

VS+

Underground void surveying system

User manual





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1 Customer information

1.1 Dear customer

The VS+ 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 VS+ system which are beyond the scope of this manual, contact the product support department at Carlson, or your local Carlson representative.

Alternatively, for information on your local Carlson Software-approved service centre, visit our website at www.carlsonsw.com.

To ensure best service, please make a note of the serial number. This can be found on a label on the instrument.

1.2 User manual

It is important that you read this manual carefully before using the instrument.

There are two manuals available with the VS+ system:

1. This VS+ hardware manual which describes the VS+ probe and all accessories supplied with a standard system;
2. A **Carlson Scan** software and operations manual;

It is essential that the accompanying **Carlson Scan** software and operations manual is also read and understood. As well as describing the software, that manual gives a brief overview of a typical deployment. Some troubleshooting guidelines are also offered which address the most common problems and questions that arise from users of the VS+.

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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2 VS+ system

2.1 System overview



Figure 1 VS+ unit

The VS+ is a development of Carlson's Void Scanner. Both units are ruggedised laser scanners designed to produce fast, efficient 3D models of underground voids where access is limited, dangerous or prohibited. The VS+ can be mounted on booms, tripods or user-customised deployment devices. The small, lightweight size of the VS+ gives flexibility in the nature of the deployment and means that volumes and dimensions which have previously been guessed or estimated can be accurately quantified.

The VS+'s laser employs the 'time of flight' technique to measure ranges to rock faces and other objects without the need to place reflectors on the target. This allows measurements to be taken from a safe distance. Two hundred such measurements are made every second, up to a range of 150 m.

Information from internal accelerometers are collected in addition to the scan data. The accelerometer data allows scans to be correctly levelled, whichever way the VS+ is inclined or rolled.

A surveyor observes to a prism on the VS+ and a prism on the back of the deployment boom. This establishes the coordinates and azimuth of the VS+ which ensures scans can be geo-referenced. Multiple scans observed from different locations can then be stitched together. The scan data can be plotted against design drawings or as-built data to help build an invaluable picture of the project site.

The VS+ incorporates an internal battery and Wi-Fi controller which means it is a completely self-contained, cableless system. The unit is controlled remotely from a PC or handheld device running **Carlson Scan** software which plots the data on-screen in real time. **Carlson Scan** allows the finished scan to be analysed, edited, transformed, combined with other datasets and exported to third-party software.

The VS+ is just one of many laser systems that have been designed by Carlson. Other products such as the C-ALS, Quarryman and Boretrak have all been proved over many years of demanding use around the world. These products complement the VS+ and provide a wide range of advanced measurement solutions within the mining, quarrying and geotechnical industries.

3 VS+ hardware

This section details the range of components supplied with a VS+ system.

Various models of the VS+ have been produced and supplied, and the technology is constantly evolving and improving. Therefore, some components described below may not feature in your VS+ system or may differ in some way.

3.1 VS+ Probe

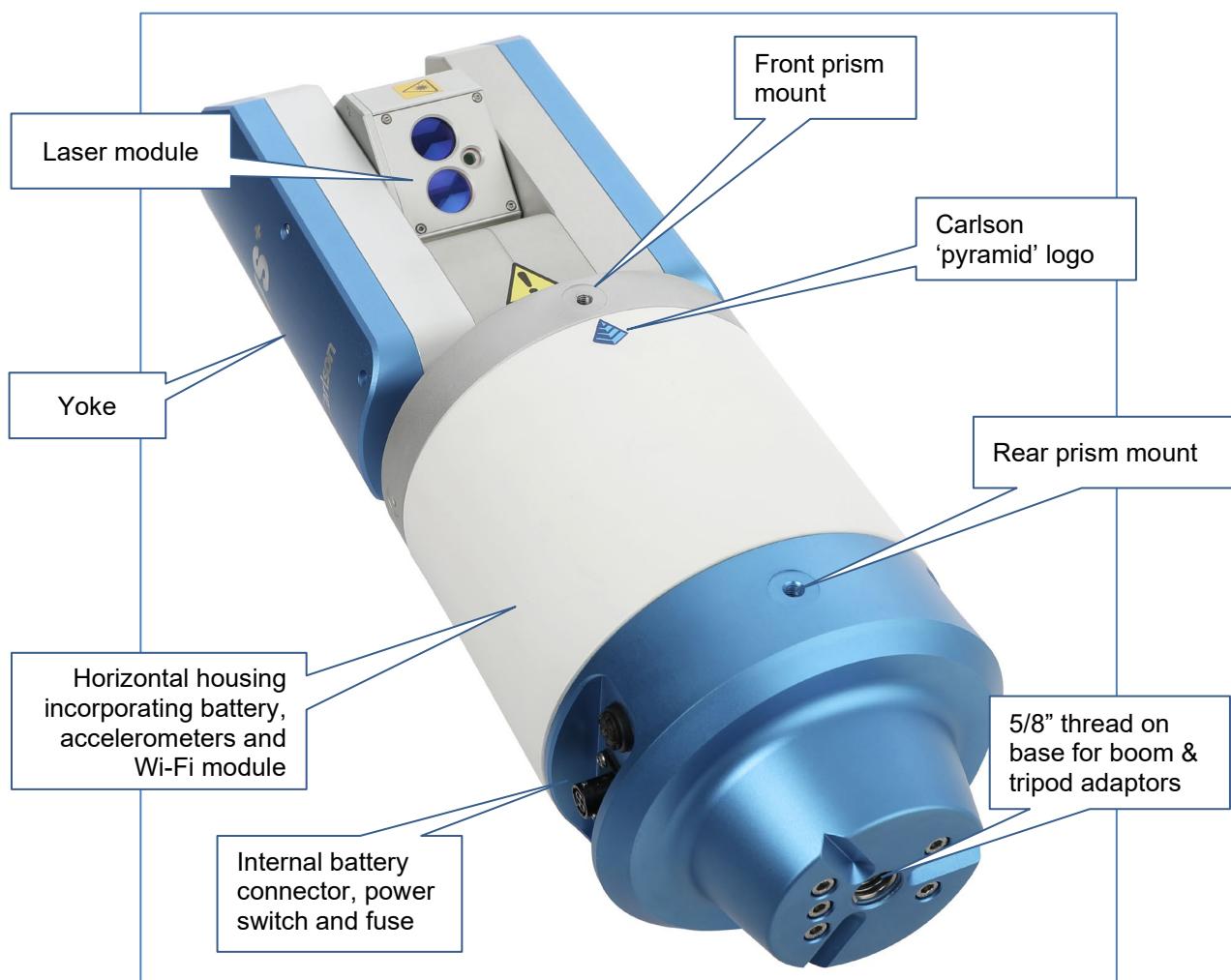


Figure 2 Component parts of the VS+

The VS+ instrument consists of a laser module held between two pivots on a yoke. The yoke itself is held on the end of the horizontal housing. The horizontal housing contains the battery that powers the system and the Wi-Fi to communicate with a PC.

3.2 Laser

The laser module houses the optical and electronic components that allow distance measurements to be recorded to reflectorless targets up to 150 m from the instrument. The laser rotates vertically within the yoke.

Two large lenses are visible in the laser module. These are the transmitting and receiving optics. The infrared measuring laser is fired through the transmitting optics. Its reflected light is then received back into the instrument through the receiving optics. A smaller window protects the visible red dot laser pointer which can be switched on to assist tracking of the VS+ distance measurement laser. The pathway of the visible and infrared lasers is co-linear, but not co-axial.

