Robit®

Robit Sense Systems

Operator's Manual

Robit M Sense

Borehole deviation measurement system

Robit Oyj

Oyj Robit Plc
Vikkiniityntie 9
FIN-33880 Lempäälä, Finland
Tel. +358 (0)3 3140 3400
E-mail: sense.support@robitgroup.com
Web: www.robitgroup.com
Business ID: 0825627-0

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1 Introduction

The Robit M Sense measurement system is used for measuring boreholes in rock drilling.

The measuring system may only be used for purposes for which Robit Plc has given its written consent. The system may not be modified without Robit Plc's written consent. If the system is modified, the documents must be updated to correspond with the new structure.

The Robit M Sense measurement system is delivered in a robust protective case, which contains the following:

- measuring probe and cable
- tablet computer
- docking station for the tablet computer
- 230 V power supply for the tablet computer
- 12/24 V power supply for the tablet computer
- measuring software and accessories
- operator's manual
- spare battery.

1.1 Operator's manual

Please study and observe the operator's manual thoroughly in order to maintain the safety and reliability of the machine.

Robit Plc reserves the right to make changes.

For production-related reasons, the figures and technical specifications in this operator's manual may deviate from the actual product.

Robit Plc cannot be held liable for any material damage or injuries caused by using the device incorrectly or in violation of the instructions.

If you do not understand the instructions or some parts of this manual appear to be missing, please contact Robit Plc.

Thank you for choosing Robit Plc as your systems supplier. We are confident that we will fulfil your expectations regarding both usability and the availability of services.

Maintaining the operator's manual

Keep the manual in good condition and available to the operator and service personnel.

Ordering a manual

You can order a manual from Robit Plc's customer service or from our Robit retailer.

1.1.1 Copyright

1.2 Warranty

See the warranty information regarding Robit Plc's general warranty terms.

1.3 Customer service

Company name:	**Robit Plc**
Address:	Vikkiniityntie 9
	FIN-33880 Lempäälä, Finland
Telephone / Telefax:	+358331403400 / +35833670540
E-mail:	robit@robitgroup.com
WWW:	https://www.robitgroup.com/contact-us/

1.3.1 Robit Sense support

Telephone / Telefax:	+358143370412
E-mail:	sense.support@robitgroup.com

2 Safety

The purpose of the safety information is to reduce the number of accidents and prevent personal injury and property damage.

Please read the safety instructions carefully and ensure that you are using the system in a safe manner. Do not use the system in ways other than those described in this manual. An incorrect method of use may be hazardous and cause an accident, fire or electrocution.

You must also observe the instructions appearing on the computer screen and abide by all warnings.

Do not operate the system if its components are damaged.

Use only components and accessories described in this manual.

3 System description

For the purpose of calculating the size of demolition charges, it is important to know the exact position, direction and deviation of the drilled holes.

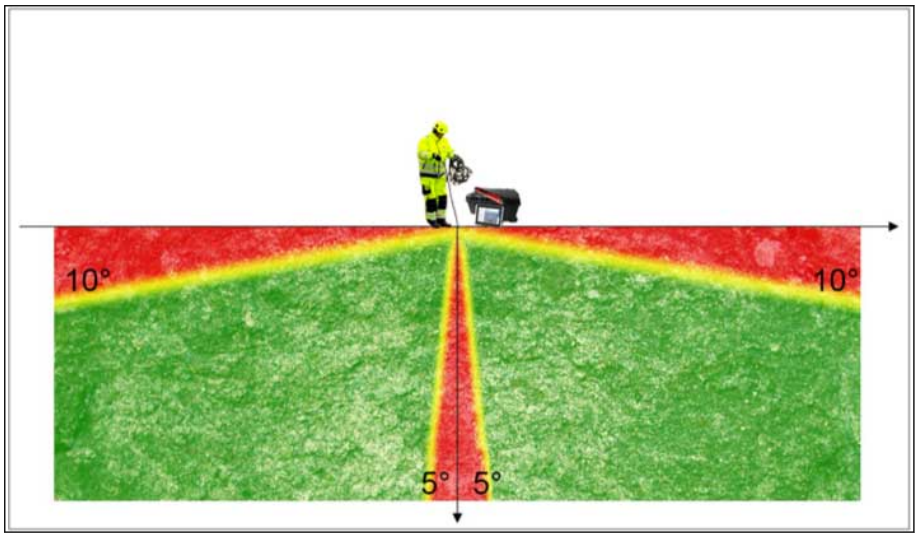
The Robit M Sense system measures the deviation of the hole using a gyroscope and accelerometer inside the measurement probe. The measurement is performed by lowering the measurement probe into the drilled hole and the measurement data is transmitted to a computer when the module is lifted.

The measurement results are available immediately after measuring. The system also provides a wide range of tools for examining the holes and analysing the field.

Note:

Borehole measurement accuracy is affected in certain borehole angles. System azimuth accuracy decreases in red zones. Inclination accuracy is not affected by the borehole angle.

These limitations affect the *Gyro only* and *Compass assisted gyro* measuring modes.



3.1 System components

The Robit M Sense measuring system consists of the following components:

1. Measurement module embedded in an aluminum probe and a measuring cable
2. Tablet PC with measurement software and accessories
3. Protective case for system components.

3.2 Operating principle

The Robit Sense measurement software is a versatile tool for measuring boreholes. The measurement data can be saved in a database, where it can be viewed after drilling or at a later time.

Holes can be measured in two ways: 1) select a site and field before measurement, which allows you to define what hole to measure, or 2) measure a hole first and decide afterwards whether or not you wish to save it in a site. All holes measured in a field can be viewed simultaneously, which provides a good overall view of the holes throughout the field. A measured hole does not need to be connected to a worksite. Instead, it can be saved in the database separately.

Selecting a field before measuring a hole

The site can be selected before measuring a hole, in which case the measurement is done as follows:

1. Select the site, level and field.
2. Select the hole to be measured.
3. Press the Start measurement button.
4. Enter the starting angle of the hole, if it is known.
5. Lower the measurement probe into the borehole.
6. Press the Begin lifting button and start lifting the measurement probe from the borehole.
7. Maintain the rod stationary for the time shown on the screen.
8. Mark the measurement points at predefined intervals points using the touchscreen.
9. Once the probe has been lifted, the hole measurement data is transferred to the computer.
10. The data for the measured hole is linked to the selected hole automatically.

Measuring a borehole without selecting a field

Measurement is done as follows:

1. Press the Start measurement button.

2. Enter the starting angle of the hole, if it is known.
3. Lower the measurement probe into the borehole.
4. Press the Begin lifting button and start lifting the measurement probe from the borehole.
5. Maintain the rod stationary for the time shown on the screen.
6. Mark the measurement points at predefined intervals points using the touchscreen.
7. Once the probe has been lifted, the hole measurement data is transferred to the computer.

The hole data is saved as follows:

1. Select the worksite, level and field where the data is to be saved. If you do not select a site for the hole, it will be saved independently in the database.
2. Select the hole from the drilled field.
3. Link the transferred information to the drilled hole.

3.3 User interface

The user interface of the Robit Sense M system is designed to be used with a touch screen or mouse. The Robit Sense measurement software can be used to design drilling fields, measure drilled holes, and inspect and analyse measurements with a range of powerful graphical view and tools.

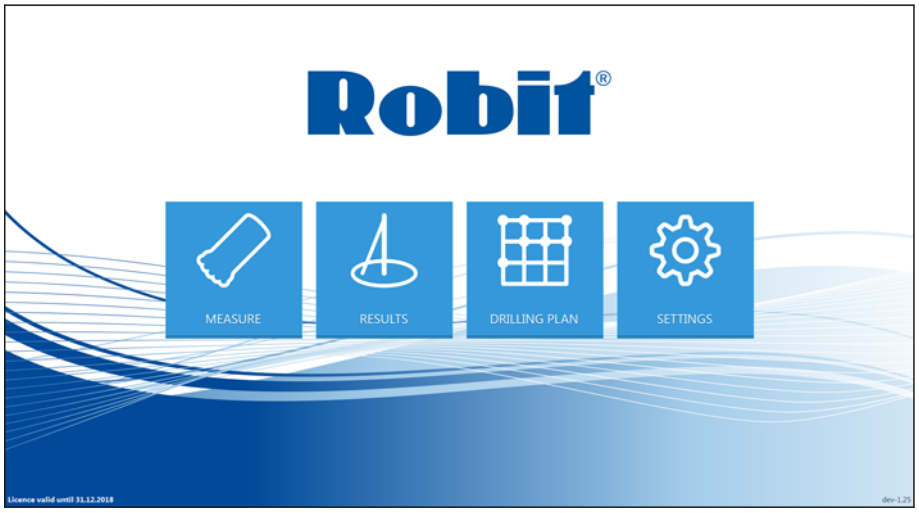


Figure 1. Robit Sense measurement software

3.3.1 Cloud synchronization

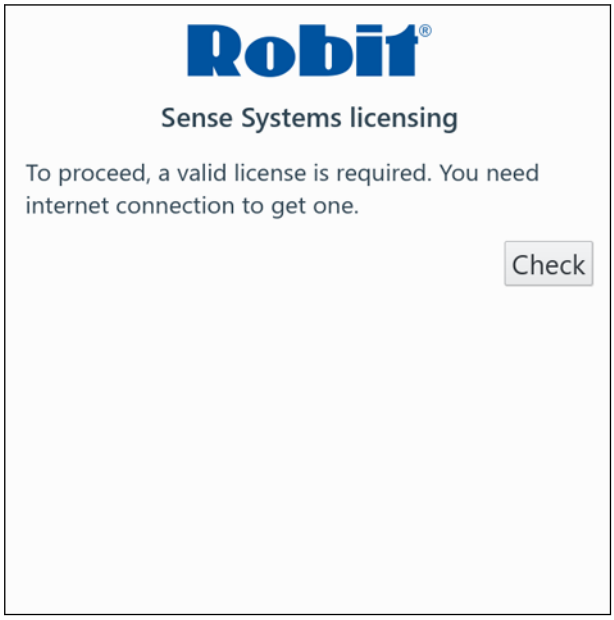
The cloud synchronization icon  briefly appears in the user interface when data has been successfully synchronized with the Sense Cloud Service.

