

Boretrak360

Borehole deviation survey system

Hardware user manual

PD-2304-8011-E



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INTRODUCTION

1 Customer information

1.1 Carlson Software

Congratulations on purchasing a Boretrak360 hole deviation surveying system from Carlson Software.

Founded in 1983, Carlson Software specialises in CAD design software, surveying hardware, and machine control products for the land surveying, civil engineering, construction, and mining industries worldwide, providing single-source technology solutions from data collection to design to construction.

The Boretrak360 is designed and built with Carlson's world-class levels of detail, quality and innovation.

Carlson's renowned dedication to customer service is unique in the industry.

For any technical support issues related to your Boretrak360 system contact us directly or, alternatively, contact your local Carlson-approved service and support centre. Details of all contacts are on our website: www.carlsonsw.com.

To ensure the best service when contacting Carlson about your Boretrak360, please make a note of the serial number. This can be found on the instrument (see Figure 1).

1.2 Contacts

Carlson's main offices, where your Boretrak360 equipment is designed, built and supported, are outlined below.

Carlson Software Inc. Head office, production and service	Carlson LMD. Engineering, production and service	Carlson EMEA BV. Sales, support and logistics
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1.3 User manual

The Boretrak360 system is designed to be easy to operate. However, please take the time to read these operating instructions carefully before using the system and always keep them with the instrument.

This manual focuses on the Boretrak360 hardware. This includes all items in a standard Boretrak360 system, together with an overview of all available accessories to the Boretrak360.

Carlson Boretrak software is integral to the operation of the Boretrak360. There are two versions of this software: one runs on Windows tablets and PCs, the other runs on Android-based mobile devices. The software is described in detail in the accompanying **Carlson Boretrak** software manual. The software manual also covers standard operations procedures in the field.

Note that there is an alternative Boretrak probe: the Boretrak3. This is a heavier, more robust probe, designed primarily for downhole deployments. A separate hardware manual is available for the Boretrak3 system. However, the Boretrak360 and Boretrak3 systems use the same software and are operated in the field in the same way, so the **Carlson Boretrak** software manual is the same for both units.

All related Boretrak manuals are available via the **About** screen in **Carlson Boretrak** software.

This document has been compiled with care. However, should you discover any errors, we would be grateful if you could contact Carlson directly.

Reproduction of this document in whole or in part, including utilisation in machines capable of reproduction or retrieval, without the express written permission of Carlson is prohibited. Reverse engineering is also prohibited.

The information in this manual is subject to change without notice.

For any feedback or comments, or if there are questions about the Boretrak360 which are beyond the scope of this manual, contact Carlson Software.

1.3.1 Manual version

The document number of this manual is PD-2304-8011-E. Compiled in October 2026.

The manual is based on **Carlson Boretrak** software version 1.8.2 and Boretrak firmware version BTG 6.4.7.2.

Updates incorporated into manual PD-2304-8011-E:

- Added company addresses.
- Updated safety & regulatory information for equipment compliance.

Manual version PD-2304-8011-D:

- Updated push rod fastener information and photos (section 4.2).

Manual version PD-2304-8011-C:

- Added the push rod fastener information and photos (section 4.2).

Manual version PD-2304-8011-B:

- Software and hardware sections split into separate manuals.
- First version of the Boretrak360 hardware manual. A separate Boretrak3 hardware manual is also available.
- Added centralisers as an optional extra (section 4.1).
- Technical specifications table updated.
- More information about screwing the rod adaptor onto the deployment system (section 4.4).
- Operational safety (section 6).
- Minor error corrections.

2 Boretrak360 system concepts

2.1 System overview

The Boretrak360 system is a simple-to-use, borehole deviation measurement system aimed at underground mining and civil engineering applications.

The Boretrak360 probe is designed to survey the route of drilled boreholes by measuring their inclination and heading at fixed intervals along the hole.

The Boretrak360 is based on previous iterations of the Cabled and Rodded Boretrak, and Boretrak2 products. The features of all previous units are combined into a single all-purpose system, capable of measuring boreholes in any inclination: down, up or horizontal.

The Boretrak360 utilises a miniature inertial measurement unit (IMU) which contains a triaxial accelerometer, magnetometer, and gyro. Prior to deployment, the probe is aligned against a known orientation or a magnetic heading on a supplied jig. This establishes a starting, reference heading for the gyro. Thereafter, the IMU provides the Boretrak360 with an accurate heading and inclination.

The Boretrak360 probe is attached to a cable or push rods and deployed along a borehole. The system is deployed at a series of fixed intervals, most commonly 2 m. IMU data is recorded at each interval as the probe is deployed along the borehole. In this way, the Boretrak360 builds up a 3D map of the borehole.

The magnetic sensors in the Boretrak360 can be enabled or disabled depending on whether the local environment is a suitably 'clean' magnetic environment. When disabled, the system is not reliant on magnetic sensors and is therefore ideally suited for measuring boreholes where there may be material present which would influence a magnetic compass. Generally underground mining environments are regarded as unsuitable for magnetic sensors.

The Boretrak360 system can be rapidly deployed on site, at any inclination, and requires no specialised tools or equipment other than those supplied with the system.

2.2 Boretrak360 v Boretrak3

The Boretrak360 is designed for underground applications where uphole and horizontal holes will be the most common deployments. The hard-anodized aluminium body weighs just 1.5 kg and is therefore much lighter and easier to push than the Boretrak3 which weighs 3.4 kg. The Boretrak360 battery cover, which screws on the nose of the probe, is made of titanium: lightweight and rugged enough to withstand bearing the brunt of repeated deployments along drilled holes.

Centralisers must always be used with a Boretrak360 when it is being pushed upwards. The centralisers keep the probe parallel with the sides of the hole and thus ensure the most accurate results. Centralisers also have the effect of protecting the aluminium from being eroded by continual friction with the bare rock during deployments.

The Boretrak360 can be used downhole if a cable and deployment adaptor are purchased. However, note that the aluminium body is less robust than the steel housing of the Boretrak3. As a result, the metal housing will erode more quickly from repeated abrasion against the inside of the boreholes. Centralisers are not required for accuracy when deploying downhole, but they can still be used to help protect the housing. For downhole use, the size of the centralisers should be significantly smaller than the hole diameter to ensure that the probe can still be lowered along the hole using gravity alone.

Note also that the Boretrak360 is not as highly waterproofed as the Boretrak3. The Boretrak360 is rated as IP66 so can withstand jets of water, whereas the Boretrak3 is IP68 and can withstand extended submersion in flooded holes.

The Boretrak3 is available for applications where holes drilled downward are the most common deployments. The steel body ensures a long life when using the probe intensively without centralisers. The high level of environmental protection keeps the Boretrak3 working in flooded holes.

2.3 Data communication and storage

During a Boretrak survey, the operator configures and controls the Boretrak360 project via **Carlson Boretrak** software which runs on a tablet or mobile device.

The Boretrak360 and the tablet running **Carlson Boretrak** communicate via a Bluetooth link. However, during a deployment, this link will usually be disconnected. Therefore, before deployment, the date and time in the probe are synchronised with the date and time in the tablet. From this point, the probe starts recording IMU data into its internal memory. Readings are taken every second and the LEDs on the probe visually indicate that this process is ongoing. Each sensor record in the probe is accompanied by a time stamp.

At each deployment interval, with the system held steady, the operator on the surface records a time stamp using **Carlson Boretrak**.

Once a survey has been completed, and the Boretrak360 is back on the surface, the Bluetooth link is re-established and all IMU data from the probe is automatically downloaded to **Carlson Boretrak**.

Carlson Boretrak reads the time stamps recorded on the tablet and extracts the records in the probe data which have matching time stamps.

