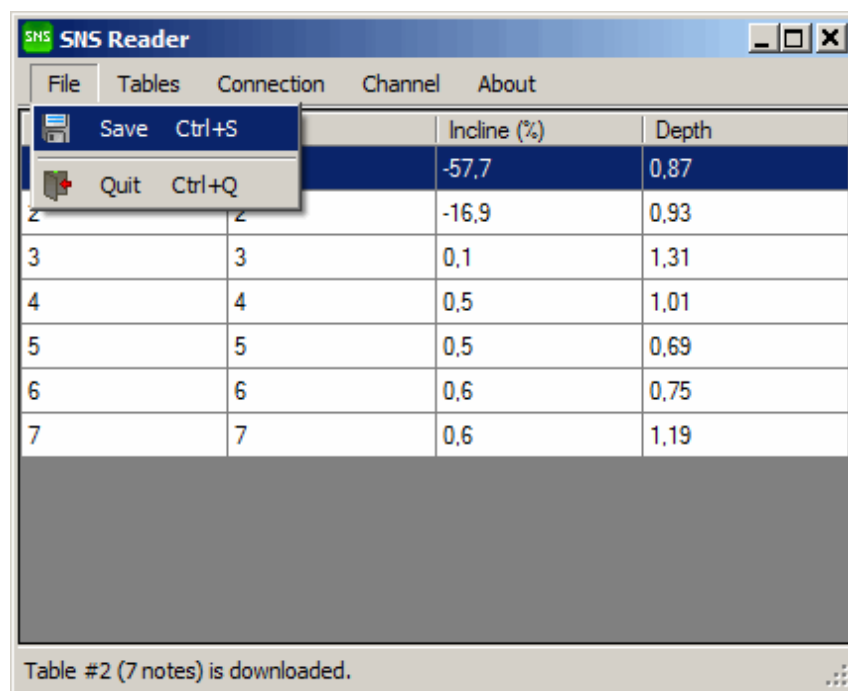


This could be done from the shortcut menu of the table as well. To display the shortcut menu right-click the recording that you want to delete:

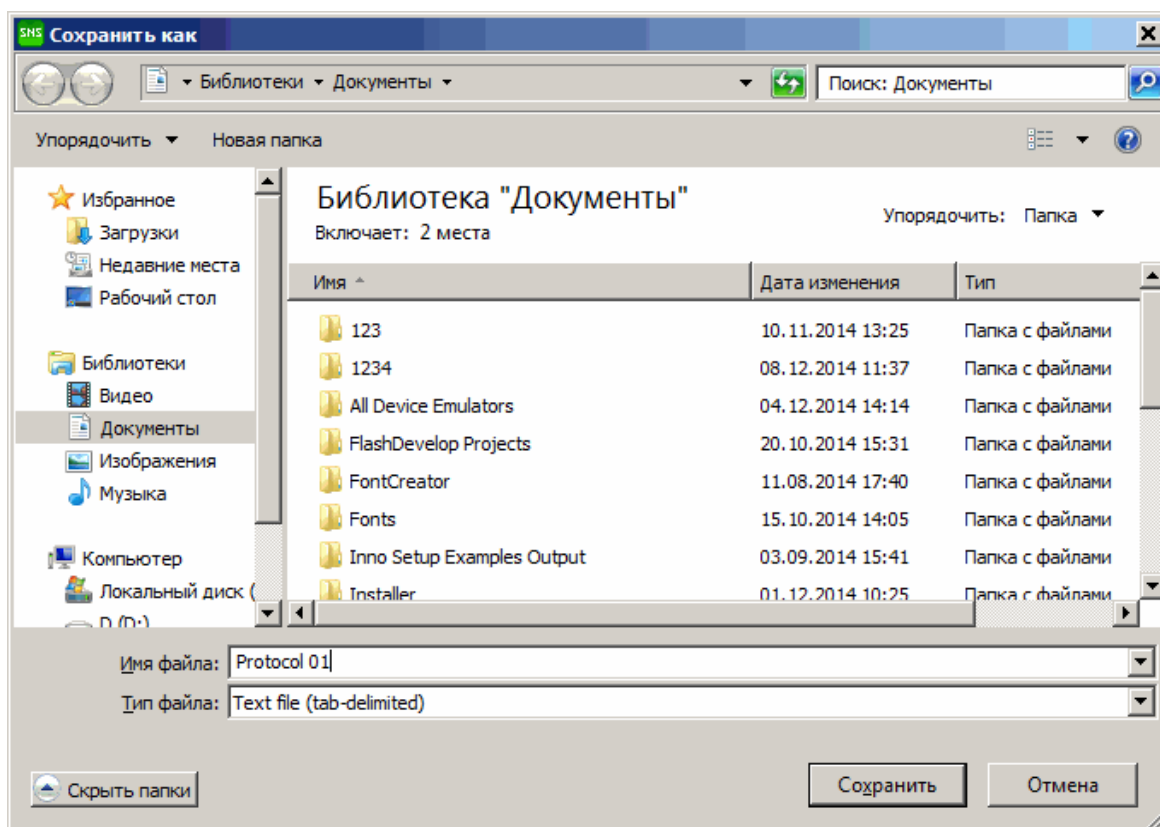


2.2. Saving tables in a file.

In order to save the table, go to menu 'File' and choose the option 'Save' or choose the option 'Save the table' in the context menu of the table:



In the window appeared choose the file where you want to save the table, state the name and the format of the final file and press 'Save':



There are two alternatives for the format:

- (1)Text file (tab-delimited)
- (2)XML table for MSExcel

Electronic tables of the majority of the office programs support both formats and will correctly display these files as tables.

The main difference between these formats is that **'the text file (tab-delimited)'** is quite well readable in any text editor in contrast with **'XML tables for MS Excel'**

Operating and services procedures

Avoid both shocks and vibrations and also the possibility of downfall and external mechanical damages of the devices.

It is FORBIDDEN for operators to open any device from SNS 300 system.

Services procedures are to inspect visually the devices in order to identify mechanical damages, external cleaning. In case of identifying inconspicuous mechanical damages on the devices it is necessary to carry out a thorough inspection of its operational performance.

If there is no opportunity for troubleshooting issues in the system work on your own, one should contact SENSE LLC, Client service Department maintaining (phone **+7 (8422) 45-72-00** or **45-80-79**)), where you can get assistance for solving this kind of problems.