If the synchronization fails for some reason, the synchronization error icon  is displayed. This icon disappears after successful data synchronization.

3.4 Licensing

During startup, the software automatically checks that the current license is valid. The license validity period is displayed at the bottom of the home screen.

If a license cannot be acquired automatically, the software prompts you to check the availability of licenses.



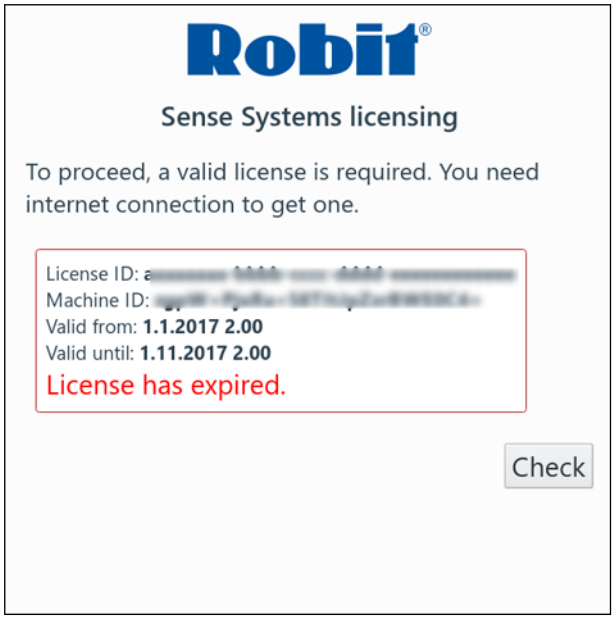
Click the Check button.The software contacts the licensing server and checks if the tablet is registered in the Sense Cloud.

If a license is available, the software displays the licensing information in a confirmation window. Click Proceed.

If a license cannot be acquired, you need to enter the organizational registration code. Click Submit to send the code.

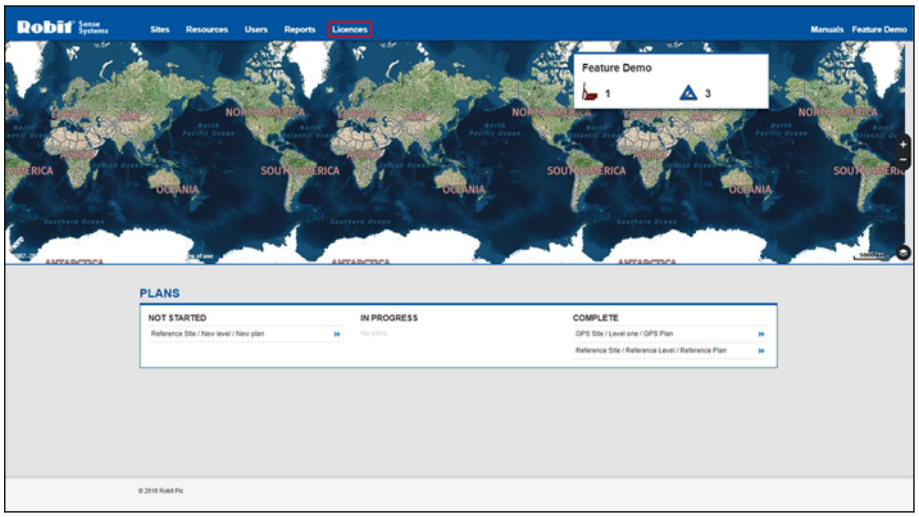
Your Company Administrator can order the organizational registration code from *https://www.sensesystems.com*.

If the licensing period has expired, an error message is displayed. Contact Robit Plc. for more details.

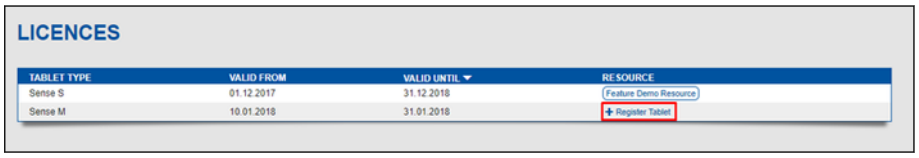


3.4.1 Registering a tablet

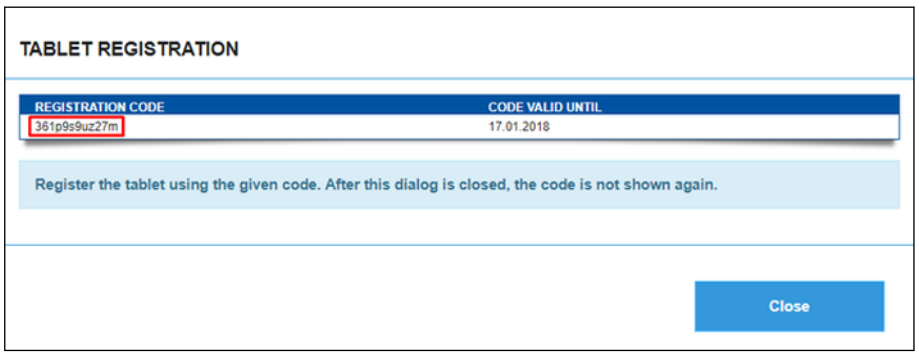
If the tablet computer's measurement software asks for a registration code, log into *https://www.sensesystems.com* with your credentials and go to the *Company* view.



You will see a list of licences. Select an available licence to register the tablet with by clicking the Register Tablet text. If the list does not have an available licence, contact Robit personnel.



A window with a registration code will open.



Write or copy the code into the registration code field on the tablet computer's Measurement UI Software. Click Submit to send the code.

Review your licence information on the tablet computer and click Proceed to start using the software.

4 Operating instructions

Note:

Before first use, the measuring system needs to be calibrated according to the calibration instructions.

4.1 Starting up the software

Procedure

1. Start up the Robit Sense software by tapping the software icon on the tablet computer.

2. Once the software has been activated, enter the measuring cable marking interval in metres or feet (imperial cable).

The marking interval defines the distance between individual measurement points during borehole measurement.

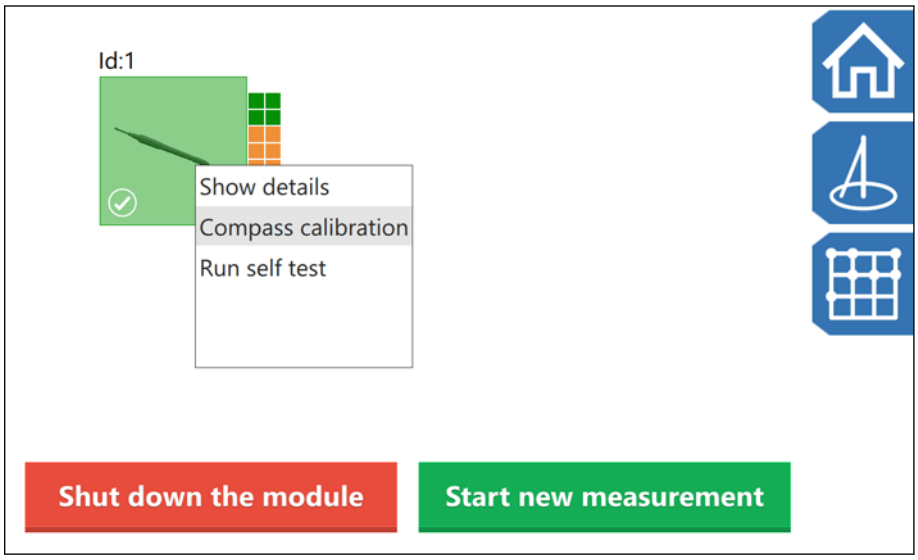
Once the cable marking interval has been approved, the program moves to the home screen where you can select the desired function.

4.2 Compass calibration

Compass calibration should be performed before beginning measuring in a new site. This is especially important if previous calibration was done far enough so that the Earth's magnetic field is different. While performing the calibration keep away from any potential sources of magnetic interference such as buildings and vehicles.

