

# Cabled Boretrak

## borehole deviation survey system

### user manual





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# 1 Customer information

## 1.1 Dear customer

The Cabled Boretrak® system is designed to be easy to operate. However, we would ask you to take the time to read these operating instructions carefully before using the system, and to keep the manual with the instrument at all times.

For any feedback or comments, or if there are questions about the Cabled Boretrak system which are beyond the scope of this manual, contact Carlson or your local Carlson representative.

For information on your local Carlson service centre, visit our website at [www.carlsonsw.com](http://www.carlsonsw.com).

To ensure best service, please make a note of the serial number. This can be found on the engraved on the Cabled Boretrak probe.

## 1.2 User manual

This manual describes the Cabled Boretrak and all accessories supplied with a standard system.

The PC software – **P3D Boretrak plug-in** – is supplied with the Cabled Boretrak system. Help for this software is available via P3D's online help menu.

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

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

## 2 Cabled Boretrak system concepts

### 2.1 System overview

The Cabled Boretrak borehole deviation measurement system is a simple-to-use, portable system for measuring the deviation of boreholes.

The Cabled Boretrak is deployed to the bottom of a borehole. As it is being retrieved, at fixed intervals the Boretrak probe uses internal sensors to measure the borehole's deviation from vertical. A magnetic compass in the probe allows the orientation to also be measured at each depth. The output from these sensors is recorded by the handheld Control Display Unit (CDU). From here the data can subsequently be downloaded to a PC for processing.

The Cabled Boretrak system can be rapidly deployed on site and requires no other specialised tools, equipment or personnel. When surveying, work need stop only for the duration of the survey: approximately three minutes for a 30 m hole. A hole summary is available immediately, while more detailed results are available when the data from the CDU has been processed by PC software.

In the office, data is downloaded from the CDU onto a PC running **P3D Boretrak plug-in** software. **P3D Boretrak plug-in** provides more comprehensive processing, data analysis and editing tools.

### 2.2 System capabilities

The Boretrak probe is designed to survey the route of drilled holes by measuring its inclination and heading at fixed intervals along the hole.

The Boretrak probe contains a dual axis inclinometer. Data from this sensor is used to derive the angle at which the Boretrak probe is inclined with respect to gravity. In a narrow borehole, the assumption is that the inclination of the probe closely mirrors that of the hole itself at each stage of the deployment.

In addition to the inclination, the orientation (or heading) of the probe is also required to fully map out the path of the borehole. This is established by reading data from the internal magnetic compass. The compass outputs a heading relative to magnetic north. Because a magnetic compass is used, care should be taken that the Cabled Boretrak system is used away from any objects or natural or manmade features which may be sources of magnetic interference.

The Cabled Boretrak is calibrated to provide data from holes of up to 40° inclination from vertical.

The system is designed to be highly ruggedized so that it can be operated reliably in the harsh environments of quarries mines and geotechnical project sites.

### 2.3 Data communication and power

The Boretrak probe is hardwired to the Boretrak cable. The cable is, in turn, connected to the CDU.

Off-the-shelf batteries in the CDU power the probe and the CDU itself. No power sources are held inside the probe.

During a Boretrak survey, the Boretrak project is configured and controlled via the CDU. The system is deployed at a series of fixed intervals (the deployment interval), most commonly 2 m. At each interval, the Boretrak's sensors report the inclination and heading of the probe in its current position.

All recorded data is sent from the probe to the CDU. No data is stored in the probe.

Once a survey has been completed, the Boretrak is disconnected from the CDU and the CDU is powered off.

Back in the office, a serial cable is connected to the CDU and all data is downloaded from the CDU to a PC that

runs **P3D Boretrak plug-in** software or a similar package.

## 2.4 P3D Boretrak plug-in

Carlson's **P3D** is a point cloud package for Windows PCs which allows users to import survey data, points, polylines, surfaces and point clouds and to create usable 3D surfaces. **P3D Boretrak plug-in** is a free P3D module which can be used as a standalone package. **P3D Boretrak plug-in** provides advanced processing functionality specifically for data collected with Carlson's Boretrak equipment.

Boretrak data can be downloaded into **P3D Boretrak plug-in** and combined with other Boretrak datasets. Hole surveys can be assigned to hole coordinates from imported ASCII files or from manually entered coordinates.

**P3D Boretrak plug-in** provides a range of tools to help edit, analyse and report on the data collected with your Boretrak system.

Further paid-for modules are available for **P3D**. These unlock additional functionality for general point cloud processing and surfacing.

### 3 Cabled Boretrak hardware

Each of the elements of a Cabled Boretrak system is described below.

#### 3.1 Control Display Unit (CDU)



*Figure 1 PDA*

The function of the Control Display Unit (CDU) is to log each probe measurement and to record details of the date, measurement interval, face number and hole number. All these values are entered or triggered by the operator. The CDU also provides power to the probe.

The internal memory can record data for a number of downhole surveys: in total, around 6,000 observations.

The CDU features a 16-button main keyboard, an LCD display, a rear battery compartment, a data/power connector at the top, a quarter-inch mounting thread at the base and a red ENTER button on the side.

If required, the CDU can be fitted to a lightweight tripod using the CDU tripod adapter bracket.

To switch the unit on: hold the ON key until the unit beeps and displays an “MDL” logo on the screen.

To switch the unit off: hold the OFF key until the unit powers down.

Three size “C” (MN1400, LR14) alkaline replaceable batteries power the CDU and Boretrak probe. These provide approximately 80 hours’ continuous running.



*Figure 2 CDU battery compartment*





**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. Should the battery or battery charger stop working or become damaged, stop using it and source a replacement from a Carlson-approved source.

If any of the following symptoms occur, the batteries will need to be replaced:

- Nothing happens when the ON button is pressed.
- The CDU fails to beep when taking a measurement.
- The CDU display is dim.
- The CDU beeps and displays a low battery warning on the main screen.

Should the battery voltage fall below the minimum level for reliable operation, the CDU will power down the system. A greater current is drawn at boot-up than during normal operation; therefore, the CDU may fail to switch on, even though it appeared to be operating normally when switched off.

To change the batteries, unscrew the knurled knob on the back of the CDU to gain access to the battery compartment. Insert the batteries in the rear of the CDU – ensure that the correct polarity is used, as marked on the battery housing.