With reference to a starting hole collar coordinate and an initial alignment heading, these raw observations are converted into a sequence of X, Y, Z coordinates. A model of the hole is then created, and a comparison can be made to a design hole or another survey of the same hole.

2.4 Carlson Boretrak software

Carlson Boretrak software acts as the survey controller which enables you to set up projects, manage holes, conduct the survey, and view results.

Versions of **Carlson Boretrak** are available to run on a Windows tablet or an Android mobile device.

Carlson Boretrak displays real-time data from the probe while the Bluetooth connection is live. During a deployment, the probe is in a borehole, so the connection is usually disconnected. The connection is automatically re-established when a hole survey is complete, and the probe has been retrieved to within Bluetooth range of the tablet.

After downloading data, a visual inspection of the hole survey is possible. You can compare the surveyed hole with design data and export the project for use in other software packages from Carlson or in third party packages.

Carlson Boretrak allows you to manage the geo-referencing of the holes, and to send final data directly from the field.

Back in the office **Carlson Boretrak** can run in **Desktop mode** on an office PC. This allows a more comprehensive data analysis to be conducted, and reports and exports can be generated.

HARDWARE

3 Boretrak360 hardware description – standard deliverables

3.1 Probe

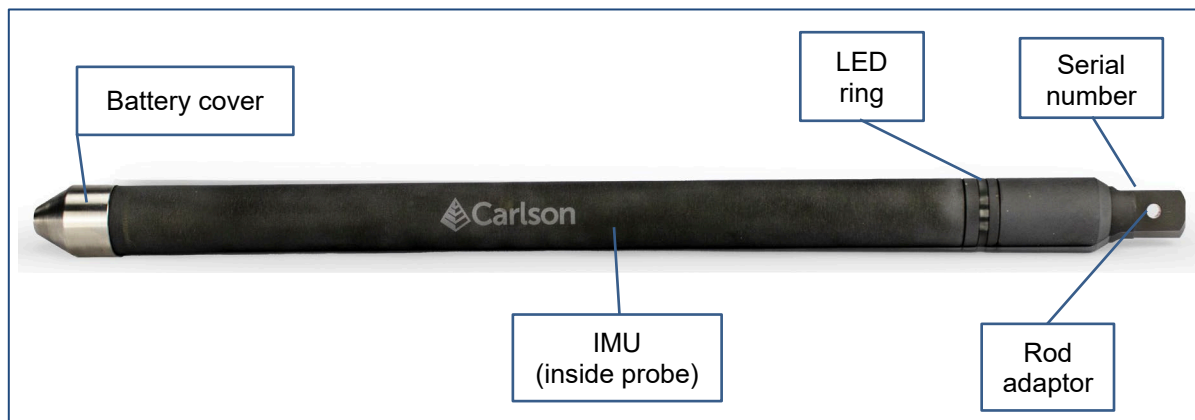


Figure 1 Boretrak360 probe

The Boretrak360 housing is constructed of hard-anodized aluminium.

The battery cover at the bottom end of the probe allows the batteries to be loaded into the unit. It must be unscrewed to change the batteries. Since the battery cover is on the nose of the probe and will take the most impacts during a deployment, it is manufactured from titanium to ensure it is sufficiently robust.

Inside the probe is an inertial measurement unit (IMU). The IMU comprises a triaxial accelerometer, magnetometer, and gyro. The Boretrak360 probe operates at any inclination. The IMU tracks the orientation of the probe whether it is deployed upwards, downwards, or horizontally.

A ring of LEDs provides visible information on the status of the Boretrak360. The information conveyed is outlined below.

LEDs during boot up sequence	Message signalled
White solid	Bootloader execution has begun
Yellow solid	Beginning power up sequence, testing battery pack voltage
Red solid	Battery voltage failed initial voltage check
Green solid	Battery voltage passed initial voltage check
Blue flashing	Power up succeeded. Waiting for Bluetooth connection.
LEDs after connection	Message signalled
Red flashing	Probe is not aligned or has lost alignment
Yellow flashing	Probe is aligned / logging is off
Green flashing	Probe is aligned / logging is on / ready to survey
Red solid	Battery is too low to run the probe
Purple flashing	Bootloader is ready for an application firmware update

The Bluetooth signal is broadcast through the LED window. Try to avoid holding the probe by the LED window during operations as Bluetooth communications with the mobile device may be affected.

The deployment adaptor provides a quick-release mechanism to attach to deployment devices. This connection ensures that the probe is secure during deployment and that attaching and detaching the selected deployment device is quick and efficient.

The serial number of the probe is engraved on the side of the rod adaptor.

The Boretrak360 probe is ruggedised but should be handled with due care to best protect the calibrated sensors inside the housing.

3.1.1 Probe power

The Boretrak360 probe is powered by four, size “D” (LR20) batteries. With each Boretrak360 system, Carlson supplies four alkaline batteries. Thereafter, source your own disposable or rechargeable batteries.

Ensure that any rechargeable batteries are fully charged prior to each day’s survey operations.

The batteries are contained in the body of the probe and can be accessed by unscrewing the battery cover at the bottom end of the probe.

Insert the batteries into the probe with the positive terminals pointing into the probe: see Figure 2. Screw the battery cover firmly into place using hand pressure only. The battery cover must be fully screwed home to ensure a watertight seal.



Figure 2 Positive battery terminal faces inward

Indications of discharged batteries are:

- The LEDs switch to solid red (battery too low to proceed with operations).
- The LEDs do not activate when the nose cone is fitted (battery exhausted).
- The tablet cannot establish communications with the probe through Bluetooth (battery exhausted).
- A message in **Carlson Boretrak** software indicating that the battery level is critical or that there is not enough power to turn on the IMU.

The probe is powered ON as soon as the battery cover is fully screwed onto the probe. Removing the battery cover powers the probe OFF.

Note that there is a supercapacitor in the probe which allows the Boretrak360 to keep running if power is momentarily lost due to a sudden shock, or displacement of the batteries. Therefore, to fully reboot the probe, leave the battery cover disconnected for at least 20 seconds to allow the supercapacitor to fully discharge.

When the Boretrak360 probe is powered ON, the LEDs will light up, initially yellow and then in a colour and pattern dependent on the current status of the probe. See a full description of the LED colours in the table in section 3.1.

When a survey is complete, and data has been downloaded from the Boretrak360 probe to the tablet, remove the batteries to preserve the battery life. Data is automatically deleted from the probe after it has been downloaded. If data has not been downloaded, it is stored in the probe even when the probe is powered OFF.



CAUTION: use only undamaged batteries in the Boretrak360 probe. Prior to each use, check the condition of your battery cells. If the plastic coating around the battery is pierced, ripped or torn, do not load the battery into the probe. Dispose of the battery and source a Carlson-approved replacement.



Figure 3 An example of a battery with a damaged outer coating. This battery should not be used in the Boretrak360 probe

WARNING: dispose of used batteries sensibly. Under no circumstances must the batteries (or instrument) be disposed of by burning. Explosion may occur!

WARNING: all batteries contain highly reactive, poisonous, and corrosive chemicals, which are hazardous if released due to physical damage. If the batteries stop working or become damaged, do not continue using them. Source Carlson-approved replacement batteries.

3.1.2 Probe firmware

The Boretrak360 runs a version of firmware that manages the probe, processes data from the IMU and facilitates communications with **Carlson Boretrak** software.

Probes running firmware versions BTG5_0_2_2 and above can be remotely updated through **Carlson Boretrak** software. If a new version is available, a message appears when the software is started. This will guide you through the firmware upgrade process.