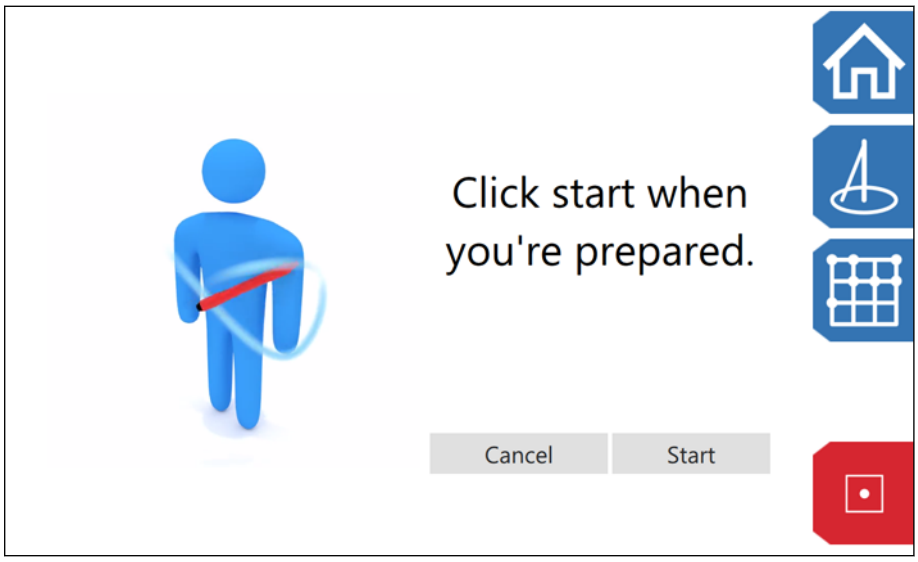
Procedure

1. Hold the measurement module at about 15 cm (½ ft) distance from the measuring cable end.
2. From the measuring module view, touch and hold the the unit you want to calibrate. Select "Compass calibration" from the popup menu.



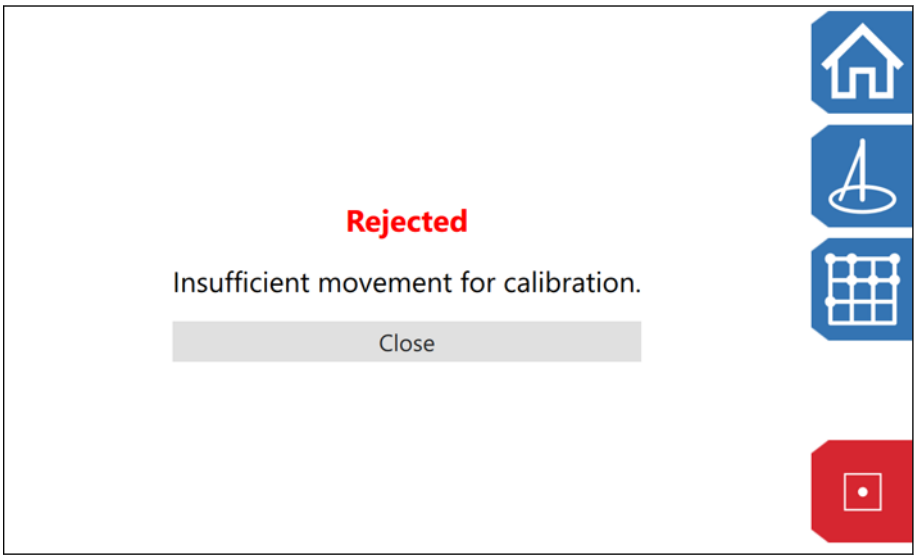
The calibration wizard starts.

3. Familiarize yourself with the movement shown by the animation. Click Start when you are ready to perform the movement for about 30 seconds.



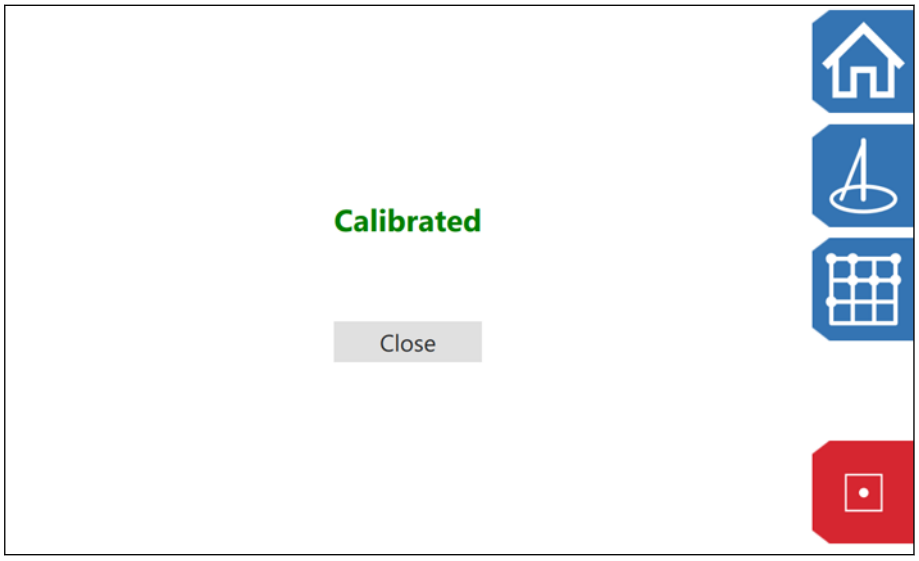
4. Carry through the movement until the animation stops.

   If the calibration wizard detects insufficient movement, the calibration is rejected.



5.

When calibration is successfully completed, you'll see "Calibrated" message. You can now close the calibration wizard.



4.3 Measurement settings

You can define the measurement settings in the Settings > Measurement settings view.

Measuring direction

A borehole can be measured either starting from the bottom or from the top.

Measurement point interval

Measuring cable marking interval in metres or feet (imperial cable).

Surface measurement point depth

Depending on the measuring direction, Surface measurement point depth defines the first or last measurement depth.

Measuring mode
The measuring mode can be defined under the Compass section:

- **Gyro only** for magnetic conditions. The Operator sets the collar heading for each hole. The Gyro only mode is sensitive to correct working methods.

  Note: Azimuth information on vertical and horizontal holes is limited.

- **Magnetometer assisted gyro** measurement to lower the magnetic influence. In this mode, the shape of the borehole is measure with gyro, whereas the collar heading is measured with magnetometer. The Magnetometer assisted gyro mode is sensitive to correct working methods.
- **Combination of gyro and magnetometer** for best accuracy and most robust results. Suitable for all hole directions.

4.4 Measuring view

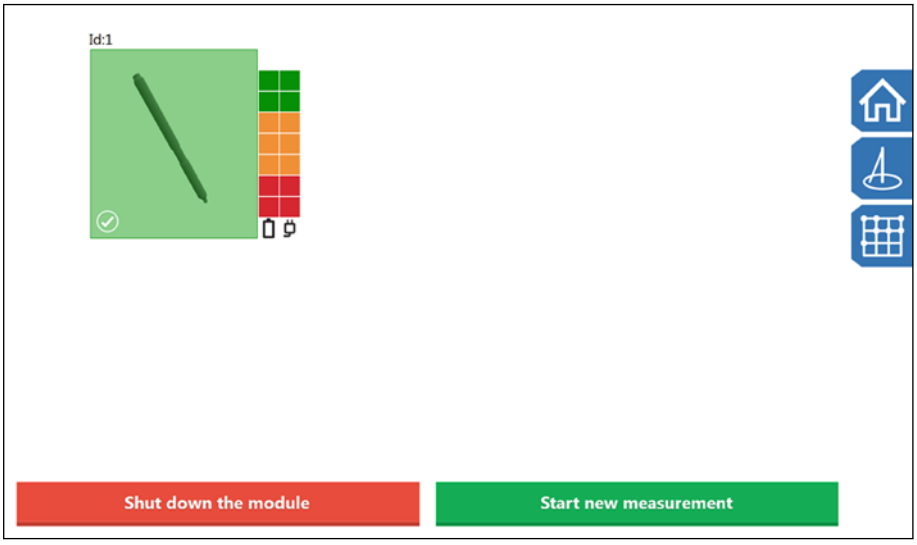
The process of measuring a borehole is initiated in the measuring view. You can access the measuring view with the Measure button in the home menu.

You can also access the measuring view by selecting the hole in the Site view and clicking the Start measurement button.