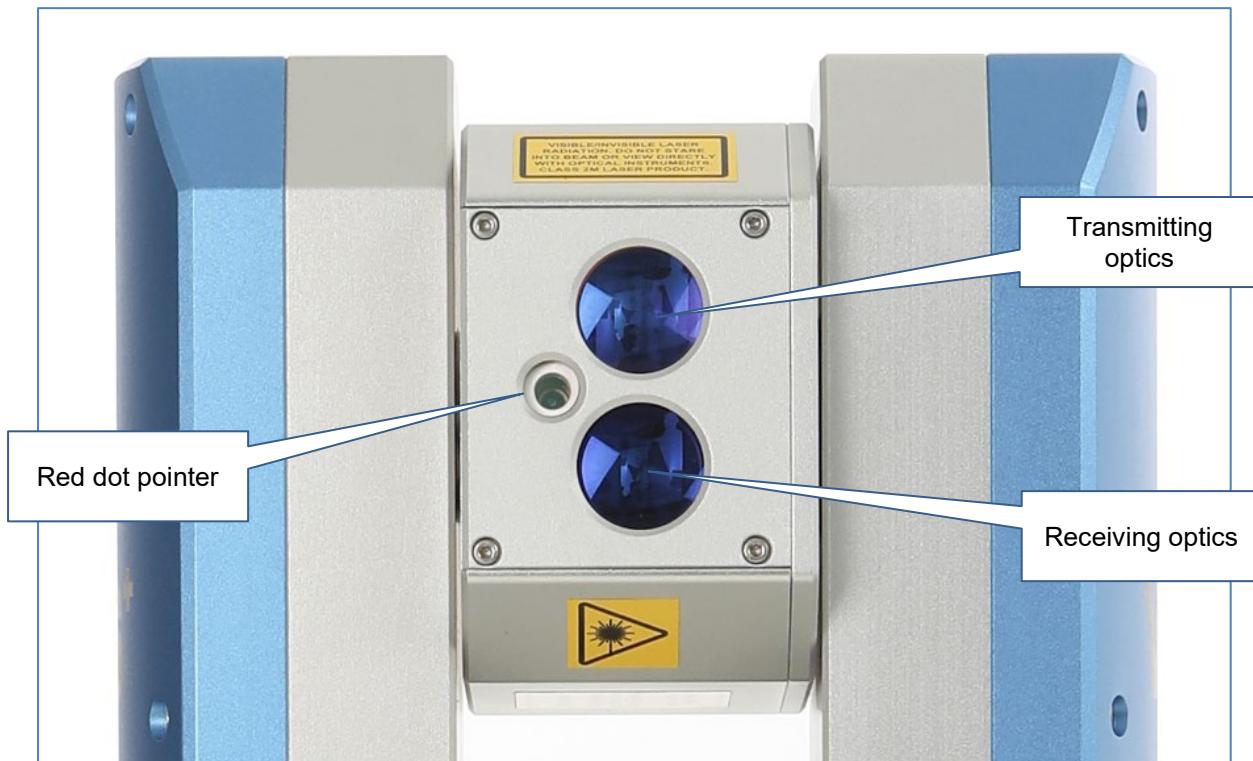


Figure 3 The VS+ laser module

3.3 Yoke and horizontal housing

The yoke which holds the laser module contains the vertical motor. This motor drives the vertical rotation of the laser module between the pillars of the yoke. The yoke also houses the vertical encoder which measures the angle through which the laser is rotated.

The yoke is attached to the horizontal housing. The horizontal housing contains the horizontal motor which drives the rotational movement of the yoke. The horizontal housing also houses the horizontal encoder which measures the angle through which the yoke is rotated.

The combination of the two axes of rotation gives the VS+ a view encompassing 360° horizontal and 270° vertical rotations respectively. The yoke itself prevents the laser from viewing a 90° sector of the vertical rotational sweep.



Both motors are protected with clutches. This means that if the unit is rotated by hand or prevented from moving by an obstruction, the motors will not be damaged. It is advisable, however, to minimise any manual movement of the unit and to keep the instrument away from potential obstructions so the motors may turn freely. Nevertheless, the possibility of finger or clothing entrapment exists. Users should not obstruct the operation of the motors or allow clothing to come into contact with the device.

Accelerometers are also contained within the horizontal housing. These sensors automatically record the inclination and roll of the VS+. This ensures that all scans are correctly levelled in **Carlson Scan** software. Information from the accelerometers, when combined with coordinate and heading information, helps to georeference the scan.

The ‘top’ of the horizontal housing is marked by a Carlson pyramid logo. This side of the VS+ incorporates two M6 threads which provide positions to mount the supplied prism. These are the ‘front’ and ‘back’ prism positions referred to in **Carlson Scan** software.

On the ‘underside’ of the horizontal housing is positioned one M6 thread. This thread is used for securing the VS+ to optional jigs and adaptors, but is not required for standard operations using a Carlson-supplied boom.

The base of the VS+ horizontal housing incorporates a 5/8” thread. This is used for securing the VS+ to the Carlson-supplied boom, and also to optional jigs and adaptors. This thread can also be used to attach the VS+ to a tripod in a vertically upright position.

3.4 Power connectors

The VS+ is powered by an internal battery. Where necessary, the VS+ can also be powered by an optional external battery.

On opposite sides of the probe, there is a separate connector, power button, and fuse holder for internal and external power.

An information sticker on the underside of the probe indicates which side of the probe relates to the internal and external power sources. The sticker also outlines VS+ power information.

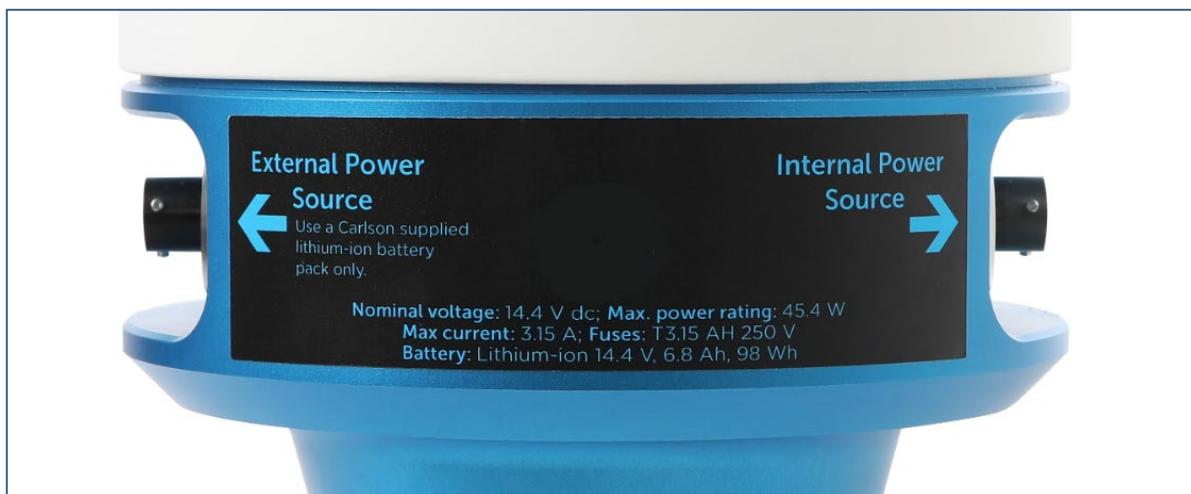


Figure 4 Information sticker

3.5 Internal battery

The VS+ incorporates a 14.4 V lithium-ion battery. The battery can power the VS+ for at least 6 hours of scanning.

If the battery is charged, press the Internal Power Source button to power on the VS+. The button illuminates with a blue light to indicate that the unit is powered on. Press the Internal Power Source button again to power off the VS+.



Figure 5 Power button, charger and fuse for the internal power source

The battery is charged through the black, 4-pin female connector labelled Internal Power Source.

A fuse located next to the Internal Power Source button is dedicated to the internal battery circuit. The fuse holder carries a 3.15 A time-delay fuse: T3.15 AH 250 V.

See section 5.1 for further details about the internal power source.

3.5.1 Battery charger

A battery charger is supplied with the VS+ to charge the internal lithium-ion battery.

Connect the battery charger to the 4-pin connector on the side of the VS+ labelled Internal Power Source. Plug the battery charger itself into a mains power supply. The battery charger is supplied with a selection of plug types to fit mains sockets around the world.



Figure 6 VS+ Battery charger (left) connected to the VS+ (right)

The battery charger only charges the internal battery if the Internal Power Source button on the side panel is toggled OFF.

The battery charger can also be used to charge an external battery. In this case connect the battery charger directly to the connector on the external battery.

An LED on the battery charger shows the status of the charging process:

- Green flashing light: charging is in progress.
- Solid green light: charging is complete.
- Red flashing light: there is a fault with the battery charger. Contact Carlson for advice.
- No light: there is no power to the battery charger or no connection with the battery.

A fully discharged battery requires around three hours to completely recharge from the mains supply.



WARNING: Only use the supplied battery charger to charge the internal or the external battery.

The battery charger is not intended for outdoor use.

3.5.2 External lithium ion battery (optional accessory)

The VS+ contains an internal lithium-ion battery. This can be supplemented with an external, Carlson-supplied lithium-ion battery which has the same power specifications as the internal battery. The external battery may be required on a particularly long job, or where there is no access to a mains power supply to charge the internal battery.

Note that a separate panel of power controls for external power is on the opposite side of the VS+ probe from those which control the internal power source.



Figure 7 Power button, charger and fuse for the external power source

A dedicated cable is required to connect the external battery to the VS+.