If your probe is running an earlier version of firmware (including any versions showing a prefix of 'MVP') then the firmware must be updated in a Carlson service centre. Thereafter, it would be possible to update to subsequent versions through **Carlson Boretrak** software.

It is strongly recommended that you use the most recently available version of firmware.

3.2 Grease

The Boretrak360 probe incorporates a battery cover. This battery cover screws onto the probe and is sealed with an O-ring above the retaining thread.



Figure 4 Silicone grease

A tube of silicone grease is supplied with the Boretrak360. Lightly smear the grease on the O-ring to ensure it is kept well lubricated and the probe retains its seal. Keep grease off the retaining thread.

3.3 USB drive



Figure 5 USB drive

A USB drive is supplied with the Boretrak360 system. This is loaded with:

- **Carlson Boretrak** software for Windows.
- **Carlson Boretrak** software for Android.
- This Boretrak360 hardware manual.
- The **Carlson Boretrak** software manual.

3.4 Alignment jig

A gyro alignment jig is supplied with all Boretrak360 systems.



Figure 6 Gyro alignment jig

When in use, the gyro inside the Boretrak360 must be aligned before a deployment. The gyro is not a north-seeking device so unless the magnetometer is used, an initial starting heading must be defined. The starting heading forms the basis of all subsequent orientation data collected over the course of a deployment. During the alignment routine therefore, the probe must be held in a position where the starting heading can be surveyed.

The jig cradles the probe during this alignment and provides a baseline which can be used to survey an accurate heading.

The heading entered in **Carlson Boretrak** software is the direction towards the nose cone of the Boretrak360 probe.

Spiked feet underneath the jig can be pushed into the ground to ensure it does not move.



Figure 7 The Boretrak360 probe on the alignment jig

A 5/8" thread in the centre of the jig allows it to be mounted on a standard survey tripod. If you are using the magnetometer for aligning the probe, it is advisable not to use a tripod, as the metal fittings and fixtures could cause the magnetic heading to be deviated.



Figure 8 Gyro alignment jig mounted on a survey tripod

Wherever the jig is positioned, if it is held securely in place, multiple, repeatable alignments can be taken from the same position. Also, if required, the jig can be left in place for a surveyor to observe with their total station after the deployment has been completed.

Note that other customised devices which perform the same function as the alignment jig may be used if they are more suitable for your specific operations.

3.1 Transit case



Figure 9 Boretrak360 transit case

Components of the Boretrak360 system are contained within a dedicated transit case. The case ensures the system is protected from shocks and vibrations. When the lid is closed and the latches are snapped in place, the case is both dust-tight and water-tight (IP67).

Always pack the Boretrak360 probe and accessories into the transit case for storage and transportation.

Clean and dry the Boretrak360 probe and other accessories prior to packing them in the transit case.

4 Boretrak360 hardware description – optional accessories

4.1 Centralisers

When deploying a Boretrak360 probe uphole, you *must* use centralisers to hold the probe parallel to the sides of the hole. Deploying the Boretrak360 uphole *without* centralisers will result in significantly inaccurate results.

Carlson can supply centralisers to fit your local site requirements and hole sizes.

The different centraliser variants listed below are plastic and connect together with a standard 'cable-tie' method. Three are required on each end of the probe. Winding tape around the end of the centralisers and onto the metal housing may help secure them to the probe.

When fitted, the centralisers expand the effective width of the probe, keeping it more tightly aligned inside the hole. The closer the total width is to the size of the hole, the less opportunity there is for the probe to 'flop' to one side.

- GT-10: bows out by 10 mm. This gives a total effective width of:
 $40 \text{ mm (probe diameter)} + 2 \times 10 \text{ mm} = 60 \text{ mm}.$
- GT-20: bows out by 20 mm. Gives a total effective width of 80 mm.
- GT-30: bows out by 30 mm. Gives a total effective width of 100 mm.
- GT-40: bows out by 40 mm. Gives a total effective width of 120 mm.

Select the variant that will provide a width that is closest to the diameter of the hole, though do not exceed the hole diameter as this may make it hard to deploy or retrieve the probe.



Figure 10 Boretrak360 probe fitted with centralisers for uphole deployment

Alternatively, you may wish to fabricate your own centraliser solution. In this case take care to ensure that both ends of the probe have an identical effective width once the centralisers are fitted.

When attaching centralisers, take care to position them in such a way that the probe can still be placed securely on the calibration jig for an accurate heading alignment.

Note that if using the Boretrak360 for downhole deployments, centralisers are not required for accuracy. However, you may wish to use centralisers to protect the aluminium housing from excessive wear. In this case use a variant significantly smaller than the hole diameter to ensure the probe can deploy freely with gravity.

Contact Carlson for further advice.

4.2 Push rod system

The push rod system is used to push the Boretrak360 probe during horizontal or uphole deployments. It is also suitable for use in shallow, downhole deployments when the hole is not steep enough for gravity to pull the probe down the hole under its own weight.

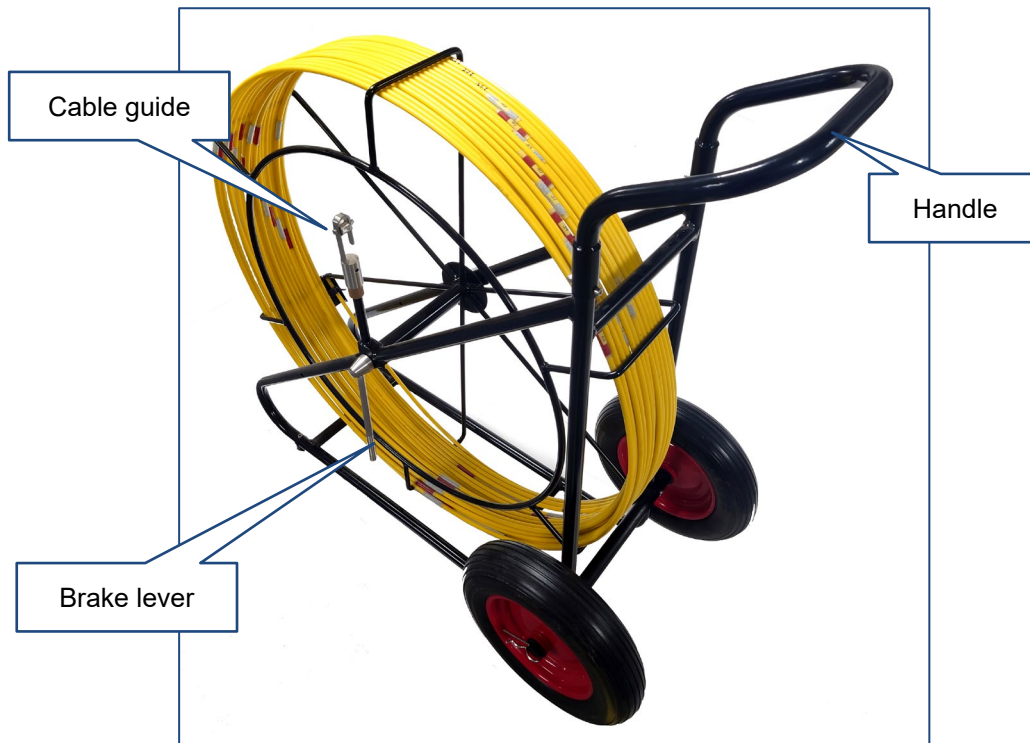


Figure 11 Push rod system

60 m of push rod is spooled in a cage held in a metal frame. The push rod is made of alkali-free fibreglass and high-quality resin for flexibility and tensile strength. The exterior layer is covered with high density UV-resistant polyethylene.

The standard push rod has a cross-sectional diameter of 9 mm. The minimum bend radius of the push rod is 30 cm.