4.4.1 Measuring a borehole from the bottom up

Procedure

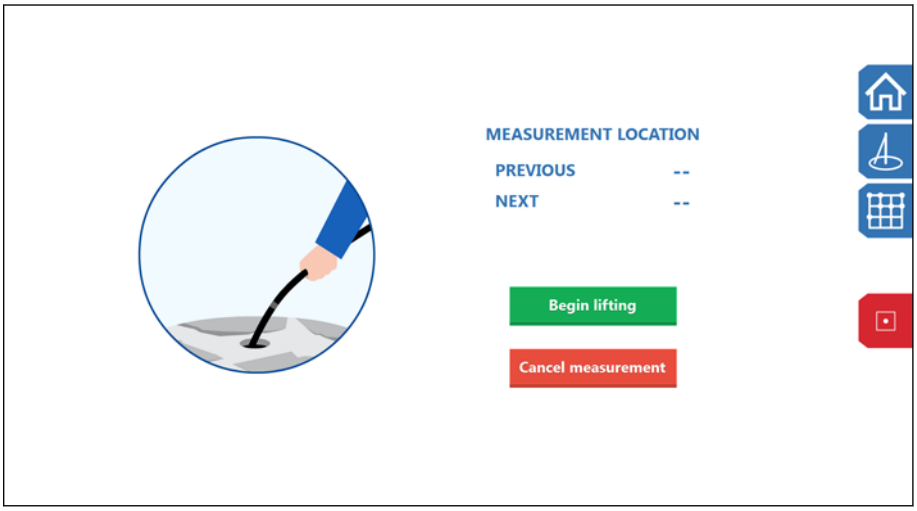
1. Select Start new measurement to start the measuring process.



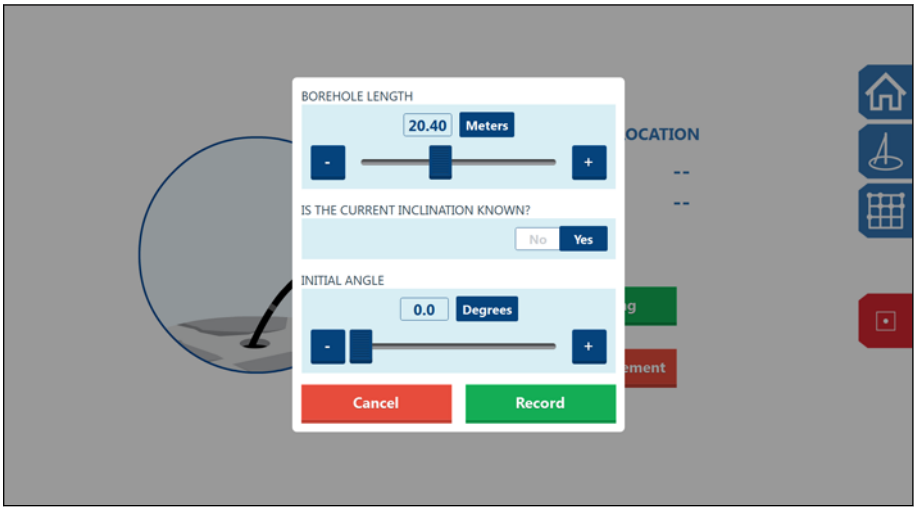
2. Lower the measurement probe into the borehole. Make sure that the probe touches the bottom of the borehole.

   Tip: To improve measurement accuracy, lift the measurement probe a couple of centimeters from the bottom of the borehole.

3. Press Begin lifting to start.



4. Enter the borehole length using the slider or the + and - buttons. If the current borehole inclination is known, select Yes and enter the initial angle using the slider or the + and - buttons.

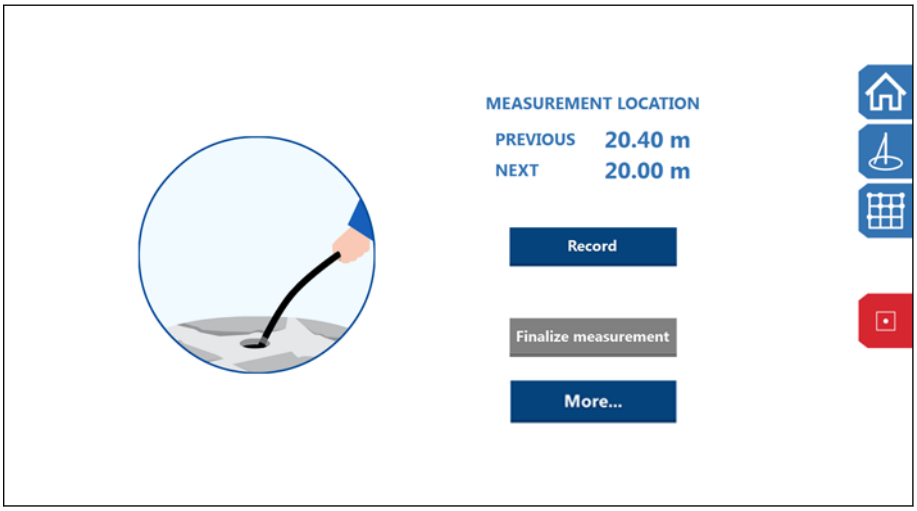


5. Press Record to take the first measurement.

Note: Do not move the measurement probe when the measurement is being recorded. Hold the measurement probe in place until the timer and text on the display disappear.

Note: If the measurement probe is shaken during measurement, the timer is reset and an alarm is sounded. In such case the system automatically records the next measurement when the measurement probe is held still. This feature identifies and rejects bad measurement data in real-time. The system eventually accepts the measurement even if the measurement probe was shaken.

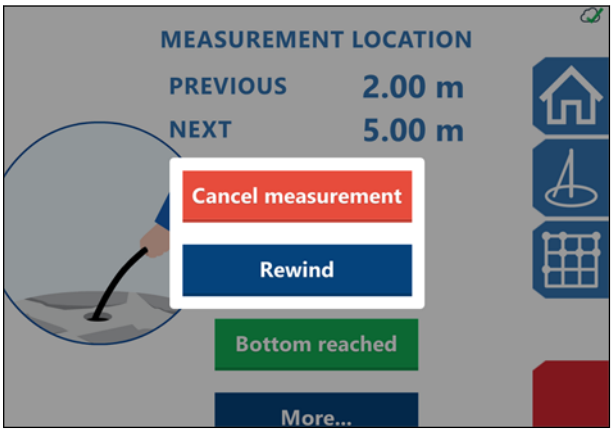
Once the measurement has been marked, the program returns to the measurement view.



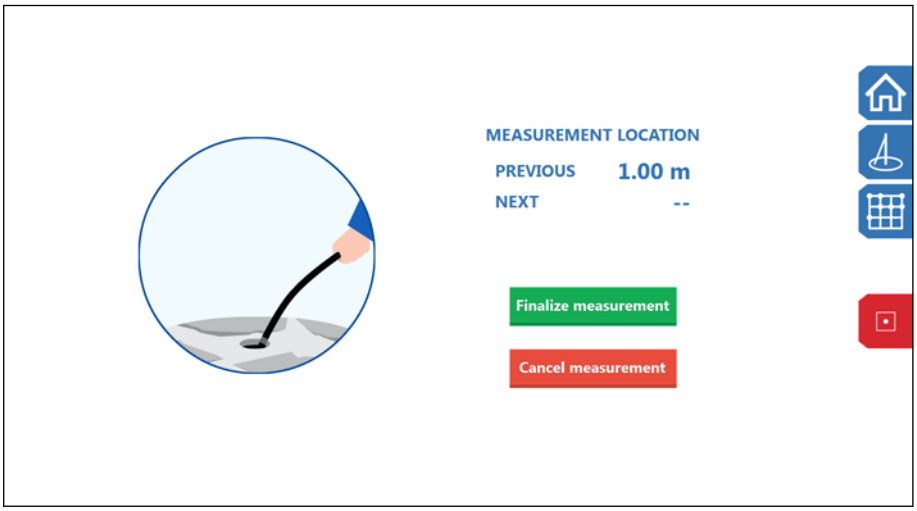
Note: If the bottom of the hole is not at full meters/feet, the second timestamp is always taken at full meters/feet regardless of the measurement interval. After the second timestamp, the chosen measurement interval applies.

Example: Borehole length is 20.4 meters, and the measurement interval is set to 2 m. The first measurement is taken at 20.4 m, the second at 20.0, after which the measurement locations are 18, 16, 14, 12, 10, 8, 6, 4, 2 and 1 meter (the last measurement is always taken at 1 m).

6. Start lifting the measurement probe out of the borehole. Mark the distance at the preselected measurement intervals by pressing the Record button.
7. You can go back to the previous timestamp by pressing More...Rewind.



8. Once the final measurement marking on the measurement cable has been reached, end the measurement by pressing the Finalize measurement button.