Figure 8 External lithium-ion battery (left) and external battery cable (right)

On this cable, the 2-pin female connector attaches to the connector on the VS+ labelled External Power Source.

The black, 4-pin connector attaches to the external battery.

To power the VS+ with the external battery connected, toggle the External Power Source power switch ON.



Figure 9 External battery connected to the VS+

See section 5.2 for further details on working with the external battery.

3.6 Prism and prism mounts

The VS+ is supplied with a 360° mini prism. This prism can be used to position and orientate the scanner when the instrument is deployed on a boom or tripod. The prism has an M6 thread on one end. This matches with two M6 threads on the top side of the VS+ horizontal housing.

The top of the horizontal housing is marked by a Carlson pyramid logo beside the front prism mount.

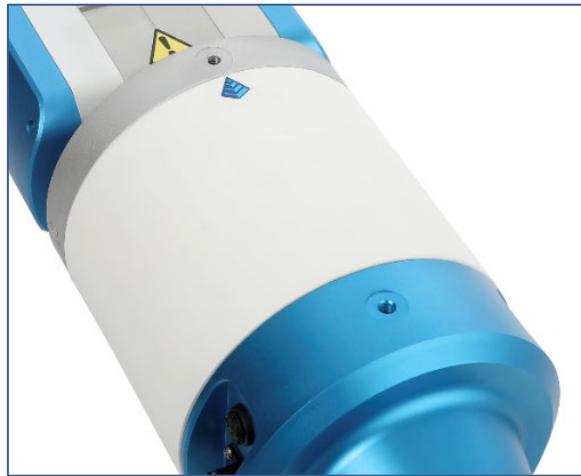


Figure 10 Top of the VS+ horizontal housing



Figure 11 Prism attached to front prism mount (top) and rear prism mount (bottom)

A surveyor can observe to the prism on the VS+ to establish the position of the unit. A second prism may be attached to the back end of the deployment boom. Observing to both prisms can then give the azimuth of the deployment.

If the VS+ is mounted on a tripod rather than on a boom, two prisms can be fixed to the VS+: one in the front mount and one in the rear mount. In this case the front prism can be used for position and the azimuth obtained from the bearing from the rear prism to the front prism.

Functionality in **Carlson Scan** software assists with the azimuth calculations.

In **Carlson Scan** software, enter the position where the prism has been mounted on the VS+ together with the coordinates of this position. In addition, the azimuth can be entered or computed.

The origin of all angle and range information from the VS+ is a position in the centre of the vertical axis of rotation inside the laser module. Carlson Scan computes this position with reference to the entered information and the inclination and roll of the VS+ - values which are read from the unit's internal accelerometers.

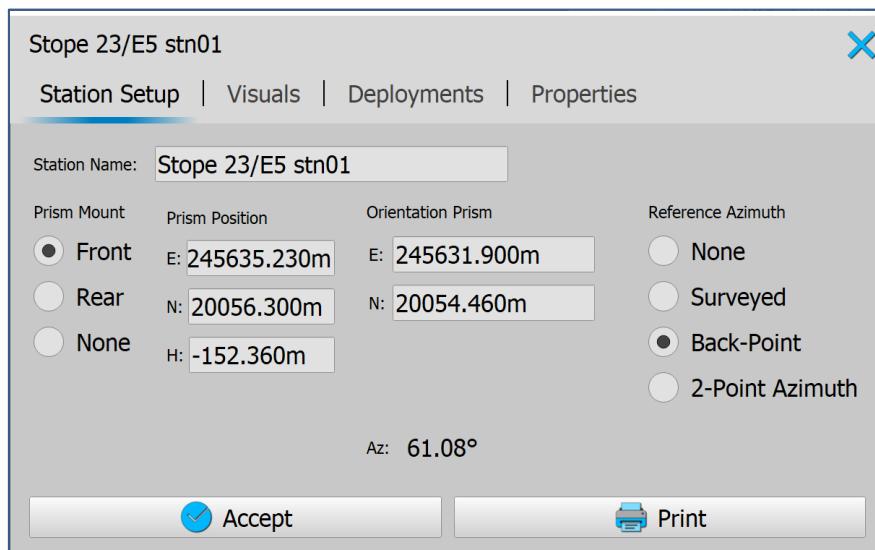


Figure 12 The Station setup window in Carlson Scan

See the **Carlson Scan** manual for further details.

3.7 Transit case



Figure 13 VS+ in transit case

The VS+ system is supplied in a rugged transit case designed to transport the instrument, surface unit, boom adaptor, battery and cables.

The case helps to protect the instrument from minor shocks and from the environment. Always use the transit case when transporting and storing the equipment.

Take care to dry the VS+ probe and accessories before packing them into the transit case.

3.8 Carlson Scan

Carlson Scan is loaded onto a Carlson USB drive supplied with the VS+.

The software provides full control over the VS+, real time visualization of collected data, and post-processing tools for analysis and editing.

Software updates can be downloaded directly from the 'Downloads' section of the Carlson website. Enter your name and e-mail address in the downloaded page to ensure you are alerted if there is a new version of the software.

Carlson Scan is also designed to be used with legacy Void Scanner units and all varieties of C-ALS scanners.

A full description of **Carlson Scan** software is included in the **Carlson Scan** manual which accompanies the VS+ system.

4 Optional accessories

4.1 Boom

Carlson supplies an optional boom which is designed to hold the VS+ and to deploy it into a stope or other hazardous area on a mine. The boom is carbon fibre and telescopic for convenient storage and transportation.

A Carlson adaptor screws on to the base of the VS+ with a long, captive 5/8" bolt. The adaptor itself then slots into the boom and is fastened onto the thread on the end of the boom with the wide, threaded collar nut.



Figure 14 Carlson boom adaptor connecting to the base of the VS+

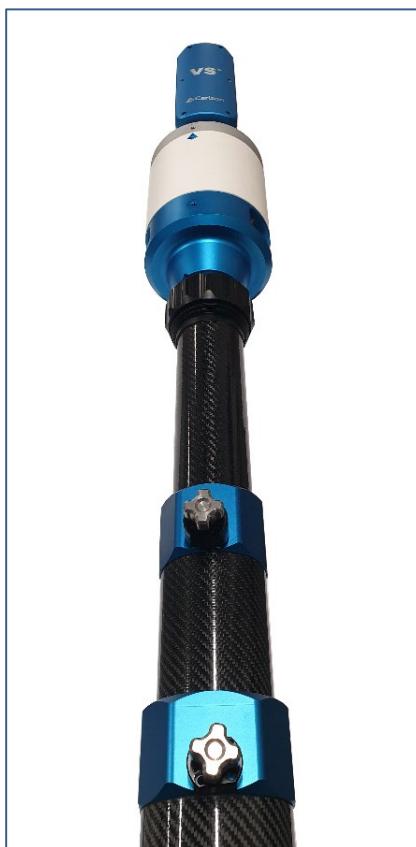


Figure 15 VS+ attached to a retracted boom

A removable set of wheels is also available. These can be attached to the boom just behind the VS+. This allows the boom to be pushed into the bottom of a stope without exposing personnel to any risk.

4.1.1 Boom assembly

To make shipping easier and more cost-effective, booms are dispatched from Carlson's factory with fixtures and fittings removed. Therefore, on receipt of a new VS+ boom, some initial assembly is required.

The steps to make the boom ready for field use are outlined below.

A new boom is shipped with an accessory box. Within the box there are:

1. 1 x large captive screw
2. 16 x M4x20 cap head screws
3. 4 x small captive screws and base assemblies



Figure 17 Packaged accessories

Unscrew one of the small captive screws so it is loosened from the captive screw base assembly.

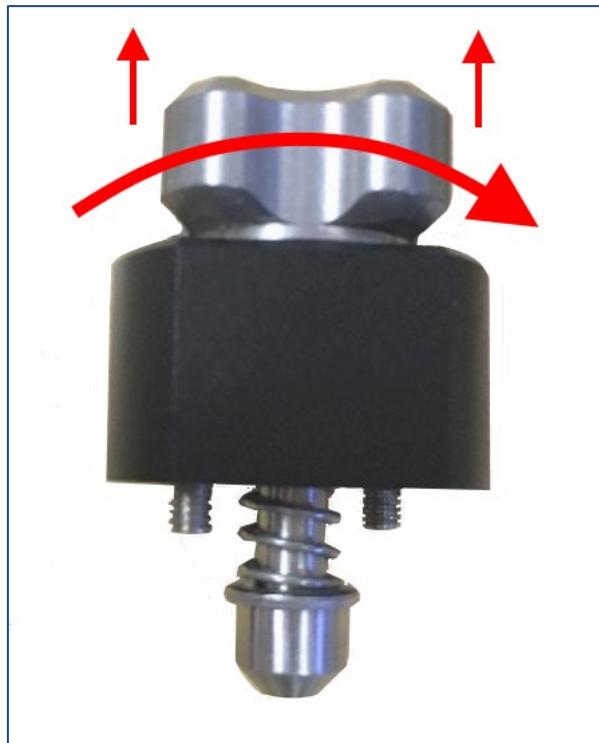


Figure 18 Captive screw base with captive screw

Insert four M4x20 screws into the captive screw base.