Always switch off the CDU after use to prolong battery life.

### 3.1.1 Sensor probe and cable



*Figure 3 Probe with CDU*

The probe contains a digital compass and accurate inclinometers which are used to measure the direction and magnitude of the deviation of the probe from vertical. The sensors operate within a range of  $\pm 40^\circ$  from vertically down. If the probe is used outside these ranges (for example, at  $60^\circ$  from vertical), then the probe will return a “null” reading of 99.99.

The inclinometers operate to an accuracy of  $0.2^\circ$ . The compass is accurate to  $1^\circ$ .

Near the top of the probe is a sighting hole. This sighting hole can be used to observe a compass bearing between

two known points. An arrow is etched into the metal to define the correct way to point the probe. The observed bearing can help to align the orientation of Cabled Boretrak with other data which is not referenced to magnetic north. (For more information on geo-referencing your survey, see section 4.2.2, “Orientation of the survey”.)

At the bottom of the probe is a brass insert which can be removed to allow the attachment of the optional ballast rod. This accessory can assist deployments in deep, flooded boreholes.

The serial number is engraved on the Cabled Boretrak towards the bottom of the probe.

The data from the inclinometers and the compass is transmitted to the CDU by the main, yellow cable. The cable also transmits power from the CDU to the probe. The cable is reinforced with Kevlar and is permanently attached to the probe by a sealed joint. On purchase, a 35 m or 65 m cable can be selected. Thereafter, the cable cannot be changed other than by a factory refit.

Markers are moulded onto the cable at 1 m intervals. The markers alternate between red (double marker) and black (single marker). The first marker above the probe is a single black marker, 1 m from the bottom of the probe.

### 3.2 CDU to PC data cable

An RS232 cable is used to connect the CDU to a PC or other remote download device. Data may then be downloaded from the CDU to a PC serial port.



*Figure 4 CDU to PC cable*

If the computer does not have a serial port you will also need to use the supplied USB–serial adaptor to connect to your PC.

### 3.3 USB-serial adaptor



*Figure 5 USB-serial adaptor*

A USB-serial adaptor is supplied in case no serial port is available on the PC. If this adaptor is used, the accompanying driver should first be loaded.

### 3.3.1 Installing the USB-serial driver

A driver for the USB–serial adaptor is stored on the USB drive which is included in the Cabled Boretrak system. Check that the driver is appropriate for the operating systems of the PC being used with **P3D Boretrak plug-in** or other Boretrak processing software.

The driver will be named ‘CDM 2.12.06 WHQL Certified.exe’ or similar. Double-click on the file to run it.

An installation wizard will appear as shown in Figure 6.

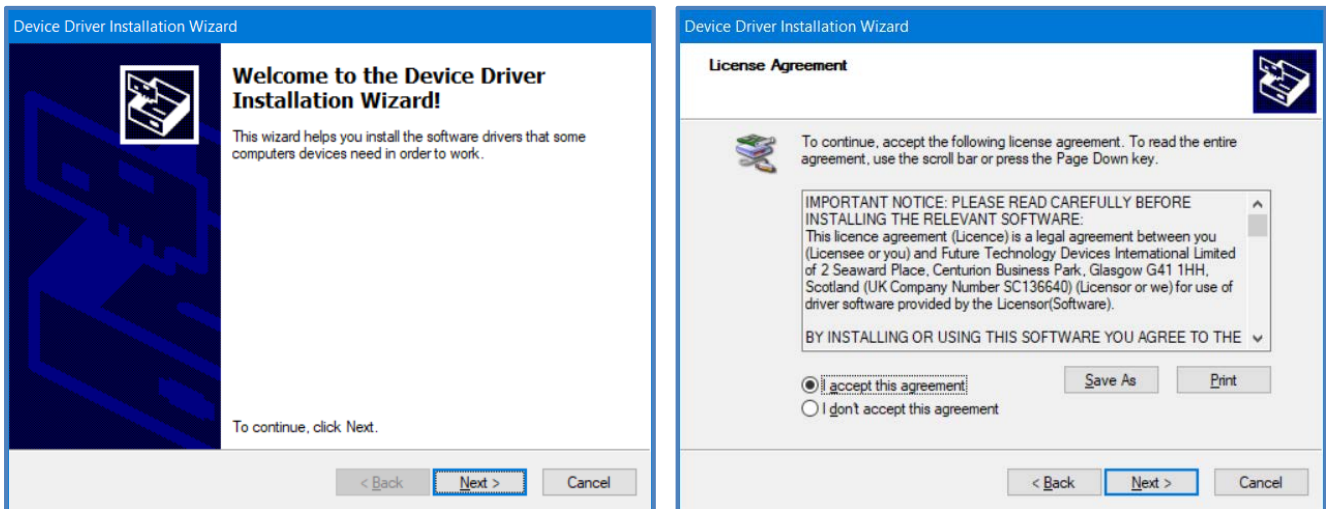


Figure 6 USB-serial driver installation wizard

Click **Next**, accept the license agreement and click **Next** again.

When the driver has successfully loaded, the window shown in Figure 7 will be displayed.

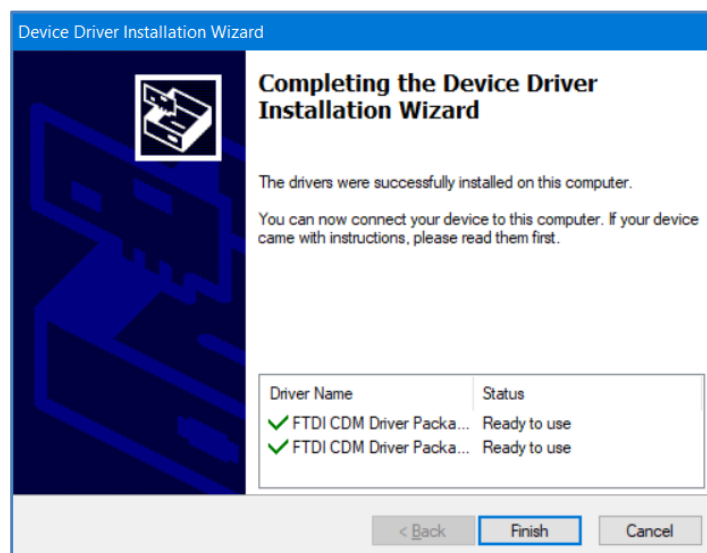
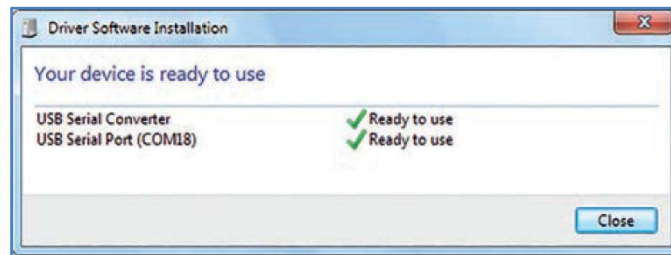