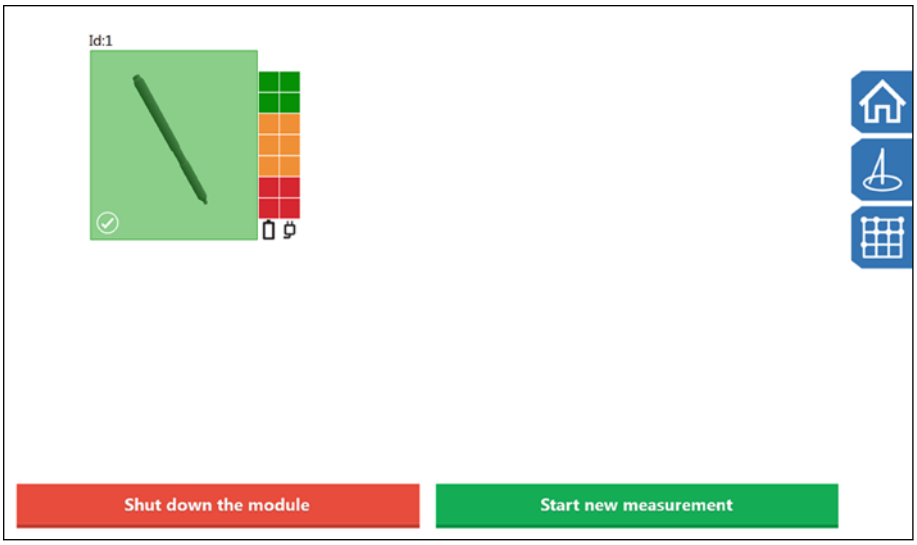
Note: The final measurement is recorded at the depth defined as nearest surface point in measurement settings.

9. Once the measurement has been done, the results can be saved for the desired field. Select the field by pressing the Browse... button. If the measurement has been initiated by selecting a hole in the field, the measurement is automatically saved for the selected hole. If a site or position is not indicated for the hole, it is saved without location data.

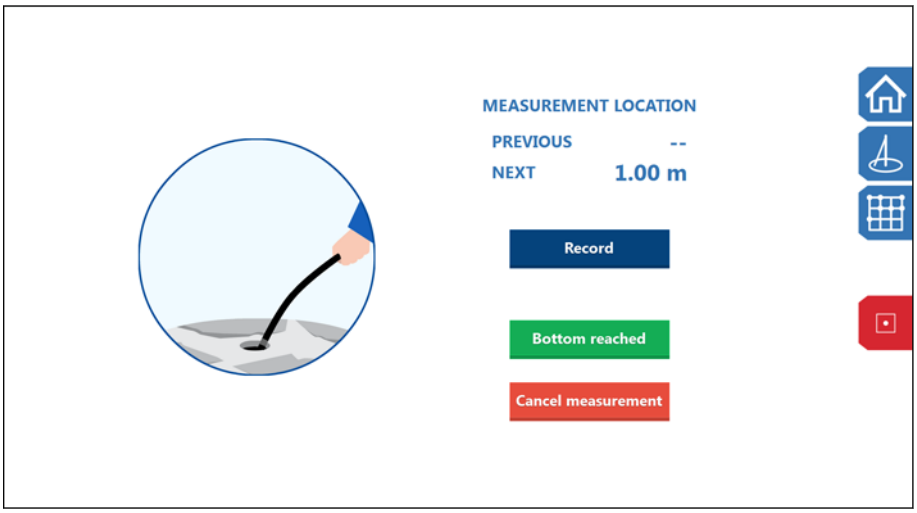
4.4.2 Measuring a borehole from the top down

Procedure

1. Select Start new measurement to start the measuring process.



2. Lower the measurement probe to the depth defined as the nearest surface point in measurement settings.
3. Press the Record button to record the first measurement.

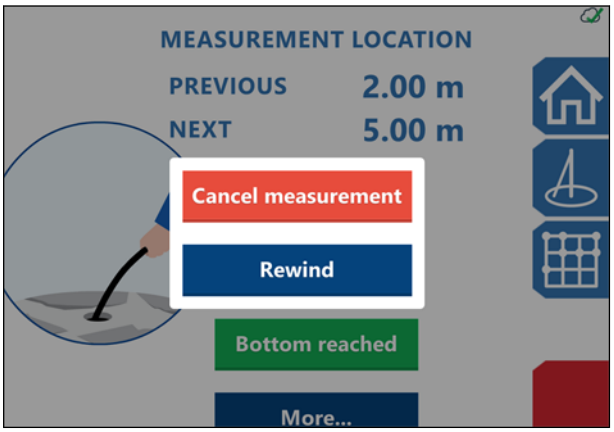


Note: Do not move the measurement probe when the measurement is being recorded. Hold the measurement probe in place until the timer and text on the display disappear.

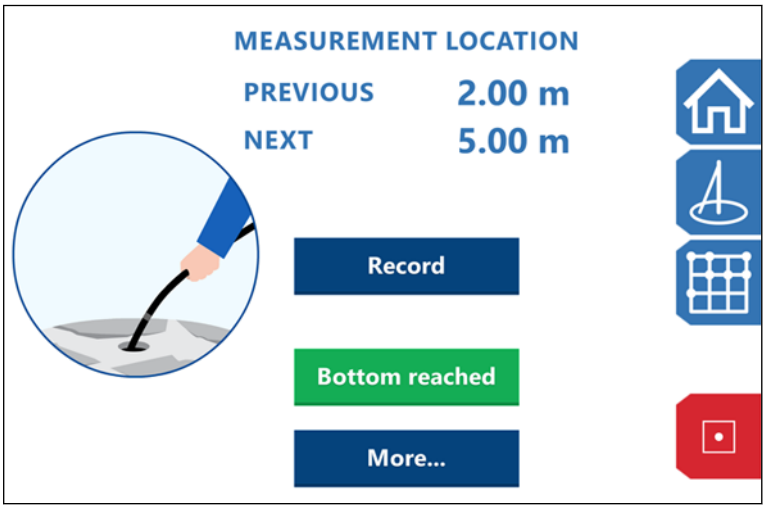
Note: If the measurement probe is shaken during measurement, the timer is reset and an alarm is sounded. In such case the system automatically records the next measurement when the measurement probe is held still. This feature identifies and rejects bad measurement data in real-time. The system eventually accepts the measurement even if the measurement probe was shaken.

Once the measurement has been marked, the program returns to the measurement view.

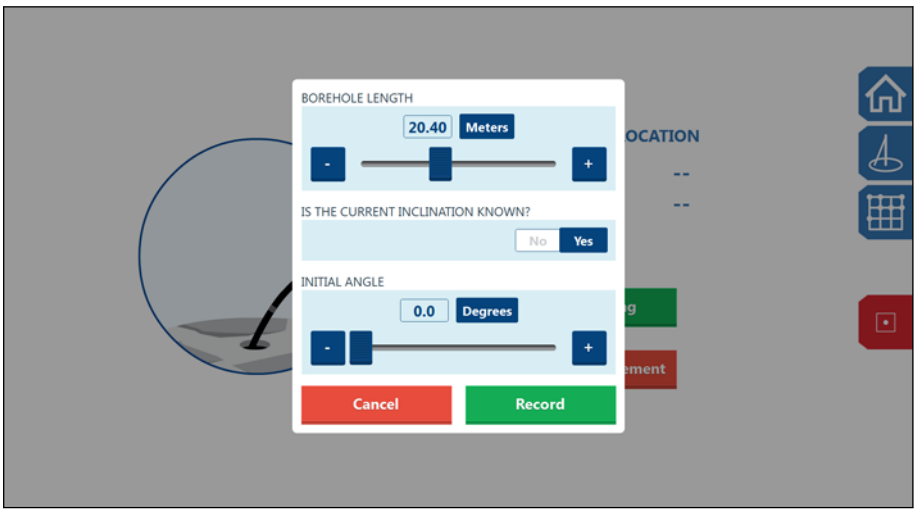
4. Start lowering the measurement probe into the borehole. Record measurements at the preselected measurement intervals by pressing the Record button.
5. You can go back to the previous timestamp by pressing More...Rewind.



6. Once the bottom of the borehole has been reached, end the measurement by pressing the Bottom reached button.



7. Enter the borehole length using the slider or the + and - buttons. If the current borehole inclination is known, select Yes and enter the initial angle using the slider or the + and - buttons.



8. Press Record to take the final measurement.
9. Once the measurement has been done, the results can be saved for the desired field. Select the field by pressing the Browse... button. If the measurement has been initiated by selecting a hole in the field, the measurement is automatically saved for

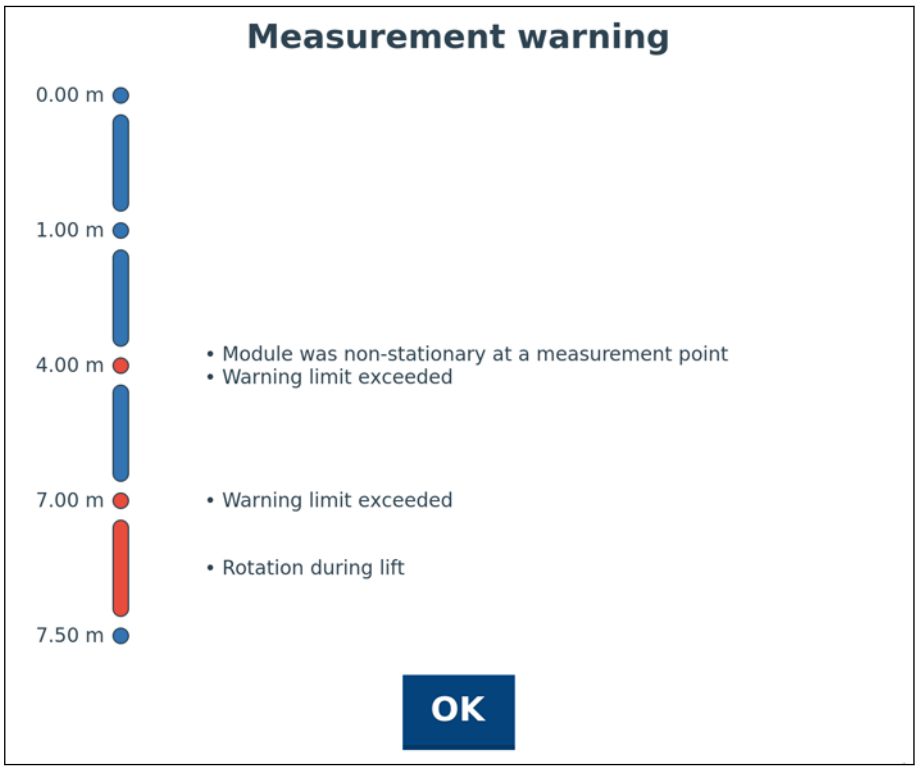
the selected hole. If a site or position is not indicated for the hole, it is saved without location data.