WARNING: a large amount of energy is stored in the coiled fibreglass rod. Always maintain control over the free end of the rod when the brake is not applied. Always keep the brake lever locked when the push rod is not being deployed or recovered.

CAUTION: do not exceed the minimum bend radius of the push rod.

The first 50 m of the push rod is marked with nodules at one metre intervals. These nodules aid accurate deployment of the Boretrak360 probe. Even numbers of metres are marked with red nodules, odd numbers with silver.

A brake lever on the side of the frame locks and unlocks the cage. Rotate the brake lever clockwise to tighten and anti-clockwise to untighten the rotation of the cage. Release the brake to deploy the push rod.

4.2.1 Attaching the Boretrak360 probe to the push rod

A threaded end-piece is located on the end of the push rod to enable a connection to the supplied push rod adaptor.

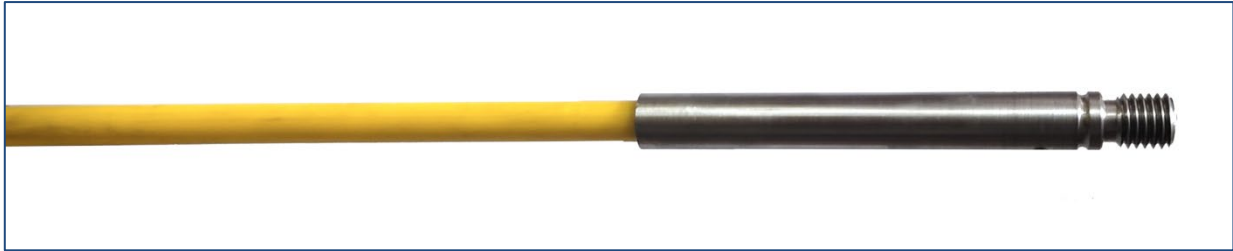


Figure 12 Push rod section with threaded end-piece

The push rod adaptor has an internal thread which allows it to be screwed directly onto the threaded end-piece.

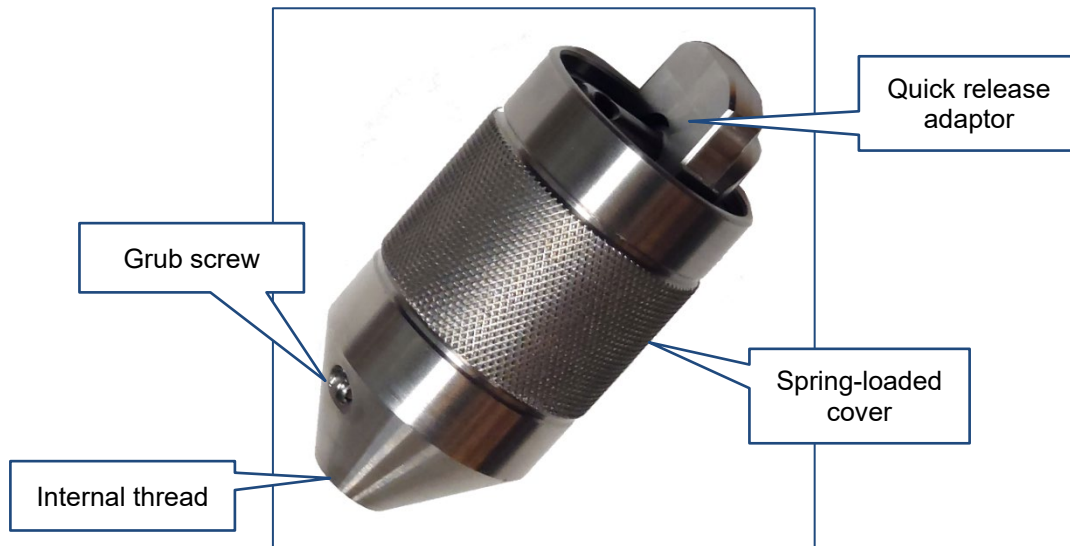


Figure 13 Push rod adaptor

Ensure the push rod adaptor is firmly screwed onto the push rod.

The push rod adaptor incorporates a spring-loaded quick release adaptor which connects onto the Boretrak360 probe rod adaptor. Retract the sprung brass cuff to reveal the quick release connection pin. See section 4.4 for further description of the quick release connection.

Two M4 grub screws are recessed into the sides of the push rod adaptor. Tighten these grub screws against the metal of the threaded end-piece to provide additional security.



Figure 14 Push rod adaptor connected to the push rod

4.2.2 Supplied parts

For transportation, the push rod system is supplied dismantled. The frame must be assembled on receipt, before the system is used on site.

The following parts are supplied as part of a push rod system.

- 1 x Push rod frame.
- 1 x Frame handle.
- 1 x Wheel axle.
- 2 x Cotter pins.
- 2 x Rubber wheels.
- 1 x Brake handle.
- 2 x M6 x 40 mm screw with nut and washer.
- 2 x M8 x 45 mm screw with nut and washer.

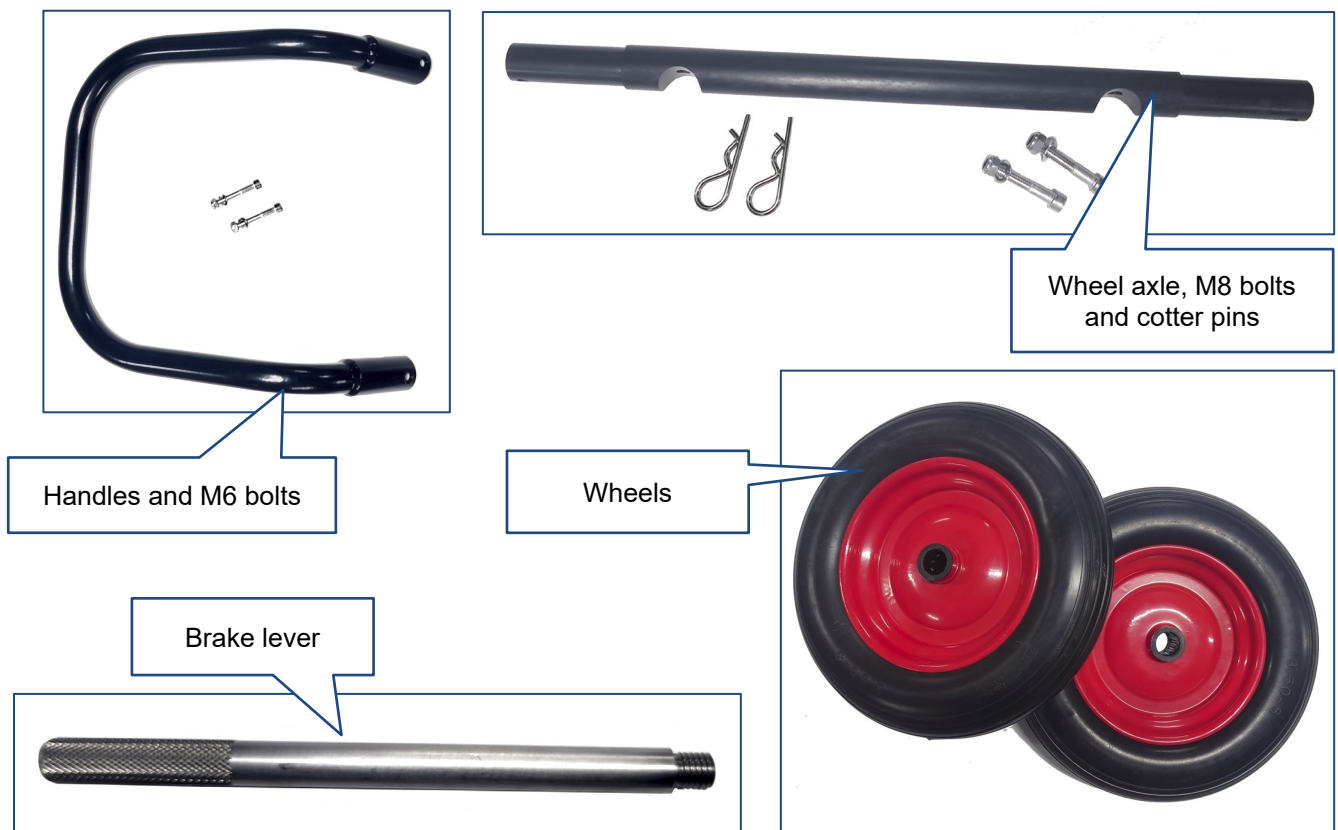


Figure 15 Push rod system parts

The tools required for assembly are:

- 6 mm hex key.
- 5 mm hex key.