Figure 7 Driver installation complete

Click **Finish**. Once the driver is loaded, plug the USB–serial adaptor into the PC. Windows will recognise the adaptor and automatically install the new hardware device driver.



*Figure 8 USB-serial adaptor allocated port*

On completion of this process, Windows will assign a **COM** port to the adaptor, noted in the message in the window shown in Figure 8. To confirm the assigned COM port, go to **Control Panel > System > Device Manager > Ports (COM & LPT)**. The USB–serial adaptor will be shown in this list, along with a COM port number. This number may be required when connecting to **P3D Boretrak plug-in** software.

### 3.4 CDU bracket

The CDU tripod adapter bracket can be screwed to the base of the CDU via the quarter-inch thread. The adapter bracket can then be attached to the supplied lightweight tripod. For one-man operations, this ensures that both hands will be free to deploy the Boretrak.



*Figure 9 CDU bracket*

### 3.5 Calibration jig



*Figure 10 Calibration jig*

To ensure reliable results from the Cabled Boretrak, it is essential that the internal compass is calibrated. It is recommended that a calibration should be carried out:

- When the Cabled Boretrak is used for the first time.
- Whenever the probe is moved to a new area.
- If the probe has been subject to strong magnetic fields.
- At least every six months.
- After servicing.

A calibration jig is supplied with the system to assist this calibration process.

Before a calibration is carried out, mount the calibration jig on the lightweight tripod. Level the jig using the integrated circular bubble.

A full description of the calibration process is outlined in section 4.9.

### 3.6 Ballast rod

The ballast rod provides additional weight for the Cabled Boretrak when it is being deployed into deep, flooded holes.

To fit the ballast rod:

1. Unscrew the brass insert from the base of the probe using a flat metal object in the groove.
2. For additional weight, fill the ballast rod with lead shot.



*Figure 11 Ballast rod and probe*

3. Screw the brass insert on to the metal base of the ballast rod.



*Figure 12 Ballast rod fitted to probe*

4. Screw the other end of the ballast rod on to the base of the probe.

### 3.7 P3D Boretrak plug-in

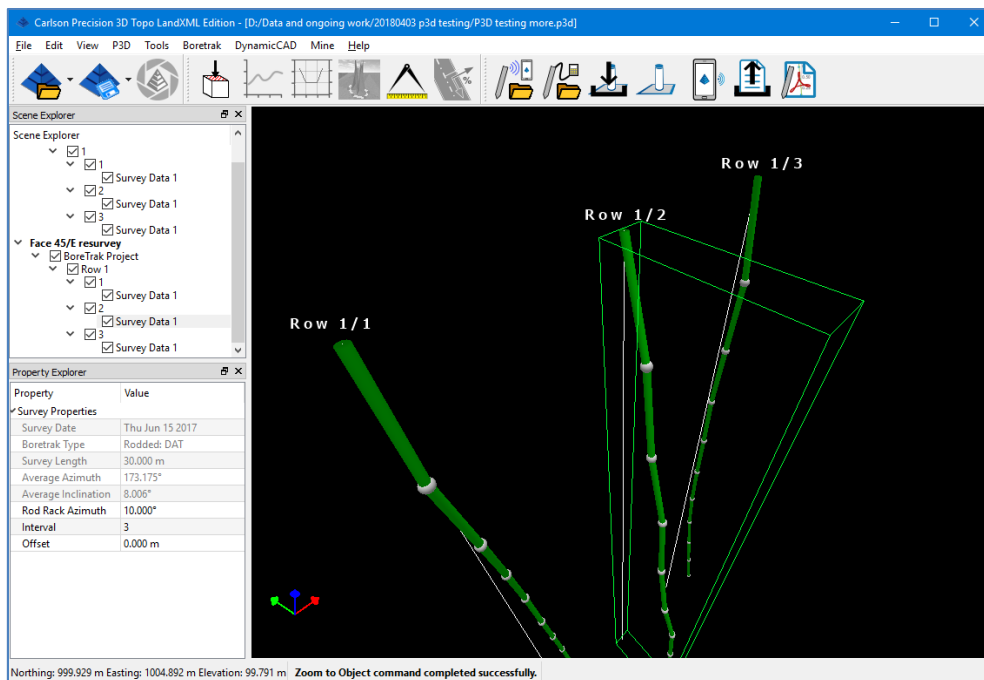


Figure 13 P3D Boretrak plug-in

The software package supplied with a Cabled Boretrak is called **P3D Boretrak plug-in**. This software allows data from the Boretrak to be processed into X, Y, Z coordinates. The Boretrak survey can be edited, viewed and exported, and reports can be generated. The exported data can be taken into a wide variety of third-party packages for further processing, analysis and integration into existing datasets.

Full information on **P3D Boretrak plug-in** is available in **P3D's** online help files.

Note: **P3D Boretrak plug-in** is the software package referred to throughout this manual, but many other packages are available that are able to directly import raw data from the Cabled Boretrak.

### 3.8 USB drive



Figure 14 USB drive

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

- **P3D Boretrak plug-in** software for PC.
- This Cabled Boretrak manual.

### 3.9 Transit case



*Figure 15 Cabled Boretrak transit case*

All components of the Cabled Boretrak system, except the tripod, 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 watertight (IP67).