4.4.3 Measurement quality view

After each measurement, the system displays a measurement quality view which helps in spotting and improving accuracy affecting issues.

The measurement quality view contains e.g. the following measurement quality observations:

- Rotation warnings
- Non-stationary warnings for each timestamp.



Press OK to close the measurement quality view.

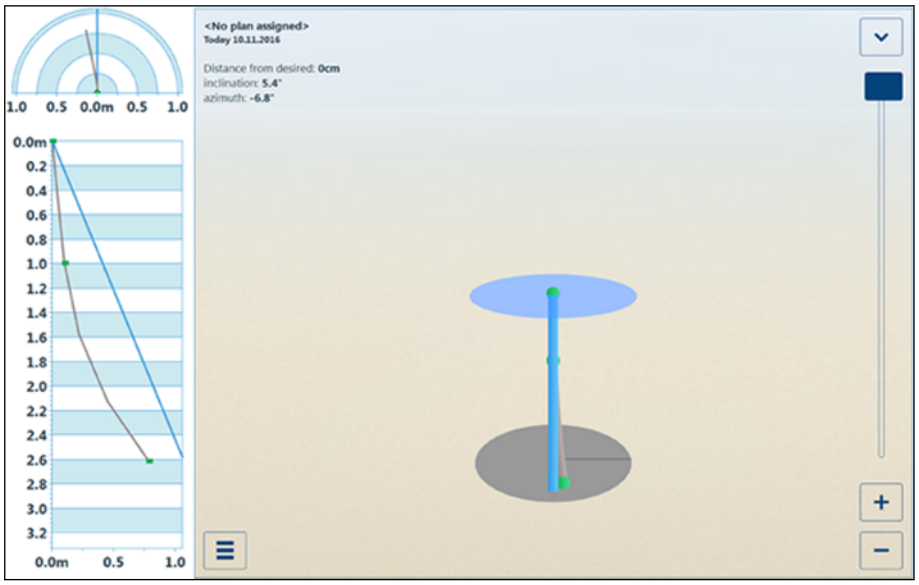
4.5 Results view

Measured holes can be examined in the inspection view. To access this view, click the Results button in the home menu.

You can also view the measurement results by selecting the desired hole in the site view and pressing the Inspect button.

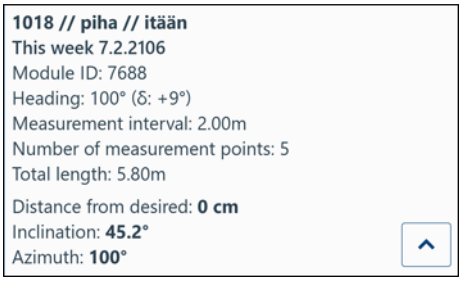
4.5.1 Inspecting measured holes

In the drill hole inspection view, the holes are presented in an interactive 3D view and a 2D planar view. The 3D view can be turned as well as zoomed in and out. The cross-section plane in the view can be moved.



Procedure

1. Open the additional information for a drilled hole by clicking the v button at the upper edge of the view. Close the information by clicking the ∧ button.



The additional information window contains the following data:

- Site, level and plan information
- Measurement date
- Measurement module ID
- Compass heading including declination. Declination (in this case +9 degrees) is derived from the latest GPS position of the tablet computer.

- Measurement interval
- Number of measurement points
- Total hole length
- Distance from the desired hole position
- Hole inclination
- Hole Azimuth value.

2. The hole being inspected can be changed by clicking the Menu button at the bottom edge of the view.
3. You can view more detailed information on the hole in the planar views on the left by moving the blue cross-section plane.

   The upper planar view indicates the azimuth of the hole. The starting direction is always shown as up in the view. The lower planar view shows the angle and length of the hole as well as its deviation from the planned specifications.

4.6 Site view

The site view displays the selected drilling plan. The way in which the drilling plan is presented can be selected with the Site button in the side menu. The 2D/3D icon below the button indicates which mode is selected.

To access the site selection and creation view, click the Drilling plan button in the start or side menu.

By selecting a hole in the drilling field, you can navigate directly to measuring the hole in question or viewing a measured hole. Measured holes can also be moved, deleted and supplemented with additional data.

In the 3D view, the bottoms of the boreholes are assumed to be at equal depth. The ground level in the 3D view is determined based on the measurements conducted. It can then be used to facilitate finding holes and to draw a graphical presentation of a hole's direction and azimuth. In other words, the vertical alignment of the holes is derived from the bottom and is horizontal in relation to the surface.

During hole measurement, the starting direction is always assumed to be the same, so all the holes in the field begin in the same direction: directly up. If the starting direction of a hole differs from the assumed direction, the graphical presentation will not match the drilled hole. The starting angle is defined before drilling and set as the hole's starting angle for measurement.

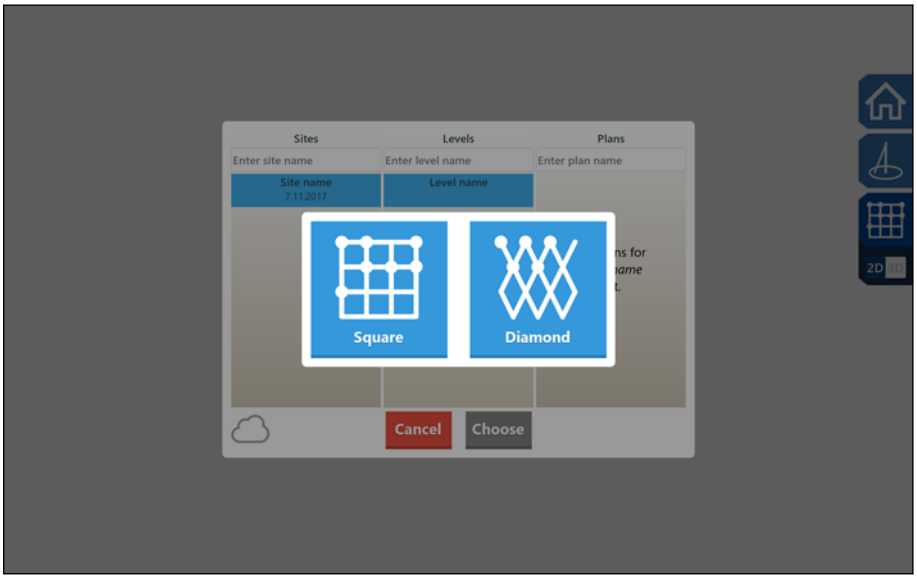
4.6.1 Creating a new field

A new drilling plan can be created via the Menu button in the lower left corner.
Procedure

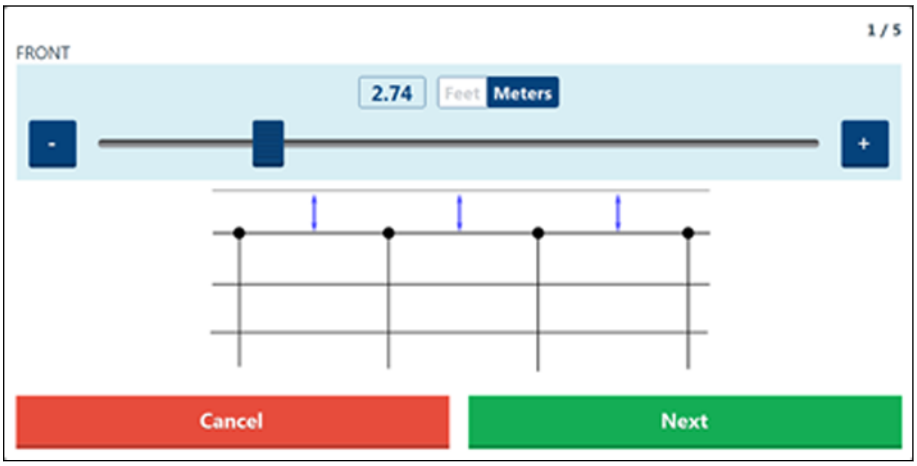
1. Enter a name for the site, level and drilling plan. You can also select an existing drilling plan.