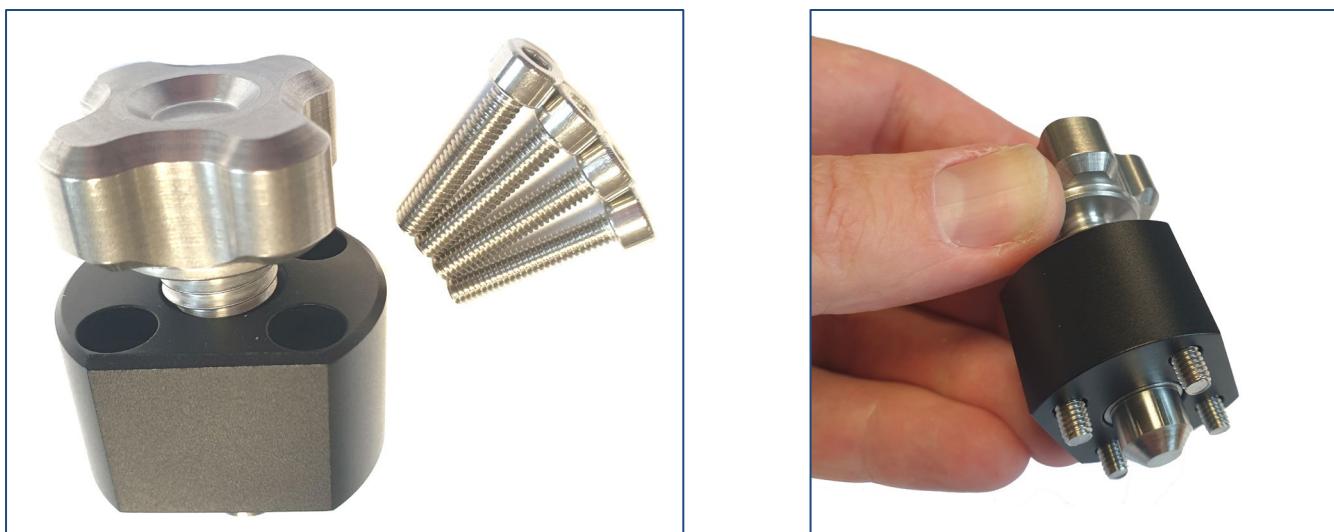


Figure 19 Four M4 x 20 screws inserted into the captive screw base

Apply Loctite 243 to the base of each of the M4 x 20 screws.



Figure 20 Locations for applying Loctite thread locker

Place the captive screw base against one of the blue joints on the boom. The tip of the captive screw should sit in the large hole. The M4 x 20 screws should be aligned with the four pre-drilled threaded holes.



Figure 21 Attaching the captive screw base to the boom joint

Tighten each M4x20 screw to 2.6Nm so that the captive screw base is securely attached to the boom joint.

For optimum stability, fit a screw base to both sides of each joint.

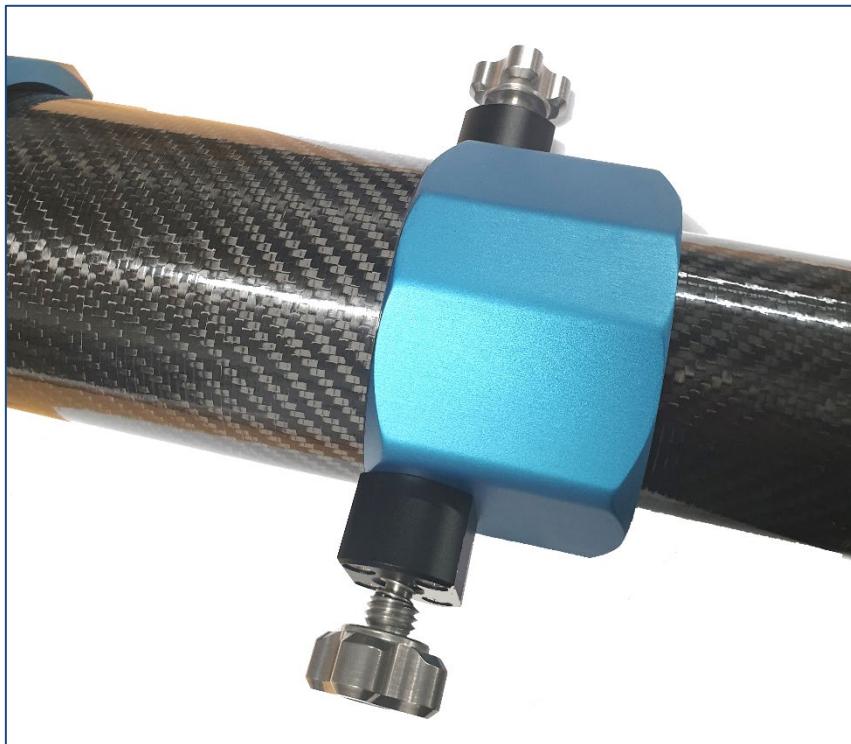


Figure 22 Captive screw bases attached to both sides of the boom joint

To lock the boom sections in place during operations, extend the carbon fibre section fully so that a hole in the tube is lined up with the hole in the blue metal joint (note: the hole in the tube in Figure 23 is shown with the captive screw base removed). The sections may need twisting slightly to allow them to fully extend.



Figure 23 Aligning holes in the carbon fibre with hole in the blue boom joint

Screw down the captive screw to lock the section in place.

The large captive screw fits into the Carlson boom adaptor which can be found screwed on the end of the boom.



Figure 24 Large captive screw

Remove the adaptor from the boom and thread the captive screw through the end.



Figure 25 Boom adaptor

Screw the captive screw into place so the thread is poking out of the end of the adaptor.



Figure 26 Boom adaptor with captive screw in place

4.2 Adaptor for legacy carbon fibre Void Scanner booms

Carlson supplies an adaptor to allow the VS+ to be connected to carbon fibre booms which have been supplied with previous generations of Void Scanner units.

The adaptor screws into the 5/8" thread on the base of the VS+.



Figure 27 VS+ carbon fibre boom adaptor (left) attached to the VS+ (right)

Once it is attached to the VS+, insert the adaptor into the end of the legacy carbon fibre boom in the same way that the neck of the Void Scanner was inserted. Use the clamp to lock the adaptor and VS+ in place.



Figure 28 VS+ connected to legacy carbon fibre boom

4.3 Tripod bracket

Carlson supplies a bracket to allow the VS+ to be connected to standard survey tripods.

This bracket also allows the VS+ to connect to legacy aluminum booms previously supplied with the Void Scanner.