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

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



## 4 Cabled Boretrak system operation



*Figure 16 Rodded Boretrak system on-site*

### 4.1 Magnetic compass - limitations

The Cabled Boretrak uses a pitch/roll compensated magnetic compass to establish the orientation of the survey data. The compass aligns with the earth's local geomagnetic field to point towards the north magnetic pole.

Users should be aware that there are many factors that affect the local geomagnetic field. These can cause the compass to produce erroneous results. Of particular concern are any nearby ferrous materials, as well as strong local electromagnetic forces. In practice, this means that there are some sites where the Cabled Boretrak should not be deployed at all, for example:

- Iron mines or mines where the rock contains significant quantities of ferrous ore.
- Holes drilled in the vicinity of reinforced concrete.
- Holes with steel lining.
- Holes drilled near to underground utilities, such as electrical cabling or steel pipes.

In these situations, Carlson's Rodded Boretrak system may be a more appropriate tool because it does not utilise a magnetic compass to derive its orientation.

On any site where the Cabled Boretrak is deployed, care should be taken to ensure that the area is clear of vehicles, drill rigs and generators. You should also be careful not to have any magnets or electrical items on your person when operating a Cabled Boretrak.

Store the Cabled Boretrak away from large metal objects, magnets and electrical equipment.

It is recommended that a compass calibration is performed at regular intervals, as outlined in section 4.9. It is vital that this procedure is carried out carefully and according to the detailed instructions in this manual. It is also recommended that the Cabled Boretrak is returned to a Carlson service centre at least once a year to undergo a full, factory calibration of the compass and pitch and roll sensors.

Note that other surveyed data used in conjunction with the Cabled Boretrak may be aligned to grid north or true north rather than magnetic north. This discrepancy will need to be taken into account when datasets from different sources are combined: see section 4.2.2.

## 4.2 Geo-referencing a survey

When using the Cabled Boretrak system it is often the case that the location and orientation of the survey will be required relative to other surveyed information. For example, if deviation is detected in the borehole, in which direction is it inclined with respect to a quarry face and how does this relate to other features on-site or underground?

In order to establish the position and orientation of the Cabled Boretrak data in relation to other surveyed data, two values are required:

1. The position of the top of the borehole (the collar).
2. The relationship between magnetic north used by the Cabled Boretrak, and grid north or true north which other data may be referenced to.

With these two values established, all data collected with the Cabled Boretrak system can be correctly geo-referenced. The surveyed hole can also be related to any other features surveyed on the same coordinate system: for example, a quarry face or an underground tunnel.

### 4.2.1 Position of the borehole

The position of the borehole collars can be established by GPS, by traditional survey methods or by a Carlson Quarryman Pro. The Quarryman Pro is used in quarrying operations to scan the quarry face as well as to position borehole collars.

The collar coordinates can be entered into **P3D Boretrak plug-in** software to fix the position of the Cabled Boretrak data.

### 4.2.2 Orientation of the survey

The compass in the Cabled Boretrak will always give an orientation referenced to magnetic north.

If you intend to combine Cabled Boretrak data with other surveyed data – such as that collected with a Carlson Quarryman Pro – you will need to be aware of the difference between magnetic north and the local grid north which the Quarryman data is related to. There are many different ways of establishing this relationship. Several examples are given below.

- If working on an established local grid system – for example, a quarry environment where there are fixed control points used for resecting the position of the survey instrument – then the relationship between magnetic north and the local grid north should be a known value which can be entered into **P3D Boretrak plug-in** or other processing software. If in doubt, have a surveyor confirm this value.
- If this value is not known, use the 'sight baseline' function in the Cabled Boretrak CDU to observe a heading between two fixed points (see section 4.7). In a quarrying application, these two points might be markers at either end of the line of hole collars, but any two fixed points can be used. Survey the same points with your Quarryman Pro.

The aim is to collect a bearing with the Cabled Boretrak which is referenced to magnetic north, and to compare this with a bearing computed from the data collected with a Quarryman, which is referenced to the local grid north. In this way a correction between the two datasets can be established.

Use **P3D Boretrak plug-in** to calculate the correction between the magnetic bearing and the grid bearing. This correction can be entered into **P3D Boretrak plug-in** as the 'grid magnetic angle'. This is the preferred method of orientating the data and will ensure that any offset errors are accounted for.

- The above method can also be used if no fixed coordinate system is being used. Use arbitrary coordinates for the Quarryman data, but link this to the Cabled Boretrak data by using the 'sight baseline' function.
- Alternatively, if working on an arbitrary coordinate system, you can reference the Quarryman Pro to magnetic north using a handheld compass, i.e. ensure that when the Quarryman Pro's horizontal encoder is reading '0.00°' it is pointing towards magnetic north.

In the software used to process the Quarryman Pro data, you will need to establish two fixed stations: one which you will identify as your instrument station (e.g. with X, Y, Z coordinates of 1000, 1000, 100), and one, your reference station, located directly to the north (e.g., 1000, 1050, 100). This will ensure that grid north and magnetic north are coincident.

## 4.3 Data collection

### 4.3.1 Set-up

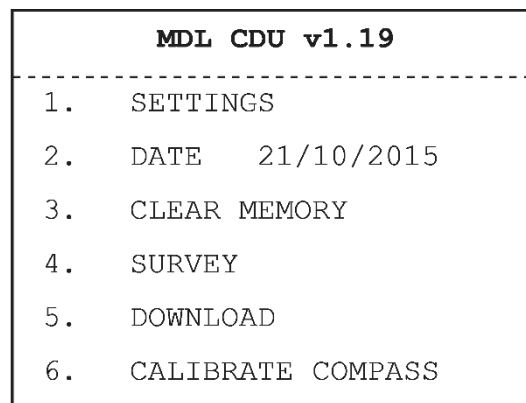
Try to ensure the area around the collar is clear of loose rubble so that there is nothing likely to fall down the hole during the survey. Also, make sure that there are no magnetic or ferrous items nearby that could interfere with the compass inside the Cabled Boretrak: for example, vehicles, drill rigs, generators or reinforced concrete.

Ensure that the batteries in the CDU are in good condition.

Connect the end of the main cable to the connector on the CDU. If required, use the CDU bracket to set up the CDU on the lightweight tripod beside the hole. This will allow both hands to be free to concentrate on the deployment.

Turn on the CDU by pressing the **ON** button.