By tapping the cloud icon, you can see the fields stored in the cloud service but have not been used locally.

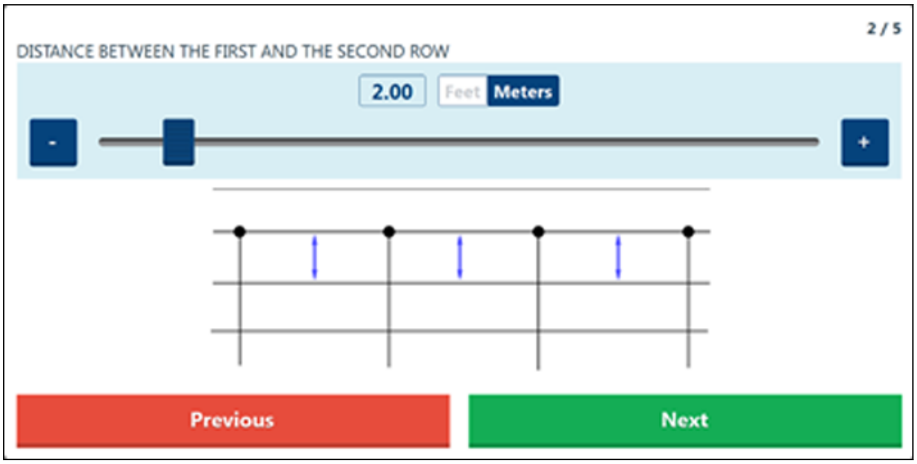
2. Select the shape of the new drilling plan.



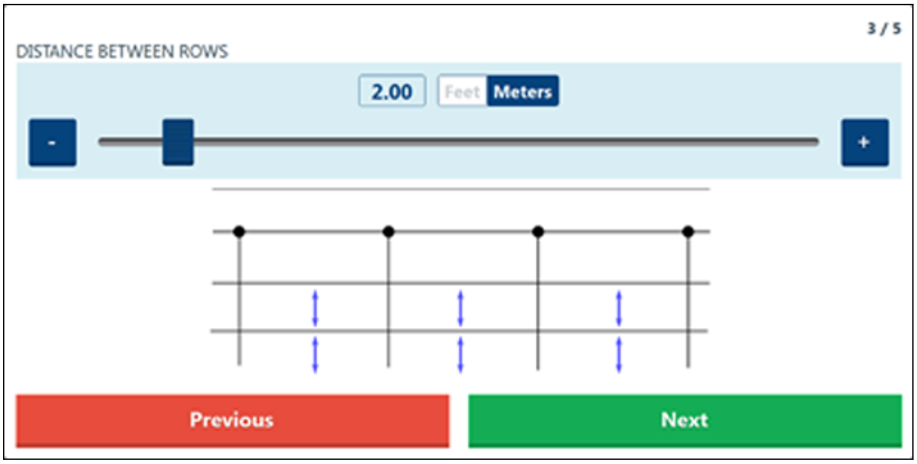
3. Set the distance of the first drilling row from the edge of the slope.



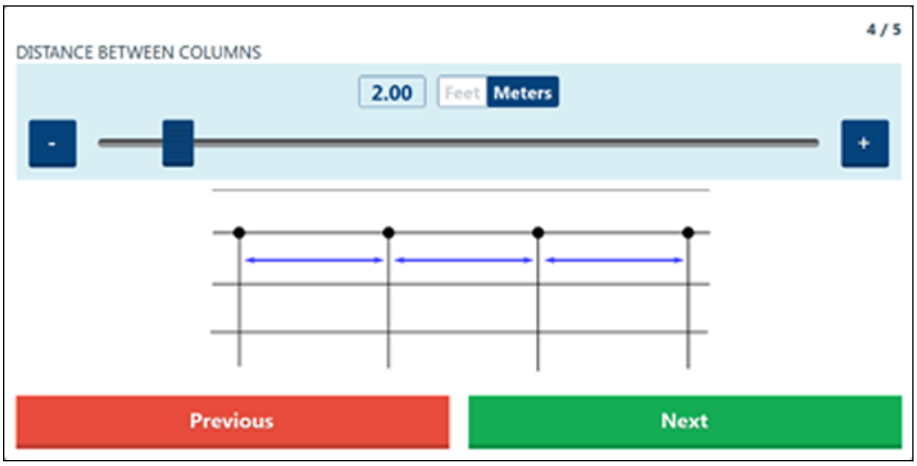
4. Set the distance between the first two rows.



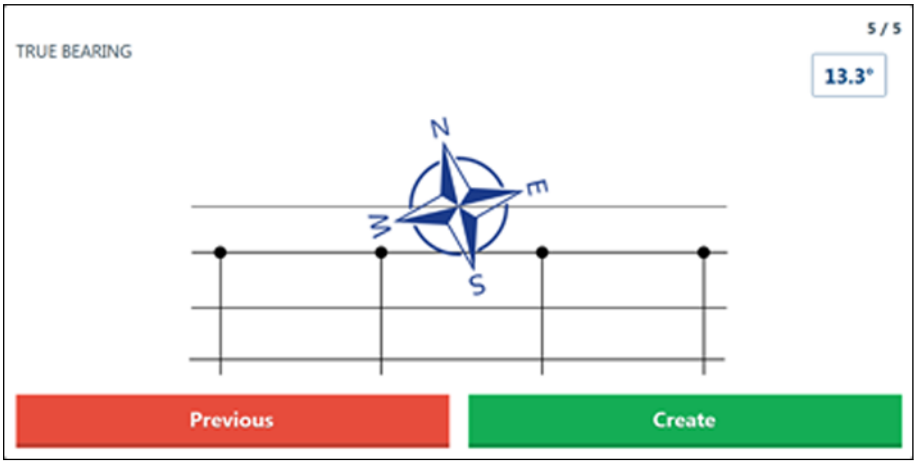
5. Set the remaining row intervals.



6. Set the distance between row columns.



7. Set the true bearing of the field by touching and rotating the compass.

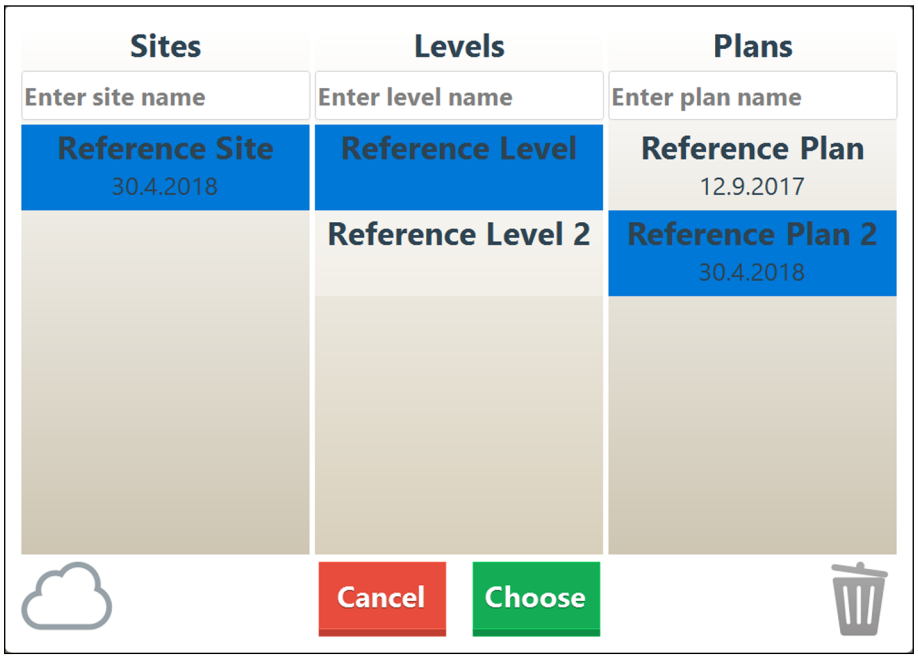


4.6.2 Deleting a site, level or plan

You can delete a site, level or plan via the Menu button in the lower left corner.