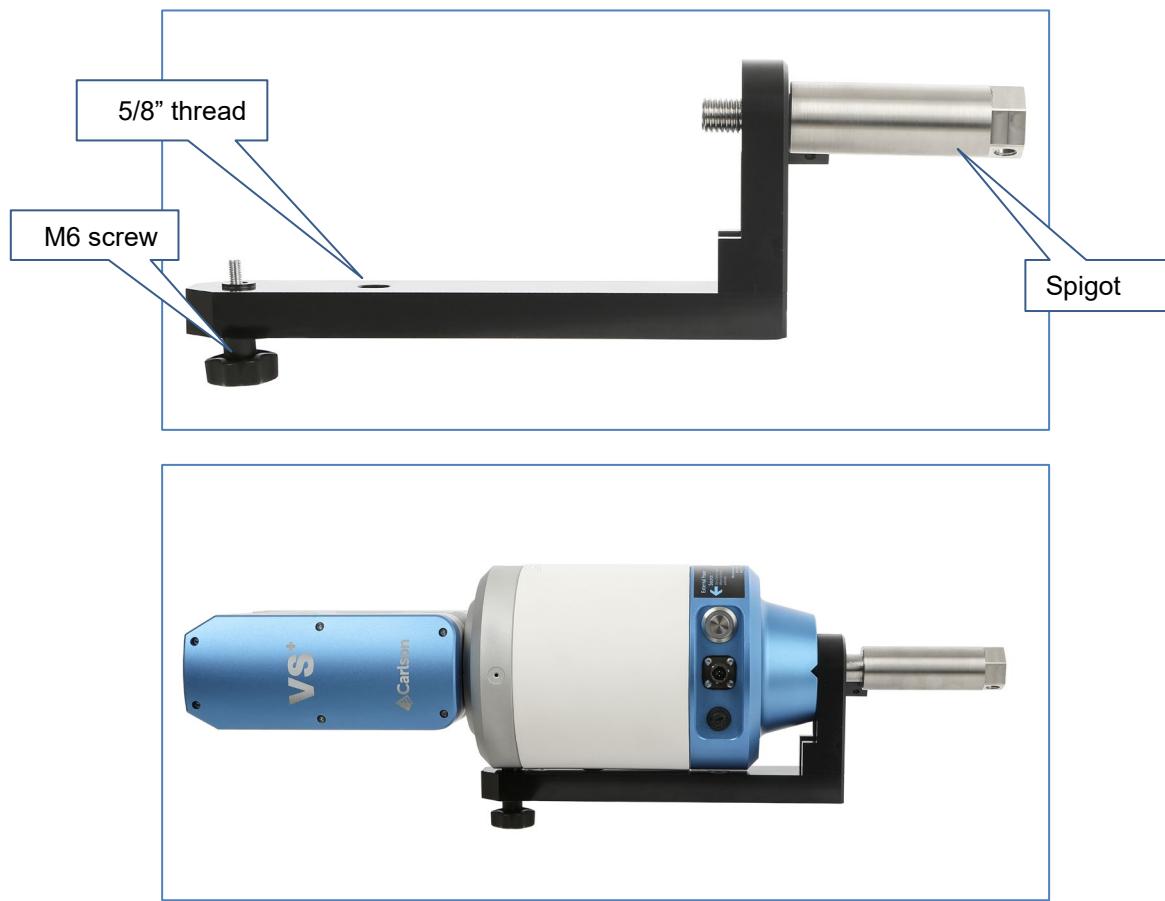


Figure 29 Tripod bracket (top) attached to VS+ (bottom)

Screw the spigot into the 5/8" thread on the base of the VS+. Screw the M6 screw, held captive in the bracket, into the M6 thread on the underside of the VS+.

Use the 5/8" thread in the underside of the bracket to secure the VS+ to a tripod.

To attach the VS+ to a legacy aluminum boom, slot the spigot into the end of the boom and secure it in place with a holding pin.

4.4 Customised deployment devices

As an alternative to a standard Carlson boom, many users design their own boom or other deployment device to suit their specific operational and site requirements. In some cases, the probe fits directly to the deployment device. In other cases, where there are different mechanical configurations, the tripod bracket or boom adaptor may be used.

Due to the wide range of possible ways of deploying the VS+, this manual does not describe any method of attachment in detail. If you wish to design your own customized deployment device, the relevant drawings and dimensions of the probe can be supplied. For further advice and information, contact Carlson.

5 Power management

The VS+ can be powered from the internal lithium-ion battery or from an optional external lithium-ion battery.

Power can also be ‘hot swapped’ between internal and external batteries to ensure that scanning operations can continue while the power source is changed.

5.1 Internal power

The VS+ contains a rechargeable lithium-ion battery which can provide up to 6.2 Ah at a nominal voltage of 14.4 Vdc. This equates to approximately six hours of scanning time.

When the internal battery drops beneath 10.8 Vdc, the VS+ shuts down.

Battery life is extended by keeping a partial charge on it when in frequent use. The battery can be damaged by deep discharge and is fitted with protection to avoid this occurring. When the battery has run out of charge, use the supplied battery charger to recharge it.

To power the VS+ from the internal battery, depress the Internal Power Source power button on the side panel. This turns the VS+ ON. The button illuminates blue when it is pressed, providing the internal battery is sufficiently charged.



Figure 30 Internal Power Source button, connector and fuse

The Internal Power Source button changes from constant illumination to flashing when the battery voltage drops below 13.6 Vdc.

Press the Internal Power Source button again to toggle the power OFF.

The VS+ shuts down automatically when the internal battery voltage drops below 10.8 Vdc. However, if a scan is in progress and the voltage drops below 11.2 Vdc, **Carlson Scan** software carries out a controlled termination of the ongoing scan. In this case, the **Carlson Scan** project is automatically saved, along with the terminated scan. See the **Carlson Scan** manual for details.

A fuse located next to the Internal Power Source button is dedicated to the internal battery circuit. The fuse holder carries a 3.15 A time-delay fuse: T3.15 AH 250 V.

To recharge the internal battery, connect the supplied battery charger. The battery charger supplied with the unit is designed to meet the specific charging requirements of the lithium-ion battery. The battery charger operates at 2 A and takes around three hours to fully charge the battery.

The internal battery will not power the VS+ when it is being recharged. If the battery charger is connected to the

VS+, it charges the internal battery until the Internal Power Source button is depressed. At this point, if there is enough charge in the internal battery, the button illuminates; power is delivered to the VS+ and the charging process is paused.

When the Internal Power Source button is toggled OFF, the battery charging resumes.

It is possible to charge the internal battery while an external power source is being used. See section 5.2.

5.2 External power

To power the VS+ from an external battery, connect a charged, Carlson lithium ion battery to the External Power Source connector on the side of the VS+.

The external battery can provide up to 6.2 Ah at a nominal voltage of 14.4 Vdc. This equates to approximately six hours of scanning time.

When the external battery drops beneath 10.8 Vdc, the VS+ shuts down.

Battery life is extended by keeping a partial charge on it when in frequent use. The battery can be damaged by deep discharge and is fitted with protection to avoid this occurring. When the battery has run out of charge, use the supplied battery charger to recharge it.

To power the VS+ from the external battery, depress the External Power Source power button on the side panel. This turns the VS+ ON. The button illuminates blue when it is pressed, providing the internal battery is sufficiently charged.



Figure 31 External Power Source button, connector and fuse

The External Power Source button changes from constant illumination to flashing when the battery voltage drops below 13.6 Vdc.

Press the External Power Source button again to toggle the power OFF.

The VS+ shuts down automatically when the external battery voltage drops below 10.8 Vdc. However, if a scan is in progress and the voltage drops below 11.2 Vdc, **Carlson Scan** software carries out a controlled termination of the ongoing scan. In this case, the **Carlson Scan** project is automatically saved, along with the terminated scan. See the **Carlson Scan** manual for details.

A fuse located next to the External Power Source button is dedicated to the internal battery circuit. The fuse holder carries a 3.15 A time-delay fuse: T3.15 AH 250 V.

To recharge the external battery, connect the supplied VS+ battery charger directly to the battery. The battery charger supplied with the unit is designed to meet the specific charging requirements of the lithium-ion battery. The

battery charger operates at 2 A and takes around three hours to fully charge the battery.

5.3 Hot swapping power sources

The VS+ has two power options: the internal battery and an optional external battery. Either or both power sources can be used to power the system. During scanning operations it is also possible to 'hot swap' between these sources so that one battery can be on charge while the other is in use. Alternatively, both power sources can be left powered ON to ensure the maximum scanning time is available.

5.3.1 Example 1

For example, if a scan is in progress and the internal battery voltage is low, the power source can be swapped to an external source to ensure that the scan is not interrupted by a power failure.

This can be done while the scan is ongoing and powered from the internal battery. Connect a charged, external battery to the VS+ and depress the External Power Source button, ensuring that it is illuminated. Power is now drawn from the external power source, assuming that it has a higher voltage than the internal battery.

Once the external battery is powering the unit, two options are available:

1. The Internal Power Source button can be left ON if required to ensure that both power sources are available. Once the two power sources have balanced, power is drawn from both batteries.
2. Alternatively, the Internal Power Source button can be toggled OFF. At this point, the internal battery can be charged, if required.

5.3.2 Example 2

Similarly, if a scan is in progress and an external power source is in use, the power source can be switched back to the internal battery. Depress the Internal Power Source button, ensuring that it is illuminated. In this case, the External Power Source button can either:

- be left powered ON, or
- be toggled OFF, and the external power cable disconnected from the VS+.

6 Data communication

Data from the VS+ is transmitted via Wi-Fi signal to the PC running **Carlson Scan** software. Commands from the software to the probe travel in the opposite direction.

The Wi-Fi signal is broadcast over a standard Wi-Fi frequency of 2.4 GHz. The system uses the IEEE 802.11 b/g/n wireless standard.