4.2.3 Assembly

Thread the brake handle onto the hub of the drum axle.

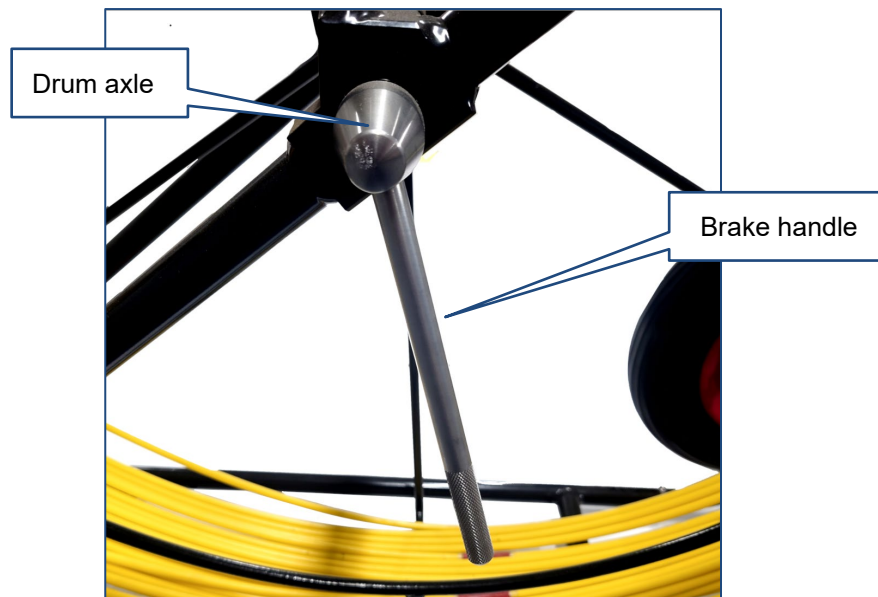


Figure 16 Attaching the brake lever

Hold the wheel axle against the push rod frame and align the holes in the axle with the holes in the frame.

Insert a M8 x 45 mm screw through both holes in the wheel axle. Secure the axle to the frame with a nut and washer. Tighten the screw with a 6 mm hex key.

Slide a rubber wheel onto each side of the axle.



Figure 17 Attaching the wheels and axle

To secure the wheels in place, insert and secure a cotter pin through the hole on each end of the axle.



Figure 18 Securing the wheels with a cotter pin

Insert the handle into the connectors at the top of the frame. Ensure the holes in the handle are aligned with the holes in the frame.

Insert a M6 x 40 mm screw through the holes in each connector. Secure the handle to the frame with a nut and washer. Tighten the screw using a 5 mm hex key



Figure 19 Attaching the handle

Thread the cable guide onto the brass connector.

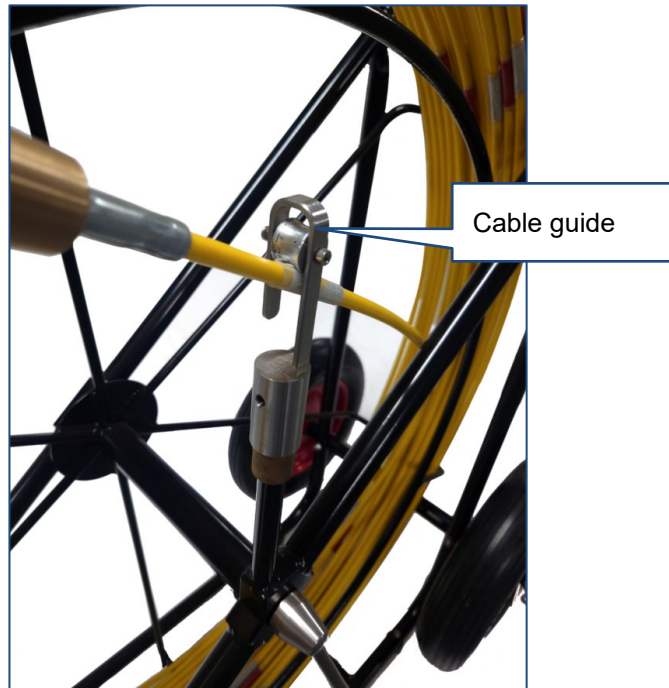


Figure 20 Cable threaded through guide

4.3 Boretrak rods

A series of hinged Boretrak rods may be used to push the probe in an uphole or horizontal deployment.



Figure 21 Rod rack with rods and probe attached

The rods are produced in 1 m lengths. The exception to this is the 'lead' rod which is 0.3 m long. This shorter rod attaches directly to the probe. The length of the lead rod plus the probe is equal to 1 m.

Rods are stacked in a rod rack. The rod rack can fit up to 36 rods, arranged in two stacks of 18. The rod at the bottom of each stack is fitted with a female quick-release joint. This joint can connect to the rod on the top of the next stack which is fitted with a male quick-release joint.

To allow the rods to be pushed, the rods are joined with uni-directional uphole links which prevent them from doubling back on themselves.



Figure 22 Uni-directional uphole link

When using the probe uphole, the length of the deployment may be restricted due to the weight of the system or the condition of the borehole.

Rods can also be used for downhole deployments. In some cases, they may be helpful to prevent the probe twisting and spinning excessively. For downhole deployments, the rods can be joined with bi-directional links to make the articulation between rods more flexible.

To connect the quick-release joints, the two rods must be held at 90° angles. The pin in the male joint is then pushed into the hole in the female joint. Once the rods are straightened out beyond 90°, the joint is locked. To disconnect the rods, they must again be held at a 90° angle and pulled apart.



Figure 23 Quick release joint

For longer deployments, further racks full of rods can be used. The rods form each stack join together in the same way as described above.

Proper use and care of the rods is essential to ensure the safety and longevity of the equipment (see section 5).



Take care to avoid trapping your fingers between the rods when deploying the Boretrak360 and when stacking the rods back into the rack.

4.4 Deployment adaptor

The deployment adaptor allows the Boretrak360 probe to be directly connected to a variety of deployment devices.



Figure 24 Deployment adaptor

The 5/8" thread screws directly into female 5/8" threads on the supplied steel cable and on the optional push rod system.



Make sure the adaptor is fully screwed onto the deployment device. Check the tightness of the connection before each use.



Figure 25 Screw the deployment adaptor firmly onto the deployment device

With the deployment adaptor connected to the selected deployment device, the adaptor can be connected to the Boretrak360 probe before commencing a survey. Retract the sprung brass cuff to reveal the quick release connection pin.