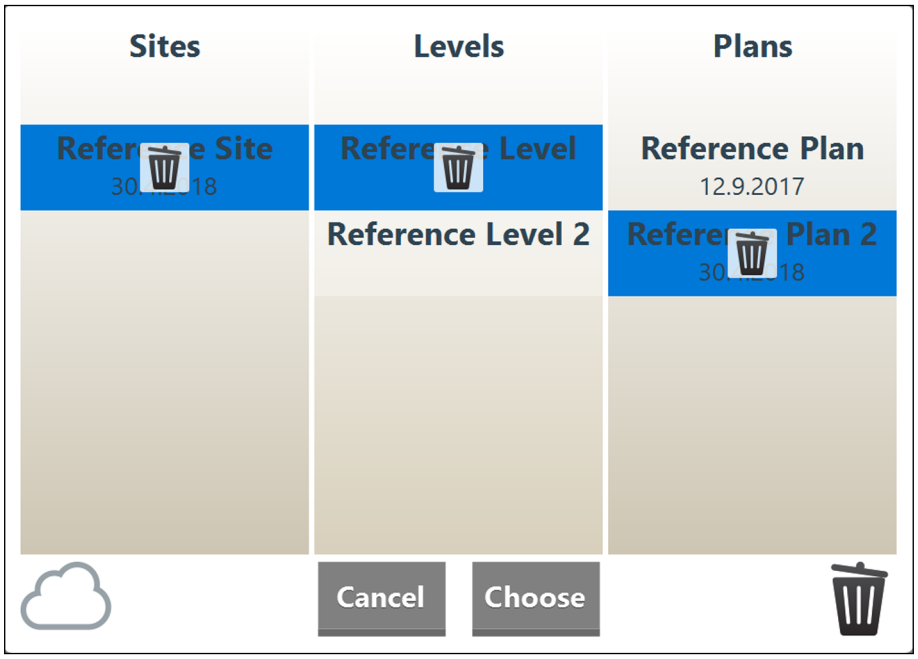
Procedure

1. Select the site, level or drilling plan to be deleted.

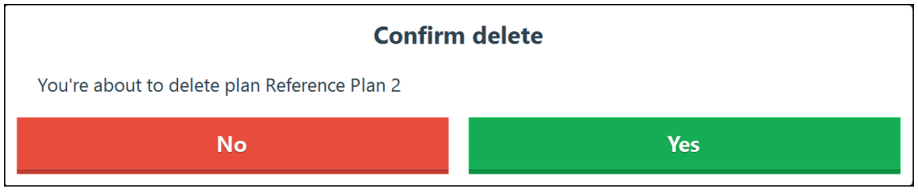


Tap on the trashcan icon the mark the selected item(s) for deletion.

2. Tap on the trashcan icon on the site, level or plan to delete the specific item.



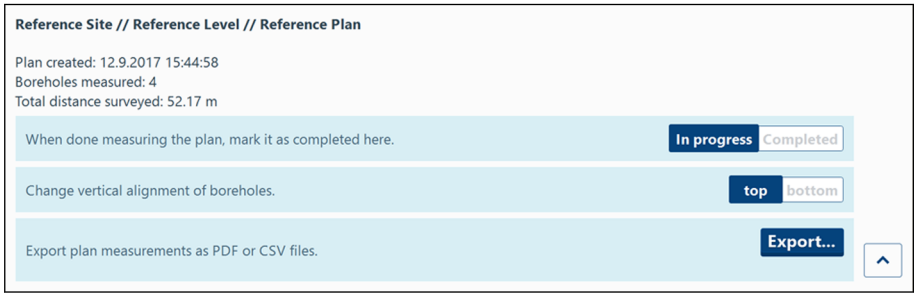
3. Confirm delete by tapping the Yes button or cancel by tapping No.



The selected item is deleted.

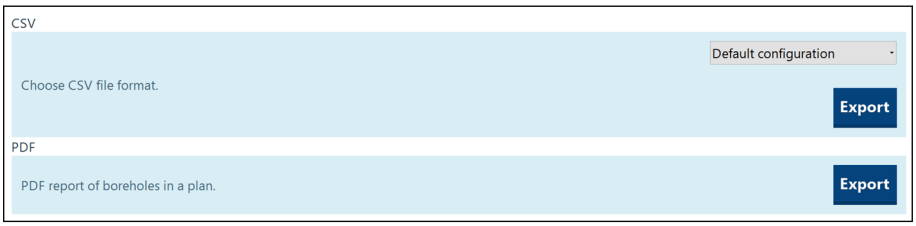
4.6.3 Additional information dialog

You can view additional information about the drilling plan by clicking the v button at the upper edge of the Site view. You can mark the plan as completed, change the vertical alignment of boreholes and export plan measurements. The system supports different export configurations which define how the data is exported.



Procedure

1. Mark the drilling plan as completed by tapping Completed.
2. Change the vertical alignment of boreholes by tapping top or bottom.
3. Export plan measurement data by tapping Export... and select the export configuration for .csv export from the drop-down menu.



   Select Export to export measurement data.

The exported data file is opened automatically.

4.7 Settings view

In the settings view, you can select the measuring direction, define the cable measurement point interval and nearest surface point. You can also select the measuring mode as well as define warning settings for inclination and hole deviation, and change the language of the operating system. To access this view, click the Settings button in the home menu.

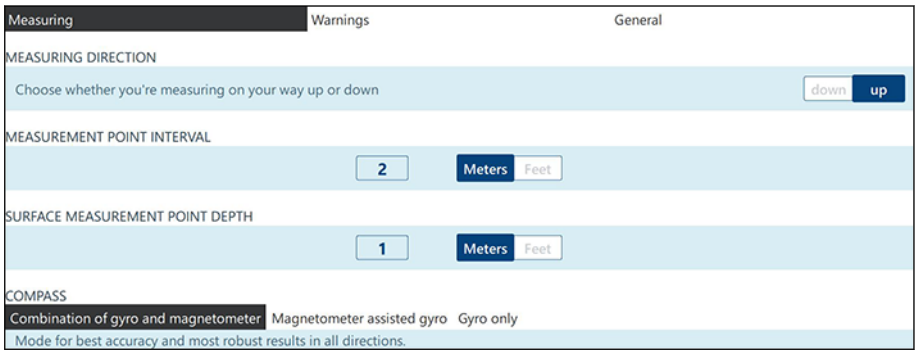


Figure 2. Measuring settings tab

The measuring mode can be defined under the Compass section:

- **Gyro only** for magnetic conditions. The Operator sets the collar heading for each hole. The Gyro only mode is sensitive to correct working methods.

  Note: Azimuth information on vertical and horizontal holes is limited.

- **Magnetometer assisted gyro** measurement to lower the magnetic influence. In this mode, the shape of the borehole is measure with gyro, whereas the collar heading is measured with magnetometer. The Magnetometer assisted gyro mode is sensitive to correct working methods.
- **Combination of gyro and magnetometer** for best accuracy and most robust results. Suitable for all hole directions.

Figure 3. Warning level tab

Figure 4. General settings tab

5 Inspection and service

The following inspections must be performed at regular intervals in order to ensure that the measuring system operates as intended.

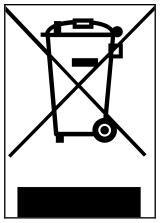
Note:

Never use damaged components!

6 Troubleshooting

7 Environment and recycling

7.1 Disposal of components



Do not dispose of electrical and electronic components with other waste. Separate electrical and electronic devices from other waste in order to avoid environmental and health detriments. If you are unfamiliar with the local recycling instructions, please contact the local retailer.

The batteries used in the product may not be disposed of with other waste. If the product or its battery carries the chemical abbreviations Hg, Cd or Pb, the battery in question contains an amount of mercury, cadmium or lead that exceeds the reference values in EC Directive 2006/66. If the batteries in question are not disposed of appropriately, these substances may be harmful to health or the environment.

Protect natural resources and promote the reuse of the materials. Separate batteries from other waste, and take batteries to a local recycling point.

8 Technical specifications

8.1 Standards

The Robit M Sense system components comply with the following industrial standards:

- IEC 61000-6-4 Part 6-4: Generic standards - Emission standard for industrial environments
- IEC 61000-6-2 Part 6-2: Generic standards - Immunity for industrial environments

RoHS

EN 50581 Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances

8.2 Licence information

OpenSSL Toolkit

The OpenSSL toolkit stays under a dual license, i.e. both the conditions of the OpenSSL License and the original SSLeay license apply to the toolkit. See https://www.openssl.org/source/license.txt for the actual license texts.

Qt Toolkit

The Qt Toolkit is Copyright (C) 2015 The Qt Company Ltd.

You may use, distribute and copy the Qt GUI Toolkit under the terms of GNU Lesser General Public License version 2.1. See https://raw.githubusercontent.com/qt/qt/4.8/LICENSE.LGPL for the actual license text.

9 Certificates

9.1 CE marking

This system bears the CE marking. This means that the system and its accessories adhere to the applicable directives, norms and regulations.

As proof of compliance with health and safety requirements, Robit Plc supplies an EU/CE certificate with each system sold in the EU/EEC area.

The system meets or exceeds the requirements of the following European standards.

- IEC 61000-6-4 Part 6-4: Generic standards - Emission standard for industrial environments
- IEC 61000-6-2 Part 6-2: Generic standards - Immunity for industrial environments
- EN 50581 Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances

9.2 FCC rules

This device complies with Part 15 of the FCC Rules [and with Industry Canada licence-exempt RSS standard(s)]. Operation is subject to the following two conditions:

1. this device may not cause harmful interference, and
2. this device must accept any interference received, including interference that may cause undesired operation.

NOTICE: Changes or modifications made to this equipment not expressly approved by the manufacturer may void the FCC authorization to operate this equipment.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes:

1. l'appareil ne doit pas produire de brouillage, et
2. l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

10 Appendices