The PC in use should have a suitable, integrated Wi-Fi card or external Wi-Fi dongle using the 802.11 wireless standard.

The VS+ can transmit a wireless signal over a distance of 50 m as long as there is a clear line-of-sight between the VS+ and the PC.

There are a number of external environmental factors that can have the effect of reducing the maximum achievable range, or preventing connection between the two devices. The most obvious is the presence of solid objects in the path of the Wi-Fi signal, for example walls, rock masses or machinery.

Where possible, ensure that there is a clear view between the VS+ and the PC.

6.1 Data channels

It is also possible that the VS+ Wi-Fi link could be affected by other Wi-Fi networks operating on 2.4 GHz. Although 802.11 devices tend to work cooperatively, sharing channel capacity, interference is possible in certain circumstances.

There are 14 channels available on a 2.4 GHz network. These are as follows:

Channel	Frequency (GHz)
1	2.412
2	2.417
3	2.422
4	2.427
5	2.432
6	2.437
7	2.442
8	2.447
9	2.452
10	2.457
11	2.462
12	2.467
13	2.472
14	2.484

By default, the VS+ is set to 'AutoSelect' a channel. Occasionally, if you suspect interference from another Wi-Fi network in the vicinity, you may consider it necessary to manually change to a specific channel.

In this case, it is recommended that the new channel should be at least five channels away from any neighbouring network. For this reason, by general convention, channels 1, 6 and 11 are recommended for 2.4 GHz operations.

Note: Before changing the channel, you should be aware of any local legislation regarding restrictions on the use of certain Wi-Fi channels. Some countries forbid the use of some channels or restrict these channels to a specified power level.

To change the channel that the VS+ is operating over, use the web browser on your PC to connect directly to the Wi-Fi adaptor inside the VS+.

Note: it is strongly recommended that you only change settings in the browser interface if absolutely necessary. Do not reconfigure any settings other than those specifically mentioned below.

Ensure that the PC is connected to the VS+, as per section 7.4.

Open a web browser. In the address bar, enter:

10.10.100.254

The browser connects to the Wi-Fi module. A **Windows Security** window appears and requests a user name and password.

Enter username:

admin

Enter password:

carlso



Figure 32 Wi-Fi module web browser interface - Login screen

Click **OK** to progress to the web browser interface.

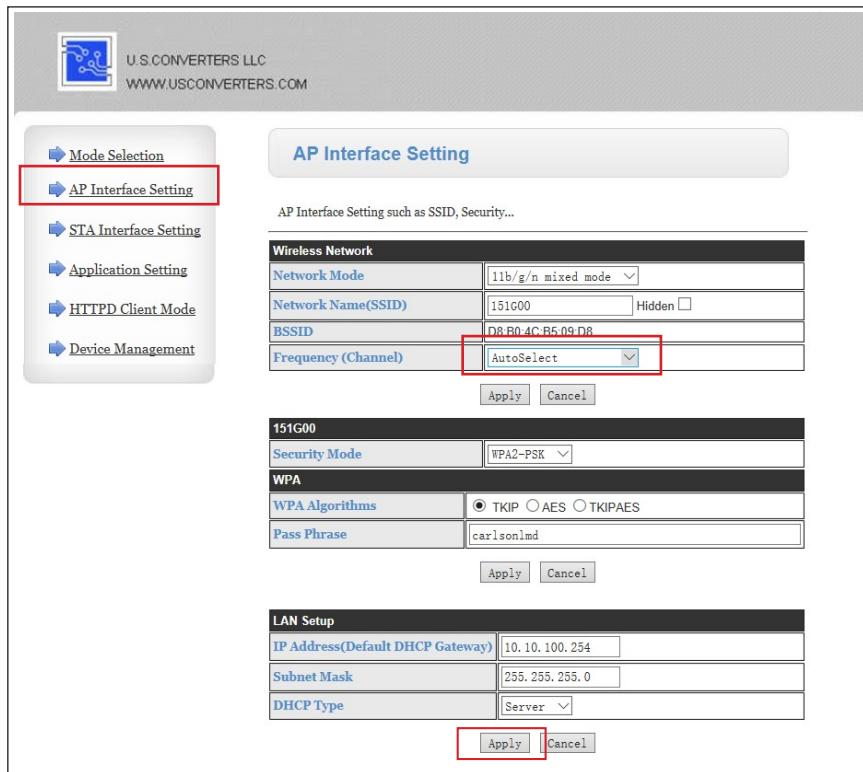


Figure 33 Wi-Fi module web browser - AP Interface Setting screen

From the left-hand menu, select **AP Interface Setting**.

From the **Frequency (Channel)** drop down list, select the required Wi-Fi channel. Click **Apply** to confirm the channel selection.

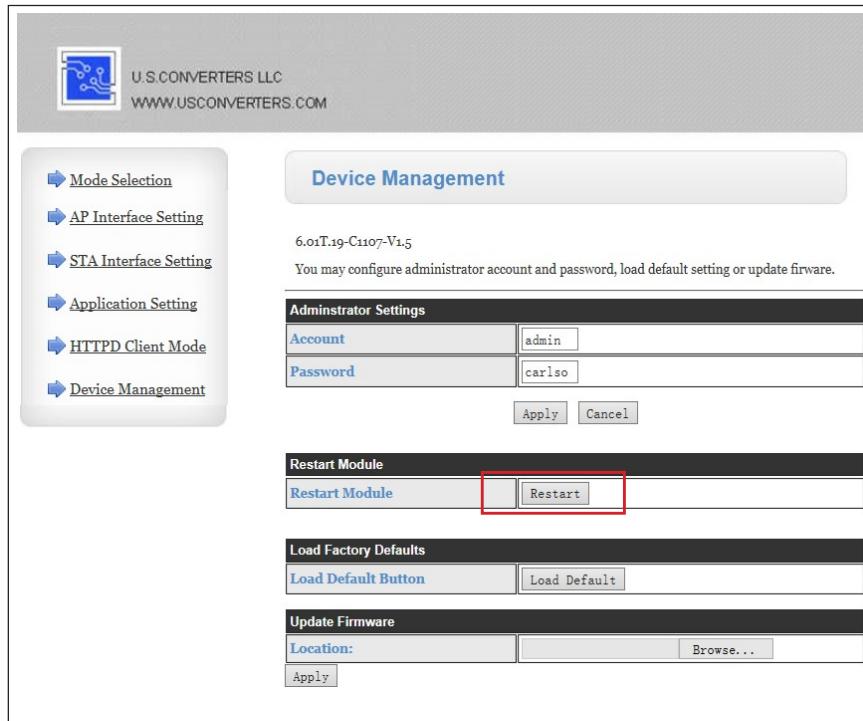


Figure 34 Wi-Fi module web browser interface – Device Management screen

After making any changes, you are redirected to the **Device Management** screen. From the **Restart Module** frame, click **Restart** to reboot the system.

Close down your web browser to end the process. You may need to reconnect your PC to the VS+ to continue using the system.

Be aware that, although interference from other Wi-Fi networks is a possibility, RF (radio frequency) interference can be generated by almost any device that emits an electromagnetic signal – from microwave ovens to Bluetooth® headsets. Such interference can be highly variable and intermittent. The closer the source of interference to the VS+ or the PC, the greater the level of interference. It may be the case that the only way of overcoming this problem is to identify and remove the source of the interference.

6.2 IP address

By default, the IP address of the VS+ is 10.10.100.254. It is strongly recommended that this address is left unchanged.

However, there may very occasionally be a specific need to change the IP address, for example in order to avoid clashing with an adjacent network or perhaps to fit into a pre-existing, on-site network.

In this case, please contact Carlson for advice on carrying out this modification and on the procedure for reconnecting with **Carlson Scan** using a non-standard IP address.

Note: In the event that you do change the IP address, it is your responsibility to maintain a record of any changed network settings. If you fail to do this, you may find it impossible to reconnect to the VS+. You must also inform Carlson of any IP address change when service or support is required.

7 Using the VS+

7.1 First-time use – Power

For protection during shipping, the VS+ is shipped with the fuse cartridges removed. The fuse cartridges are packaged inside the transit case.

Remove the Internal and External Power Source fuse holder caps from the side of the VS+. Rotate them anticlockwise to the unlocked position.

Press each fuse cartridge into a fuse holder cap and screw the fuse holder cap back into the internal panel by rotating it clockwise.

The battery may have lost some charge during transportation. To fully charge the battery, connect the battery charger to the Internal Power Source connector. Ensure the Internal Power Source button is toggled OFF.