The CDU boots up and displays a splash screen. During this process an indication of the amount of free memory available is displayed. After a few seconds, the main menu is displayed.



*Figure 17 CDU main menu*

Press the appropriate number on the keypad to select the corresponding menu option.

**Note:** In all operations, the red **ENTER** button on the side of the CDU can be used interchangeably with the keyboard **ENT** key.

## 4.4 Settings

From the main menu, press **1** to enter the **CDU SETTINGS** menu.

CDU SETTINGS		
1.	BAUD RATE	19200
2.	KEYPAD BEEP	ON
3.	BACK-LIGHT	AUTO
4.	FILE FORMAT	MDL
SEL = MAIN MENU		

*Figure 18 CDU settings menu*

Press the **SEL** key at any point to return to the main menu.

The options in the CDU settings are detailed below.

### 4.4.1 Baud rate

Press **1** to toggle the baud rate setting between 1200, 4800, 9600 and 19200. This will determine the rate at which data is communicated to a remote device such as a PC.

Ensure that any equipment likely to be connected to the CDU matches the value selected. All serial communications have a data format of 8 bits, no parity and 1 stop bit.

### 4.4.2 Keypad beep

Press **2** to toggle the keypad beep between ON and OFF. This will determine whether a beep is emitted when a key is pressed on the keypad.

### 4.4.3 Backlight

Press **3** to toggle the backlight between:

- ON – always on.
- OFF – always off.
- AUTO – automatically switches off when no activity on the keypad has been detected for a period of time (in this state, when a key is pressed, it will automatically switch on again).

The backlight draws a significant current from the batteries. In order to prolong the life of the batteries it is recommended that this selection should be set to OFF when the backlight is not required.

### 4.4.4 File format

Press **4** to toggle the data format between MDL and CSS. This will determine:

- how recorded data is stored in the unit
- how software packages deal with the data.

The MDL format saves pitch and roll values that are related to the observed baseline azimuth, usually taken along

the line of shot holes.

The CSS format saves computed borehole azimuth and inclination values.

The correct file format must be selected before a survey is begun. Once the data has been collected, it cannot be converted into the alternate format.

**Note:** It is recommended that the CSS format be used as the default setting. MDL format is used in some old, legacy packages, but the CSS format is accepted most readily by modern blast design and borehole deviation software.

## 4.5 Date

From the main menu press **2** to enter the date. The CDU does not have an internal clock, so the current date needs to be entered by the user before surveying. The date format is displayed on the CDU as: DDMMYYYY.

## 4.6 Clearing memory

From the main menu, press **3** to clear all previously logged data in the CDU. Press the **SEL** key to confirm that you wish to continue, then press the **ENT** key to implement the selection and return to the main menu.

Ensure that all data is downloaded, processed and backed up before clearing the CDU. It is recommended that the memory is cleared before each new survey is started.

## 4.7 Survey

Press **4** from the main menu to begin a survey. Instructions on the screen guide you through the survey process.

When prompted, enter the face number – a two-digit number from 00 to 99 – then press **ENT**. The CDU prompts:

SIGHT BASE LINE  
AND STEADY PROBE

This function allows you to collect a compass bearing that can help orientate the Cabled Boretrak data against existing data which is not referenced to magnetic north.

Stand on one known point and use the sighting hole in the probe to sight another known point.

In a quarrying application, these two known points might be markers at either end of the line of hole collars, but any two known points can be used. The aim is to collect a bearing with the Cabled Boretrak which is referenced to magnetic north, and to compare this with a bearing collected with a Quarryman, GPS device or other survey instrument which is referenced to the local grid north or to true north. In this way, a correction between the two datasets can be established.

Hold up the probe until you can see directly through the sighting hole. Make sure that the arrow next to the sighting hole is facing forward, towards the point you are aiming at. Rotate the probe until you can see your reference point through the hole. You have now aligned your probe to the reference azimuth. Hold the probe steady and press **ENT** to record the observed bearing.

**Note:** Some software packages will ignore the value observed during the “sight base line” operation. In this case, just press **ENT** to skip this function.

Enter a hole number – a two-digit number from 00 to 99 – then press **ENT** to continue.

Enter a depth interval to be used during the deployment. This equates to the number of cable markers that will be deployed between Boretrak readings being taken. This value will usually be either 1 or 2, but 3 can also be selected. Press **ENT** to continue.

Select whether or not a ballast rod is attached. Press **SEL** to toggle between ATTACHED and NOT ATTACHED. Press the **ENT** key to confirm and proceed.

The CDU prompts:

DEPLOY PROBE  
PRESS FIX...



*Figure 19 Deploying the probe into the borehole*



*Figure 20 Probe deployed*

Carefully lower the probe to the bottom of the hole. Keep tension on the cable to ensure that the probe is upright at the bottom of the hole.

The CDU prompts for an 'offset'. The offset is the distance from the hole collar up to the next interval marker on the cable. Note that you should disregard markers that are not in use for any given deployment. For example, if a deployment depth of 2 m has been selected, only the red markers will be used, so ignore the black markers and measure from the hole collar up to the next red marker.

Enter the measured distance in centimeters (or hundredths of a foot if using imperial units). Press **ENT** to continue.

The CDU is now ready to take Boretrak readings.

Hole# 01	OBS# 00
-----	
INCLINATION	20.6
HEADING	289.3
63558 BYTES FREE	

Figure 21 CDU screen during a survey, with CSS format selected

The screen displays:

- **Hole# 01:** the current hole number.
- **OBS# 00:** the number of readings that have been taken. This will read '00' before a reading has been taken.
- **INCLINATION:** a live display of the angle, in degrees, that the probe is inclined at. Vertical = 0.00. CSS mode only.
- **HEADING:** a live display of the direction, in degrees, which the probe is inclined in. Magnetic north = 000.0. CSS mode only.
- **BYTES FREE:** the amount of memory remaining. Each reading uses 11 bytes.

With the probe still at the bottom of the hole and tension on the cable, press **ENT** to log the first reading. Always ensure the probe is as steady as possible before taking a reading. As a guide, observe the displayed values on the CDU and allow them to settle before pressing **ENT**.

The CDU will beep and display:

PLEASE WAIT

Then:

LOGGING

Wait until these displays have disappeared before continuing. The 'OBS#' will increment by 1.