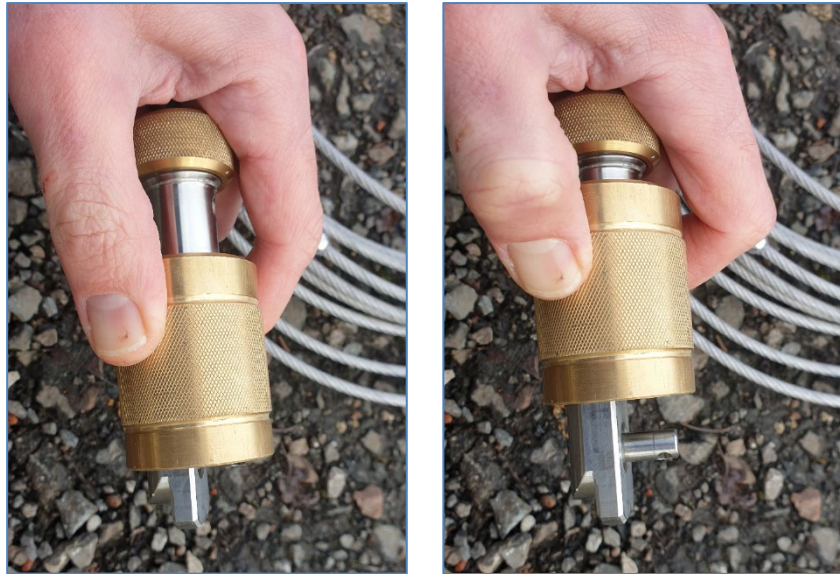


Figure 26 Deployment adaptor with brass cuff un-retracted (left) & retracted (right)

To connect the deployment adaptor to the probe, hold the two at 90° angles. Push the quick release pin into the hole in the probe. Now straighten the probe so it is in line with the deployment adaptor.



Figure 27 Retracted deployment adaptor ready to connect to the probe



Figure 28 Connecting the deployment adaptor to the probe

Allow the brass cuff to spring back into place, locking the Boretrak360 probe in line with the deployment adaptor.



Figure 29 Deployment adaptor connected to the probe

To disconnect the probe, retract the brass cuff, move the probe so it is at a 90° angle with respect to the deployment adaptor and disengage the probe from the deployment adaptor.

4.5 Steel cable

The steel cable is an alternative deployment system. This cable can be used for downhole deployments along any borehole steep enough for gravity to pull the probe to the bottom of the hole. For shallower holes, or holes drilled horizontally or uphole, the steel cable is not suitable. In these cases, use a push rod system.



Figure 30 Steel cable

The standard cable is 50 m long. For deployments down boreholes longer than 50 m, contact Carlson Software to enquire about cables of different lengths.

A threaded brass cap on the end of the steel cable provides a connection point for the deployment adaptor. Fully tighten the adaptor onto the brass cap. Check this connection before each use.

The steel cable is marked along its length by steel nodules and distance labels every metre. These are arranged in the order:

- Yellow marker = 1 m and subsequent odd metre intervals.
- Red marker = 2 m and subsequent even metre intervals.

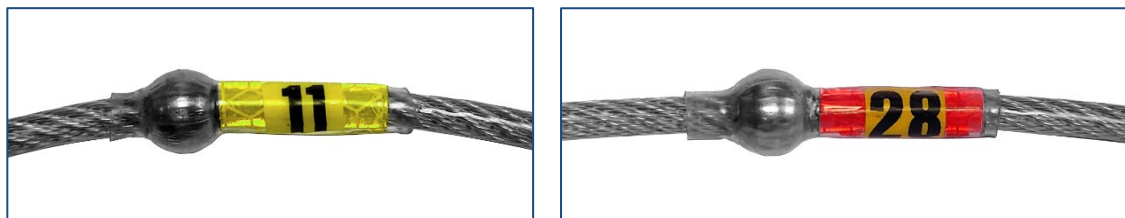


Figure 31 Odd (left) and even (right) metre markers

With the Boretrak360 probe connected to the cable, the first nodule along the cable from the probe is exactly 1 m from the tip of the Boretrak360 nose cone.

On the other end of the steel cable a clip gives the option to attach the wire to a belt or fixed object in case there is

concern that the probe might be dropped down the borehole.

The steel cable is supplied wound into a coil and packed into a cable bag.



Figure 32 Steel cable spool in transit case

Note that the nodules on the steel cable can become magnetised. Therefore, if the magnetometer is enabled for your survey, keep the steel cable stretched away from the probe during an alignment. Avoid leaving the probe lying on the coiled steel cable.

4.6 Android devices

An Android device can run the **Carlson Boretrak** application and interact with the Boretrak360 probe.



Figure 33 Example of an Android PDA

An Android tablet or PDA can be supplied by Carlson as part of the Boretrak360 system. **Carlson Boretrak** is pre-loaded on any such device supplied by Carlson.

The specific Android tablet supplied by Carlson is subject to change but, currently, it is the RTA.



34 Carlson's RTA Android tablet

The RTA tablet is rated as IP68 which means that it is protected against dust ingress and waterproof to at least 1 m.

A 12,200 mAh battery runs for up to 72 hours when set to auto brightness, or 10 hours when set to full brightness.

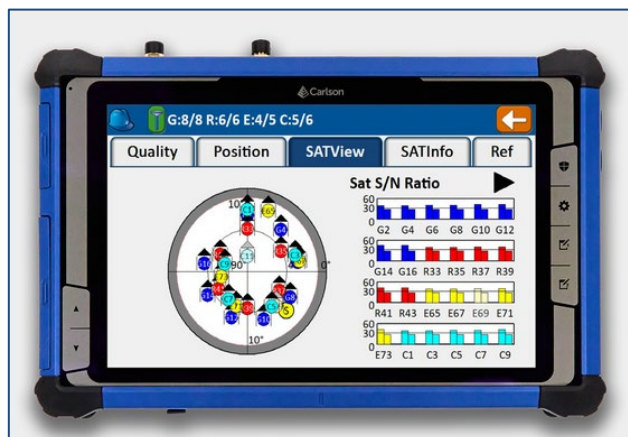
Alternatively, you may choose to source a preferred Android device of your own.

4.7 Windows tablet

A Windows tablet can run the **Carlson Boretrak** application and interact with the Boretrak360 probe in the field.

A Windows tablet can be supplied by Carlson as part of the Boretrak360 system. **Carlson Boretrak** is pre-loaded on any such device supplied by Carlson. Alternatively, the customer can source a preferred Windows device of their own.

The specific tablet supplied by Carlson is subject to change but, currently, it is the RT5.



35 Carlson's RT5 Windows tablet

The RT5 is IP68 which means that it is protected against dust ingress and waterproof to at least 1 m.

Hardware touch buttons are located below the screen and can assist with navigation within Windows.

A stylus, carry strap and screen protector are supplied with the RT5.

5 Regular checks and preventative maintenance

Carlson recommends that you carry out regular functional testing of the Boretrak360 system. Report any damage, malfunctions or poor performance to Carlson. Also contact Carlson to arrange a yearly service and calibration.

Where necessary, replacement accessories such as rods and cables can be purchased from Carlson or from your local Carlson representative.

Before and after each session in the field, carry out routine checks of the system as outlined below.

5.1 Probe

Clean the probe thoroughly with warm soapy water.

Ensure that the screw threads in the nose cone and body of the probe are free of dirt, grease and grit.

Check the O-ring around the nose-cone thread. If there are any visible damage or breaks, replace it with a new O-ring: size BS124 Fluorocarbon 75 (31.42 mm ID × 2.62 mm CS).

Clean any dirt from the nose cone and O-ring seal. Lubricate the O-ring with the supplied silicone grease.

Store within the specified environmental temperature limits.