Plug the battery charger into a mains power supply. The LED indicator flashes green to indicate that the internal battery is charging. When the battery charge is complete, the LED shows as solid green.

The unit can now be switched ON. Depress the Internal Power Source button so that it is illuminated.

7.2 First-time use – PC compatibility

Carlson supplies an optional ruggedised tablet PC which is optimised for use with the VS+. It is highly recommended that such a PC is used to control the VS+.

However, you may opt to use your own PC hardware. For further advice on PC compatibility, see the **Carlson Scan** software manual or contact Carlson.

7.3 First-time use – PC set-up

The first time that the VS+ is used with a new PC, first check that the PC is set up correctly.

In Windows, go to **Control Panel** and select **Network and Sharing Centre** (or select **Network and Internet**, then **Network and Sharing Centre**). Select **Change adaptor settings**.

Right-click on your Wi-Fi adaptor and select **Properties** from the context menu.

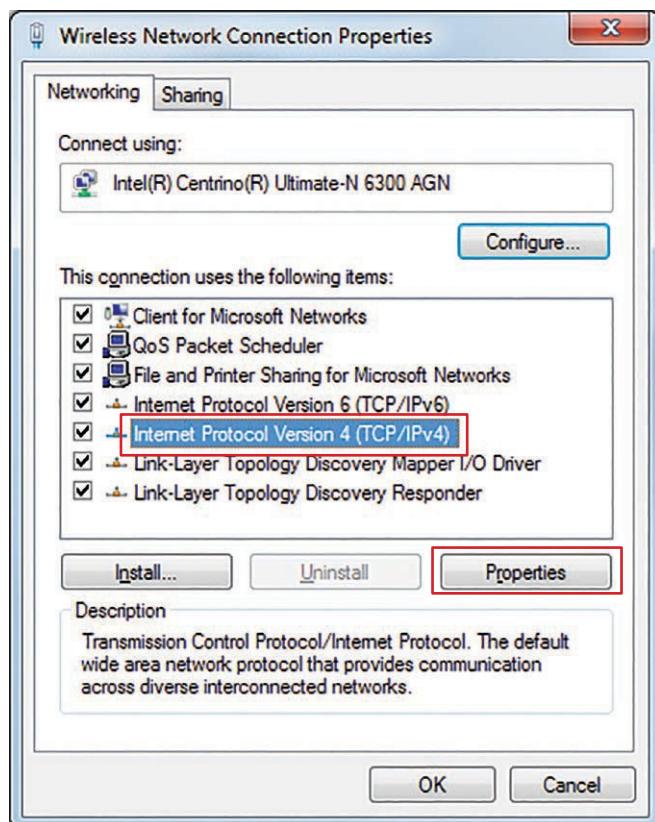


Figure 35 Wireless network connection properties window

In the **Wireless Network Connection Properties** window, select **Internet Protocol Version 4 (TCP/IPv4)**. Click the **Properties** button.



Figure 36 Internet Protocol Version 4 (TCP/IPv4) Properties window

In the **Internet Protocol Version 4 (TCP/IPv4) Properties** window, select **Obtain an IP address automatically** and **Obtain DNS server address automatically**.

Ensure the PC's Wi-Fi adaptor is physically switched on, if required, and that it is not disabled in the **Change adaptor settings** window.

7.4 Connection with PC

Switch on the VS+ so that Internal Power Source button is illuminated.

On the PC, in the task bar, click on the Wi-Fi icon to see the available Wi-Fi networks. The VS+ is identified by its serial number. In the case below, the VS+ Wi-Fi network is named **VS+_190551**.

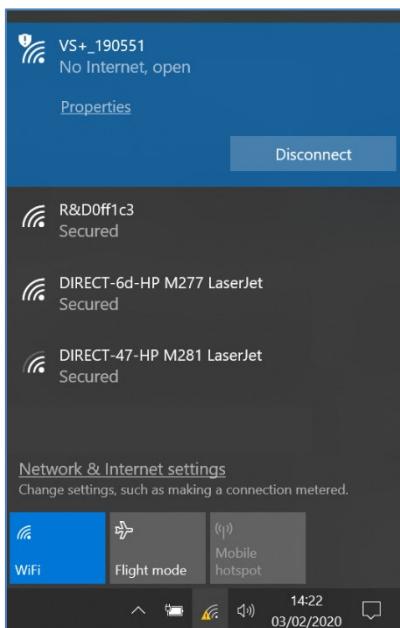


Figure 37 Wi-Fi network connections

Click on the appropriate network and allow the PC to connect with the VS+.

You are now ready to run **Carlson Scan**.

7.5 Carlson Scan

A full description of **Carlson Scan** software is included in the **Carlson Scan** manual which accompanies the VS+ system. This section is concerned only with connecting **Carlson Scan** to the VS+.

Once the VS+ is connected to the PC (see section 7.4), start **Carlson Scan** software as normal.

Carlson Scan has an autodetect routine to establish if there are any scanners connected to the PC. Once the routine is initiated, any scanner which is powered on and correctly interfaced with the PC is detected. **Carlson Scan** first identifies that a VS+ is connected and then establishes the serial number, firmware and internal sensors within the instrument.

The autodetect routine can be started automatically by tapping the **Quickstart** option from the **Touch mode Home** screen. This is the quickest way to get started with scanner operations.

On detection of a VS+, **Carlson Scan** runs through checks to establish that comms with the scanner are sound and to read information from the VS+.

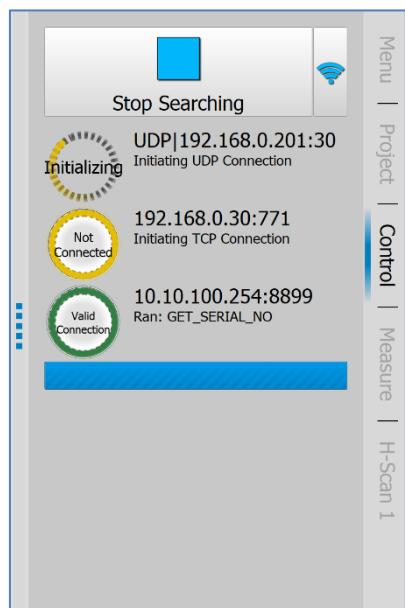


Figure 38 Establishing connection with scanner

With all checks complete, a graphic of the VS+ appears in the **3D View**.

The **Control** tab is active, displaying an interface specific to the VS+.