Pull the probe up the hole until the next cable marker is at the collar. Ignore markers that are not in use. For example, if the selected depth interval is 2 m then only the red markers should be used.

Allow the inclination and azimuth values displayed in the CDU to settle. Press **ENT** to take a reading.

Continue pulling the probe up the hole, stopping to take readings at the pre-defined interval. The last reading will be taken when the last marker that is in use is at the collar.

**Caution:** Do not log a reading with the probe at the top of the hole.

Press **SEL** key to complete the hole survey.

A summary of the survey appears:

Hole# 01		RESULTS
DEPTH	=	18.3
AV. INCL.	=	15.5
AV. HEADING	=	289.5
PRESS ANY KEY...		

Figure 22 CDU screen showing a summary of a hole survey

The summary displays:

- **DEPTH:** total hole depth, calculated by multiplying the number of readings by the depth interval, and subtracting the offset.
- **AV. INCL:** the inclination of the hole, taken as an average of all readings.
- **AV. HEADING:** the heading of the hole, taken as an average of all readings.

Press **ENT** to return to the main menu.

When carrying out a survey with the CDU set to log in MDL format, the screen display will be similar to that in Figure 23.

Hole# 01		OBS# 00
	RAW	CORR
PITCH	12.7	-7.5
ROLL	-35.4	14.4
HEADING	289.3	
63558 BYTES FREE		

Figure 23 CDU screen during a survey, with MDL format selected

In this mode, the raw pitch, roll and heading values are shown, together with the pitch and roll values corrected to account for the reference bearing taken at the start of the survey.

When logging with the CDU in MDL format, the corrected readings (CORR column) for the pitch and roll should read as shown in Figure 24. With boreholes drilled in a line parallel to an inclined quarry face, and the reference azimuth observed as in Figure 24, roll will typically be positive.

Where the borehole is inclined in a specific direction, the readings on the CDU can be used to check whether the reference azimuth has been sighted correctly. If this is not correct then you have sighted your reference point incorrectly and should clear the memory and restart.



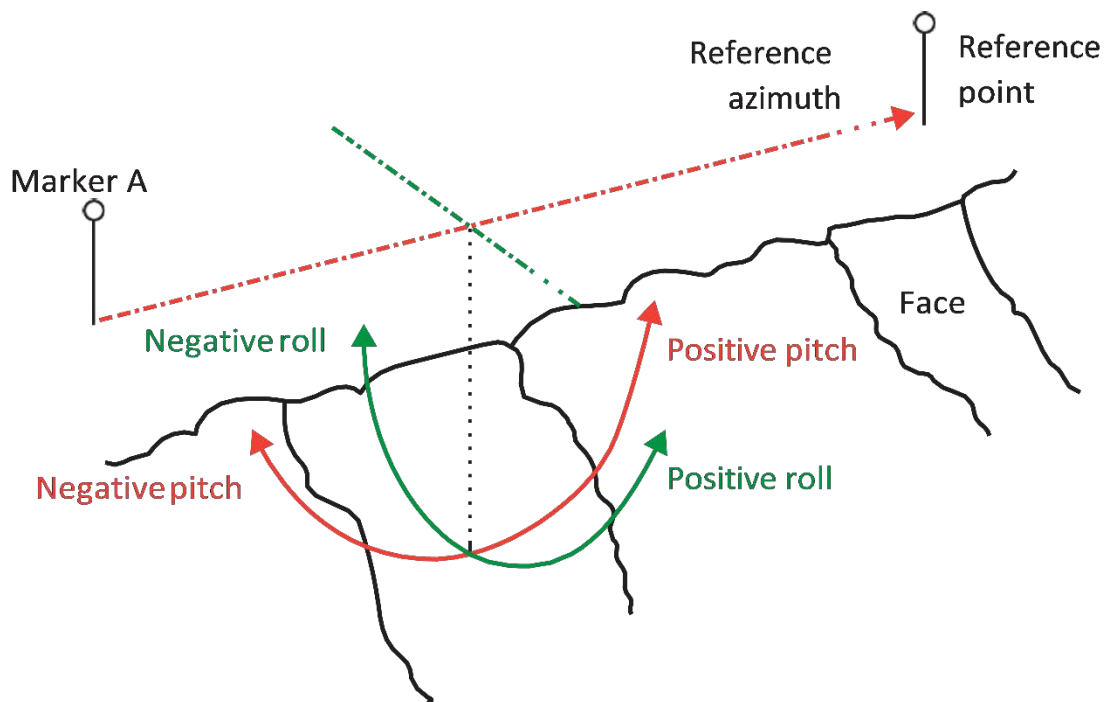


Figure 24 MDL format pitch and roll conventions

**Note:** It is recommended that CSS format be used as the default setting. This is the format that is accepted most readily by the majority of modern blast design and hole deviation software packages.

## 4.8 Download

Once a survey has been completed, the data stored internally in the CDU is available to be downloaded to a PC or other remote device.

All data collected since the memory was last cleared will be downloaded.

The file format selected in the **Settings** menu *before* each survey will determine how the survey data is formatted on download: see section 4.4.4.

The data will be downloaded at the baud rate selected in the **Settings** menu: see section 4.4.1.

For full instructions on downloading into **P3D Boretrak plug-in** software, see the **P3D** online help files. In general, when downloading a data file to the PC, follow these steps:

1. Connect the CDU to the PC serial port using the supplied CDU to PC serial cable. If necessary, use the supplied USB–serial adaptor to connect to a USB port.
2. From the main menu in the CDU, press **5** to select DOWNLOAD.
3. The display indicates the baud rate for the transfer of data. The CDU prompts:  
PRESS ANY KEY TO START...
4. At this point, ensure connection is made to the remote device and the device is ready to accept the data.
5. Press a key on the CDU to start the data transmission. It should generally take a few seconds (unless the file is unusually large).

6. The CDU prompts:

DONE PRESS ANY KEY...

Press any key to return to the main menu.

## 4.9 Compass calibration

A compass calibration is recommended:

- When the Cabled Boretrak is used for the first time.
- Whenever the probe is moved to a new area.
- If the probe has been subject to strong magnetic fields.
- At least every six months.
- After servicing.