Only use battery cells which are in an intact condition. Prior to each use, check the condition of your battery cells. If the plastic coating around the battery is pierced, ripped or torn, do not load the battery into the Boretrak360 probe. Dispose of the battery and source a Carlson-approved replacement.

The Boretrak360 is rated as IP66. This means it is protected against jets of water. It is not designed to be deployed downwards into flooded holes. The Boretrak3 product has a significantly higher IP rating and can be used for deployment into flooded holes.

The Boretrak360 is designed to be lightweight for uphole use. Consequently, it is not intended for regular use downhole without centralisers. Constant abrasion against bare rock will erode the aluminium housing. The Boretrak3 product has a steel housing which is more suited to this application.

Wear and tear to the Boretrak360 hardware from unprotected deployments along boreholes, and damage caused by submersion of the Boretrak360 in flooded holes, are not covered by the standard Carlson warranty.

5.2 PDA / tablet

Recharge the internal battery after use.

Check all ports and connectors to ensure that they are free from mud and water.

Ensure that any battery or memory card covers are fully closed. The device is not environmentally protected if the cover is partially open.

Store within the specified environmental temperature limits.

Wherever possible, use a dedicated carry case or neck strap to keep the device protected and secure.

5.3 Push rod

Regularly inspect the push rod for signs of damage which could cause it to fail.

The minimum bend radius of the 9 mm push rod is 30 cm. Do not exceed this bend radius.

5.4 Rod stack

Clean the rods by soaking thoroughly with warm soapy water.

Ensure the rod joints are clear of mud and grit to maintain the condition of the rod stack.

Check the rods and hinges prior to every deployment. Ensure that they are in good condition, that there is no apparent “twist” in the rods, and that all nuts and bolts and connecting pins are in place and secure.

Periodically check the nuts and bolts used to hold the hinges in place. Tighten the bolts to a torque of 1.5-1.8 Nm. If necessary, use a small amount of thread-locking compound (Loctite 270), but do not use this compound on the hinge itself.

If any rod approaches end-of-life, or becomes non-functional or damaged, stop using it immediately and request a replacement from a Carlson-approved service centre.

The rods and hinges are designed to be used predominantly in the plane of the rack. They are designed to be load-bearing along their length (tensional loads) so can withstand the weight of a long Boretrak360 deployment. However, take care not to force the rods in a twisting action (torsional loads) or a lever action (transversal loads).

Side pressure, dragging the rods against the collar or excessive leverage on the rods will weaken the system and reduce rod life or even result in unexpected breakage.

5.5 Transportation

In addition to the points above, take care when transporting the Boretrak360 system.

Always pack the Boretrak360 system into the transit case supplied for storage and transportation.

Clean and dry the Boretrak360 probe and other accessories prior to packing them in the transit case.

Do not allow the equipment to slide around inside transport vehicles or containers.

5.6 Storage

The Boretrak360 uses a magnetometer which orientates the probe relative to the Earth’s magnetic field. The probe is manufactured using materials which are hard to magnetise but, over time it is possible to induce magnetic change into the body of the probe. Be aware of this when handling, transporting and storing the Boretrak360.

Always store the Boretrak360 in its transit case. This will protect the probe from direct contact with any magnetised items. Do not store any magnetic items in the transit case with the Boretrak360.

Do not store the Boretrak360 directly next to any sources of strong magnetic interference. These include:

- Transformers.
- Generators.
- Motors.
- Power cabling.
- Electronic equipment and power supplies

- Highly magnetised tools.

It is possible to permanently damage the IMU if an extremely strong magnet (i.e. >3000 Gauss) is held against the probe.

Remove the batteries from the nose cone when storing the probe in the transit case.

Always store the Boretrak360 in a dry location within the recommended storage temperatures.

6 Operational safety

Various potential hazards related to Boretrak operations have been listed below. This list is not exhaustive; it is merely a guideline for potential risks when using any Boretrak system. Carry out your own risk assessment each time you use the system on site. Boretrak units should only be used by appropriately qualified and trained users.

Hazard	Actions required
Slips, trips, falling	Consider the risk, particularly when deploying the Boretrak on uneven ground or in wet, muddy and low-light conditions. Take care around the area of the deployment as there may be a long length of cable on the ground as well as other accessories and tools. Keep an ordered work site and cordon off the operational area if necessary.
PPE	Protective gloves are recommended for use when deploying the Boretrak, particularly in wet, muddy, or cold conditions. Most sites where the Boretrak is likely to be used will also have specific PPE requirements according to the site conditions and on-going operations.
Transport of equipment including lifting, loading, unloading, unpacking, and packing	When carrying the complete Boretrak system in its Peli case, and when unpacking and repacking the system, use the Manual Handling Operations Regulations 1992 as a reference for the safe method of lifting equipment.
Working at heights	Operation of the Boretrak will often be in locations where there is a severe drop nearby in the form of a quarry face, a deep hole, or the side of a cherry picker. Take care in this case and put appropriate precautions in place such as keeping a safe distance from the drop or erecting a temporary barrier.
Manual handling during a deployment	For longer deployments, the weight of the Boretrak plus any deployment device can become heavy. Ensure there are enough personnel to bear the load of the system, and consider mechanical deployment aids such as winches and tripods. If deploying uphole, the manual handling can become more difficult. Again, ensure that enough personnel are present and do not deploy beyond a distance where the system is under control. Ensure that probes and deployment devices being used for uphole surveys are under control and secured. Ensure that no equipment can freefall back down the hole towards personnel on the ground.
Working alone	If working alone, ensure other personnel onsite are aware of the location, nature and duration of Boretrak operations. Never attempt uphole Boretrak deployments alone.
Moving Vehicles during Survey Operations	Ensure other personnel on-site are aware of the Boretrak operations. Be aware of vehicles moving around the survey area when deploying a Boretrak.
Trapping fingers between Boretrak rods	The concertinaed Boretrak rods can act as a finger-trap hazard. When restacking the rods, keep fingers away from the rod rack.

If there are any concerns about safety when using the Boretrak360, contact Carlson Software for advice before commencing any work.

PRODUCT INFORMATION

7 Product specifications

Construction		
Probe	Hard-anodised 6082-T6 aluminium with a titanium battery cover.	
Push cable	9 mm fibreglass rod with aluminium frame and reel.	
Rods	1 m long glass fibre rods, acetal joints, and stainless steel quick release joints, housed in an aluminium rack.	
Downhole cable	5 mm plastic-coated steel cable with metre markers.	
Physical	Weight	Dimensions
Probe (including batteries)	1.5 kg	710 mm × 40 mm. (Battery cover is 42 mm dia.)
System in case with accessories and optional Android device	8.0 kg	850 mm x 430 mm x 150 mm
Sensors		
Build	IMU with 3-axis gyro, accelerometer & magnetometer.	
Deployment range	Full 360° range.	
Gyro rotational limit	Configurable: up to 960° per second.	
Inclination accuracy	+/- 0.1°	
System deployment accuracy*	Final position to within 1% of hole depth.	
Communications		
Bluetooth	2.402 - 2.480 GHz band at 3.13 dBm e.i.r.p.	
Power		
Probe	4 × 1.5 V “D” cells (LR20).	
Environmental		
IP degree of protection (probe)	IP66	
Operating temperature (probe)**	–10 °C to +60 °C	
Storage temperature (probe)**	–20 °C to +70 °C	
Altitude	Up to 5000 m	
UL weather rating	Wet location	
IEC pollution degree	PD3	
Humidity	95% non-condensing	

* Proved under Carlson test conditions.