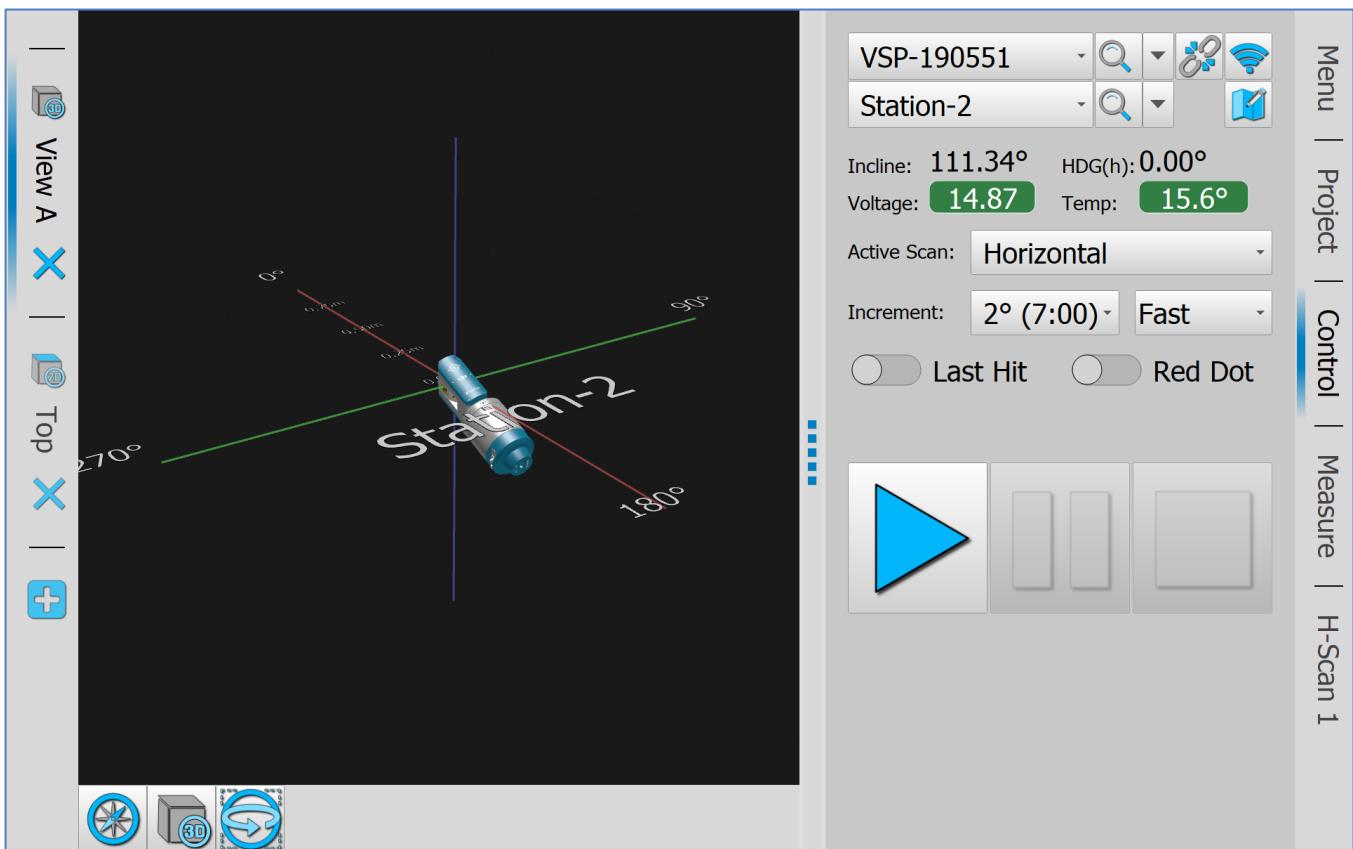


Figure 39 Carlson Scan connected to a VS+

You are now ready to carry out scanning operations with your VS+.

8 Maintenance and care of the VS+

8.1 General

Attempts to dismantle or repair the VS+ 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 should be restricted to the cleaning and inspection of external surfaces, lens windows 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 VS+ 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 the accompanying **Carlson Scan** software manual. For other issues, contact Carlson for further assistance.

8.2 In use

Avoid directing the VS+ laser towards the sun or other high-power infrared light sources.

Avoid mechanical shock.

Avoid manually moving the scan head, either horizontally or vertically, as this can strain the mechanics within the probe.

Ensure the boom or other mounting system is securely set up and on stable ground to avoid the instrument being disturbed or knocked over. When moving from one instrument set-up to another, always detach the VS+ from the boom or tripod and carry the two items separately.

The internal battery in the VS+, as well as the optional battery pack, benefits from being kept fully charged and receiving steady use. Recharging the battery after a short period of use will not affect its performance or life expectancy.

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

Always clean and dry the equipment after use. See below for details.

8.3 Cleaning the VS+

Always ensure that the VS+ 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 VS+ in water. The VS+ is rated IP65: it is dust-tight and protected against high pressure water spray from all directions, but not against submersion.

For further cleaning of the VS+ metalwork and side panels, 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 litre 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 VS+. 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 VS+ for storage.

To clean the lens windows and the red dot laser pointer window on the laser module, use HPLC-grade (> 99.8%) acetone in combination with lint-free cotton wool buds or wipes.

NOTE: repeated exposure to acetone may cause skin dryness or cracking. It is recommended that personal protective equipment (PPE) such as eye-shields and/or face-shields as well as protective gloves is used when dispensing and using HPLC-grade acetone.

8.4 Storage and transportation

Dry the system thoroughly before storing.

If the instrument remains unused for several weeks, it is advisable to remove power sources from the instrument.

Store within the environmental temperature limits of -25° C to +70° C.

Before transporting the VS+ system, pack the equipment correctly in the supplied transit case.

Secure the transit case to prevent the possibility of shock or vibration.

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

9 Laser safety

The VS+ is supplied with the standard laser module described below which has an integrated red dot laser pointer.

9.1 VS+ laser module with red dot laser pointer

The laser classification of the VS+ is a Class 2 laser product in compliance with the British and European standards for the safety of laser products BS EN 60825-1: 2014.



Pointer Laser	Range Finder Laser
Wavelength	650 nm
CW/Pulsed:	CW
Average Power:	< 0.54 mW
Pulse Width:	-
Pulse Energy:	-
Pulse Rate:	-

BS EN 60825-1:2014

WARNING: invisible and visible laser radiation. Do not stare into the beam or direct it into the eyes of others. Do not view directly with optical instruments, e.g. binoculars, theodolite or telescope.

CAUTION: use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.

CAUTION – CLASS 3B INVISIBLE LASER RADIATION WHEN OPEN. AVOID EXPOSURE TO BEAM

WARNING: opening the protective housing may result in exposure to Class 3B radiation.

All the laser safety labels are located upon the laser module head.

Only qualified and trained persons should be assigned to operate the VS+. When not in use, the laser should be stored in a location where unauthorized personnel cannot gain access.

We recommend that the instrument is not directly pointed at people's eyes, especially if they are using optical instruments. Do not unnecessarily look into the transmitter lens of the VS+ laser scanner.

Eye protection, designed to provide adequate protection against specific laser wavelengths (905 nm typically), should be used in all hazard areas. Any exceptions should only be undertaken with the approval of the laser safety officer. All laser protective eyewear shall be clearly labelled with information adequate to ensure proper choice with the particular laser. For the VS+ instrument, the recommended CE marked laser eyewear shall be marked as "R 905 L1" as specified to EN 207, or equivalent. Note that protection shall be afforded to infrared laser radiation, and not the visible laser radiation. The visible laser is however Class 2 when operated by itself and as such is considered "non-hazardous" for unintentional eye exposure (aversion response) without eyewear use (unless deliberately stared at). Laser protective eyewear is not normally necessary.

10 VS+ Specifications

Laser module	
Laser classification IEC/ EN 60825-1:2014 (Complies with 21 CFR 1040.10 and 1040.11 except for conformance with IEC 60825-1 Ed. 3., as described in Laser Notice No. 56, dated May 8 2019.)	Class 2*
Infrared laser module	
Type	InGaAs laser diode
Wavelength (typ)	905 nm
Average power	94.5 mW
Beam divergence	≤ 2 mrads
Resolution	1 cm
Accuracy	±5 cm**
Maximum range to a passive target	Up to 150 m***
Minimum range	0.5 m
Lens aperture size	18 mm - location at front of module
Visible laser module	
Type	InGaAsP laser diode
Wavelength	650 nm
Maximum power	< 0.6 mW (continuous wave)
Lens aperture size and location	3 mm (location at front of module)
Angle measurement	
Encoder type	Opto-electronic encoder
Encoder accuracy	0.2°
Encoder resolution	0.1°
Mechanical range	Vertical: -135° to -135° Horizontal: 0° to 360°
Mechanical motion	Servo-driven gear systems with manual clutches
Pitch and roll sensors	
Type	Triaxial, digital accelerometer
Pitch and roll accuracy	±0.2°
Pitch and roll range	360°

Physical data	
Probe construction	Machined aluminium and stainless steel
IP degree of protection****	IP65
Operating temperature	-10 °C to +45 °C
Probe weight	7.5 kg
Probe dimensions	437 mm × 148 mm (length x diameter)
Internal battery	14.4 V dc, 6.8 Ah lithium-ion battery
External power input	10 to 15 Vdc and 110 to 240 Vac
Power consumption during scan	Approx 0.8 A
Physical data	
Continuous scanning time (typical)	6 hours
Charge time (typical)	3 hours
Wi-Fi range limit	Up to 50 m line-of-sight
Control software	Carlson Scan for Windows

* Viewing laser output with optical instruments designed for use at a distance (e.g. binoculars) may pose an eye hazard.

** Under Carlson Test Conditions

*** Maximum measuring ranges are recorded against Kodak white card (90% reflectivity).

**** Environmental compatibility requirements of EN 60529:1992+A1:2002.

11 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 VS+ is a robust, ruggedized, field instrument whose applications include the 3D mapping of underground stopes, voids and tunnels. Unit range is 150 m to non-reflective surfaces. 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 on 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 measures are incorporated into the equipment operation. Further guidance can be found in the European Standard EN292 *Safety of machinery – General principles of design – Risk assessment and risk reduction*.

The safety of any operations involving the VS+ system is the responsibility of the operator.

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 VS+ system, including those mentioned in Carlson product literature.

Safety information



This symbol is used in this manual wherever important safety information is present.

Before proceeding with any electrical connection or operation of the laser system, refer to the general safety information throughout this manual.

EC declaration of conformity



Carlson declares that the VS+ complies with the applicable standards and regulations.

Contact Carlson or visit www.carlsonsw.com for the full EC declaration of conformity.

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 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.