Keeping the probe within calibration is essential for accurate results. A calibration jig is supplied with the unit for this purpose, as shown in Figure 25.



*Figure 25 Boretrak calibration jig*

The calibration should be conducted outside and away from any objects that could interfere with the magnetic compass. Close proximity of vehicles, drilling rigs, generators, electrical equipment and steel-toecap boots should be avoided. Metal objects, watches, mobile phones and anything electromagnetic should be removed from the person conducting the calibration. Care should be exercised with jackets and mobile phone holders as these may contain magnetised parts. The CDU and cable coil should be kept away from the probe.

From the main menu in the CDU, press **6**. On selection of the CALIBRATE COMPASS option the user must position the compass at 12 equidistant angles.

Mount the calibration jig on the lightweight tripod and use the levelling bubble to level the jig. Set the pointer on the

calibration jig to read '0°' in the engraved scale in the jig. The zero mark and pointer do not have to be pointing towards 'north'.

Loosen the collar on top of the jig. Put the probe in the jig so that it is standing upright, but do not tighten the collar around the probe. The probe should still be free to rotate independently inside the jig.

Rotate the probe until the compass reading has stabilised to a value of as close to 0° as possible, as displayed on the CDU. The displayed compass reading must be equal to, or just greater than, 0°. If it goes below 0°, the calibration will not work, i.e. 0.1° would be acceptable but 359.9° or less would not. Tighten the collar around the probe.

Once the reading on the display has settled, the calibration jig scale and the compass display should both read 0°. Press the **ENT** key to log the zero bearing.

The display will then request further angles in 30° increments. Turn the probe to each of these pre-defined angles by turning the collar of the jig (with the probe fixed within it) to the correct value imprinted into the scale on the jig. The compass value displayed on the CDU should be ignored for the duration of the calibration. It is likely that after the first reading the compass value will differ from those read off the scale on the jig.

Once the jig has been carefully turned to the required angle, press **ENT** to log a reading. Repeat this step for all requested angles until the CDU prompts:

CALIBRATION COMPLETE

The unit will automatically return to the main menu.

If problems occur during calibration, switch off the CDU and repeat the process from the beginning.

The user should be aware that despite a successful calibration being completed, the digital compass in the Boretrak probe is still susceptible to interferences in the magnetic field. These may be caused by metals in the rock, borehole casings, vehicles, generators nearby, or even by mobile phones or other electronic equipment on the user's person. Such interference in the magnetic field can lead to erroneous Boretrak data.

## 5 Regular checks and preventative maintenance

Attempts to dismantle or repair the Cabled Boretrak and accessories can be hazardous and costly if attempted by untrained personnel. Unauthorised attempts to carry out maintenance work on the equipment will void all warranty cover. Maintenance carried out by the operator therefore, should be restricted to the cleaning and inspection of external surfaces and operating controls.

In addition, you should carry out regular functional testing of the system. Detect and report damage, malfunctions or poor performance to Carlson or a local Carlson representative.

Arrange a yearly calibration for your Cabled Boretrak system to ensure that it is kept in optimum condition and to ensure the highest possible quality of data.

A troubleshooting guide which outlines some of the most common support questions is included in section 6.1. For issues not dealt with below or in the troubleshooting section, contact Carlson or a local Carlson representative for further assistance.

### 5.1 In use

Avoid mechanical shock.

Inspect and check the probe and accessories for wear, tear and damage after each use.

Always ensure that the Cabled Boretrak and all accessories are thoroughly cleaned and dried before packing them in the transit case after a deployment.

Use clean water to remove mud, grit and other materials from the main body of the probe after use. Do not immerse the CDU in water. The CDU is rated IP66: it is dust-tight and protected against high pressure water spray from all directions, but not against submersion.

For further cleaning of the Cabled Boretrak and CDU, Carlson recommends that you use a product such as Amberclens anti-static foam cleaner. If this is not available then use a generic, mild dishwashing liquid diluted in warm water (0.001%, i.e. 1 ml for every 1l of water). Do not use paint solvents or any other personal, laundry, or household cleaning detergents as they may contain chemicals that could corrode seals in the Cabled Boretrak system. Apply the diluted detergent with a non-abrasive, lint-free cloth.

Rinse the unit with plain water after using a detergent.

Dry the unit thoroughly after cleaning. Where possible, leave the unit unpacked until it is dry. In case the system is packed before it has dried, the equipment should be unpacked at the earliest opportunity. Clean and dry the system, and the inside of the transit case, before repacking the Cabled Boretrak for storage.

Check the probe metalwork for external damage. Clean mud from the probe, especially from the reference azimuth sighting hole. Any use in salt water conditions should be followed by cleaning the probe in fresh water.

Do not use paint solvents to clean the instrument. A mild detergent may be applied, using a lint-free cloth, to clean the metalwork.

### 5.2 CDU

Check the battery compartment seal to ensure there are no breaks which might allow water in.

Check the keypad membrane for any damage which might allow water to penetrate.

### **5.3 Cable**

Check the cable periodically for wear, breaks in the sheath and missing markers. Also check the area where the cable joins the probe.

Cable breaks can permit water entry into the probe and CDU which may lead to premature failure.

Missing markers can produce erroneous survey results.

Damaged cable can be factory-repaired by Carlson. Contact your local Carlson representative or Carlson service centre.

### **5.4 Transportation**

In addition to the points above, care should be taken when transporting the Cabled Boretrak system.

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

Clean and dry all elements of the system prior to packing them in the transit case.

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

## 6 Cabled Boretrak system troubleshooting guide

### 6.1 Diagnosis of some common issues

Some of the most common support questions are outlined below. If you experience a problem with your Cabled Boretrak system or the resulting data, check the list to find the cause and recommended action.