**The probe operating & storage temperature may be limited by the choice of battery.

8 Further product information

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Warranty

The full Carlson warranty document is available from the support and training page Carlson Software website:

- **Limited warranty**

Carlson warrants solely to Purchaser that the Products shall be free from defects in materials and workmanship and will substantially conform to applicable specifications for the Product for a period of 12 months and 90 days for Accessories from delivery of such Product (the "Warranty Period"). This warranty does not cover software. Repairs and replacement components for the Products are warranted, subject to the exclusions and procedures set forth below, to be free from defects in material and workmanship, and will substantially conform to applicable specifications for the Product for 90 days from delivery, or for the balance of the original Warranty Period, whichever is greater.

Carlson warranty	
LMD products	12 months
Accessories	
Batteries, chargers	90 Days
Deployment cables and rods (excluding metre markers)	90 Days
Adaptors	90 Days
RMA Repairs	90 Days

Wear and tear to the Boretrak360 hardware from unprotected deployments along boreholes, and damage caused by submersion of the Boretrak360 in flooded holes, are not covered by the standard Carlson warranty.

- **Exclusion of all other warranties**

The limited warranty shall apply only if the product is properly and correctly installed, configured, interfaced, maintained, stored, and operated in accordance with the relevant user's manual and specifications and is not modified or misused. These warranties are expressly in lieu of all other warranties, express or implied, including, without limitation, all implied warranties of merchantability and fitness for a particular purpose.

- **Limitation of remedies**

The purchaser's exclusive remedy against Carlson shall be, at Carlson's option, the repair or replacement of any defective product or components thereof or the full refund of the purchase price of the defective product. The purchaser shall notify a Carlson-approved service centre immediately of any defect. Repairs shall be made through a Carlson-approved service centre only. Repair, modification or service of products by any party other than a Carlson-approved service centre shall render this warranty null and void. The remedy in this paragraph shall only be applied in the event that the product is properly and correctly installed, configured, interfaced, maintained, stored, and operated in accordance with the relevant user's manual and specifications, and the product is not modified or misused. Carlson shall in no event be liable for special, indirect, incidental, or consequential damages of any kind or nature due to any cause.

Carlson is not responsible for the purchaser's negligence or unauthorized use of the product. In no event shall Carlson be in any way responsible for any damages resulting from the purchaser's own negligence or from the operation of the product in any way other than as specified in the relevant user's manual and specifications. Carlson is not responsible for defects or performance problems resulting from (1) misuse, abuse, abnormal working conditions, improper installation, or neglect of the product; (2) the operation of the product under any specification other than, or in addition to, the specifications set forth in relevant user's manual and specifications; (3) damage caused by accident or natural events, such as lightning (or other electrical discharge) or fresh/salt water immersion of product; (4) damage occurring in transit; (5) normal wear and tear; or (6) any defects in the equipment arising from any drawing, design or specification supplied or modification requested by the customer, failure to follow Carlson's instructions (whether oral or in writing), alteration or repair of the equipment without Carlson's approval.

- **Obtaining warranty service**

In order to obtain warranty service, the end purchaser must bring the Product to a Carlson-approved service centre along with the end purchaser's proof of purchase or must be intimated in writing to Carlson, who will then issue written instructions to the end user. Following the authorised return of the equipment, which the customer must make on a freight prepaid basis, Carlson will examine the equipment and, if the claim is justified in Carlson's opinion, will repair the defective equipment or will make a replacement without charge. Carlson does not warrant claims asserted after the end of the warranty period. For any questions regarding warranty service or to obtain information regarding RMA's or Warranty Claims, please contact any of Carlson's approved service centres.

Safety

It is essential that the unit and all accessories are operated in accordance with the instructions in this user manual and it is the responsibility of the user to ensure that, in the event of a failure of any part of the Carlson system, the equipment remains safe.

In the case of equipment with powers or speeds capable of causing injury, it is essential that appropriate safety protection measures are included in the machine usage. Further guidance can be found in *BS EN ISO 12100:2010 Safety of machinery – General principles for design – Risk assessment and risk reduction*.

The safety of any operations involving the Boretrak360 system is the responsibility of the operator. If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

Information to the equipment supplier/ installer

It is the equipment supplier's responsibility to ensure that the user is made aware of any hazards involved in any operations involving the Boretrak360 system, including those mentioned in Carlson product literature.

EC declaration of conformity



Hereby, Carlson Software Inc. declares that the radio equipment type Boretrak360 (Model A-2304-0015) is in compliance with Directive 2014/53/EU.

The full text of the EU declaration of conformity is available in the Carlson Knowledge Base here:
https://web.carlsonsw.com/knowledgebase/kbase05.php?action=display_topic&topic_id=1455.

Radio-frequency disturbance characteristics

As defined by *BS EN 55011:2016 Industrial, scientific and medical equipment – Radio-frequency disturbance characteristics – Limits and methods of measurement*, the Boretrak360 probe is defined as Group 1, Class A equipment.

The Boretrak360 probe is suitable for use in all locations other than those allocated in residential environments and those directly connected to a low-voltage power supply network which supplies buildings used for domestic purposes. The Boretrak360 probe does not use radio-frequency energy for the treatment of material, for inspection/analysis purposes, or for transfer of electromagnetic energy.



CAUTION: This equipment is not intended for use in residential environments and may not provide adequate protection to radio reception in such environments.

FCC (USA only)

Information to the user (47CFR section 15.19)

This device complies with part 15 of the FCC Rules. 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.

Information to the user (47CFR section 15.21)

The user is cautioned that any changes or modifications not expressly approved by Carlson or authorised representative could void the user's authority to operate the equipment.

Information to the user (47CFR section 15.105)

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

WEEE directive



The use of this symbol on Carlson products and/or accompanying documentation indicates that the product should not be mixed with general household waste upon disposal. It is the responsibility of the end user to dispose of this product at a designated collection point for waste electrical and electronic equipment (WEEE) to enable reuse or recycling. Correct disposal of this product will help to save valuable resources and prevent potential negative effects on the environment. For more information, please contact your local waste disposal service or Carlson representative.

Battery safety

The Boretrak360 is supplied with non-rechargeable alkaline batteries (4 × Duracell LR20 1.5 V). The probe also contains a CR 2032 3 V 220 mAh lithium coin cell. The PDA contains a lithium polymer battery (4500 mAh).

- Do not attempt to recharge the probe batteries.
- Please dispose of waste batteries in accordance with your local environmental and safety laws.
- Replace the batteries only with the specified type.
- Ensure that all batteries are inserted with the correct polarity.
- Do not store batteries in direct sunlight.
- Do not heat or dispose of batteries in a fire.
- Do not short-circuit or force discharge the batteries.
- Do not introduce a metal connection between the batteries in the nose cone and the external metal housing.
- Do not disassemble, pierce, deform or apply excessive pressure to the batteries.
- Do not swallow the batteries.
- Keep the batteries out of the reach of children.
- Do not get batteries wet.
- If a battery is damaged, exercise caution when handling it.

Battery disposal



The use of this symbol on the batteries, packaging or accompanying documents indicates that used batteries should not be mixed with general household waste. Please dispose of the used batteries at a designated collection point. This will prevent potential negative effects on the environment and human health which could otherwise arise from inappropriate waste handling. Please contact your local authority or waste disposal service concerning the separate collection and disposal of batteries. All lithium and rechargeable batteries must be fully discharged or protected from short circuiting prior to disposal.

Bluetooth module: U.S. compliance

Contains Transmitter Module FCC ID: T9J-RN42

This device complies with part 15 of the FCC Rules. 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.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/ TV technician for help.

Bluetooth module: Canada compliance

Contains Transmitter Module IC: 6514A-RN42

This device complies with Industry Canada's licence-exempt RSSs. Operation is subject to the following two conditions:

1. This device may not cause interference; and
2. This device must accept any interference, including interference that may cause undesired operation of the device.