Symptom	Cause	Action
Suspected erroneous pitch and roll readings or results	<ol style="list-style-type: none"> <li>1. Sensors out of calibration</li> <li>2. Vibration at or near borehole</li> </ol>	<ol style="list-style-type: none"> <li>1. Check probe vertically to give 0.00° angles, or against a known angle</li> <li>2. Stop the source of vibration and restart the survey</li> </ol>
CDU beeps periodically	Batteries nearly flat	Replace 3 x "C" (MN1400, LR14) batteries in CDU unit
Unit does not switch on or switches off during survey	Batteries below minimum charge level	Replace 3 x "C" (MN1400, LR14) batteries in CDU unit
Unexpected extra reading in data	Ballast rod option selected	On CDU, select "Ballast rod not attached"
Hole longer or shorter than expected	<ol style="list-style-type: none"> <li>1. Extra reading taken during deployment</li> <li>2. Reading omitted during deployment</li> <li>3. Wrong offset entered</li> </ol>	<ol style="list-style-type: none"> <li>1. Take one reading per depth interval</li> <li>2. Make sure a reading is taken at every depth interval</li> <li>3. Correctly measure from the collar to the next marker in use - this will depend on the depth interval selected</li> </ol>
Last reading at unexpected angle	Probe leaning at borehole bottom	Maintain tension on cable while probe is at the bottom of the borehole
Data not downloading	<ol style="list-style-type: none"> <li>1. Damaged data cable</li> <li>2. Incorrect baud rate selected</li> <li>3. Wrong COM port selected</li> <li>4. USB-serial adaptor driver not loaded</li> </ol>	<ol style="list-style-type: none"> <li>1. Check data cable for damage and connectivity</li> <li>2. Select correct baud rate on CDU set-up screen prior to download</li> <li>3. Select the correct COM port in the PC software</li> <li>4. Ensure that the driver used for your USB-serial adaptor is loaded and is appropriate for your PC</li> </ol>
Data not processing or processed incorrectly	Incorrect data format selected for software	Select correct format (CSS or MDL) in CDU set-up screen prior to the survey; make sure the processing software can cope with the selected format
Orientation of data and results incorrect	<ol style="list-style-type: none"> <li>1. Compass affected by magnetic or ferrous object</li> <li>2. Compass out of calibration</li> <li>3. Incorrect grid magnetic angle applied in your processing software</li> <li>4. Incorrect reference azimuth used</li> </ol>	<ol style="list-style-type: none"> <li>1. Check there are no metal, magnetic or electromagnetic objects nearby</li> <li>2. Calibrate compass at survey location</li> <li>3. Check that the correct grid magnetic angle is used in your processing software</li> <li>4. Check co-ordinates of borehole and reference point are on same survey datum; make sure probe sighting hole is targeted correctly</li> </ol>

## 6.2 Other faults

If you are not able to repair or pinpoint a fault from the table above, you should contact Carlson or your local Carlson representative for further assistance.

## 7 Technical specifications

Information contained herein is believed to be accurate. However, no responsibility is assumed by Carlson for its use. Technical information is subject to change without notice.

### 7.1 Specifications

Construction		
Probe	316 stainless-steel body Brass insert	
Ballast rod	Fibreglass/stainless steel	
Cable	Kevlar reinforced polyurethane	
CDU	Black acetal	
Physical	Weight	Dimensions
Probe	2.5 kg	480 mm x 38 mm (L x Dia)
Ballast rod	960 g	100 mm x 38 mm (L x Dia)
Cable	50 g per metre	N/A
CDU	800 g	210 mm x 102 mm x 41 mm
Sensors		
Dual-axis inclinometers		
Range	±40° from vertical	
Accuracy	0.2°	
Resolution	0.1°	
Compass		
Range	0° to 360°	
Accuracy	±1° typical (vertical and calibrated)	
Resolution	0.1°	
CDU		
Display	128 x 64 - four lines of text	
Keypad	4 x 4	
Memory	64 KB	
Data Download	RS232, 1200, 4800, 9600, 19200 baud (selectable)	
System power		
Probe	3 x 1.5 V "C" (MN1400, LR14) cells	
Environmental		
Probe	Water-proof. Pressure-rated to 100 m (flooded hole).	
CDU	IP66	
System operating temp.	0° to +45° C	
System storage temp.	-10° to +50° C	
Software		
USB-serial adaptor	Driver available for Windows 7, 8 and 10	
P3D Boretrak plug-in	See P3D online help files for recommended PC specs	



## 8 CDU to PC cable

The CDU is fitted with an RS232 output port. The configuration of the pins is described in Table 2.

Circular military-style 7-pin connector	Signal	9-way female D-type connector
Pin A	Ground	Pin 5
Pin D	CDU data output	Pin 2
Pin C	CDU data input	Pin 3

The RS232 protocol for downloads is described in Table 3.

<b>Baud rate</b>	1200,4800,9600,19200 (selectable)
<b>Parity</b>	None
<b>Data bits</b>	8
<b>Stop bit</b>	1
<b>Handshaking</b>	None

## 9 Product information

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### Warranty

Unless otherwise specified, Carlson warrants all supplied equipment for a period of 12 months from the date of delivery. This warranty is given subject to the following conditions:

- Carlson shall be under no liability in respect of any defects in the equipment arising from any drawing, design or specification supplied or modification requested by the customer.
- Carlson shall be under no liability in respect of defects arising from willful damage, negligence, abnormal working conditions, failure to follow Carlson's instructions (whether oral or in writing), misuse or alteration or repair of the equipment without Carlson's approval.
- Software is not covered by this warranty.
- Claims in respect of defective equipment must be made in writing to Carlson and the equipment must be retained by the customer pending written instructions from Carlson.

Following authorised return of the equipment, which must be made by the customer on 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 replacement without charge. Carlson will have no further liability to the customer.

### Safety

The Cabled Boretrak is designed as a means of auditing the results of drilling activity quickly and accurately, for downhole use. The system is non-magnetic and therefore may be used in all types of rock, flooded holes and areas of ferrous materials and hole castings. 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*.

### 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 Cabled Boretrak system, including those mentioned in Carlson product literature.

### EC declaration of conformity



Carlson declares that the Cabled Boretrak complies with the applicable standards and regulations.

Contact Carlson or visit [www.carlsonsw.com](http://www.carlsonsw.com) for the full EC declaration of conformity.

### 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 Carlson Cabled Boretrak probe is defined as Group 1, Class A equipment.

The Carlson Cabled Boretrak 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 Carlson Cabled Boretrak 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 an 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 Cabled Boretrak is supplied with non-rechargeable alkaline batteries (3 x 1.5 V "C" (MN1400, LR14) cells).

- Do not use rechargeable batteries in the probe.
- 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.