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Void Scanner

underground void surveying system

user manual

Contents

1 Customer information

1.1 Dear customer

The Void Scanner 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 Void Scanner 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 three manuals available with the Void Scanner system:

1. This Void Scanner hardware manual which describes the Void Scanner probe and all accessories supplied with a standard system;
2. A **Cavity Profiler – VS** software and operations manual;
3. A manual for the Void Scanner Wi-Fi box which is an optional accessory.

It is essential that the accompanying **Cavity Profiler – VS** 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 Void Scanner.

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

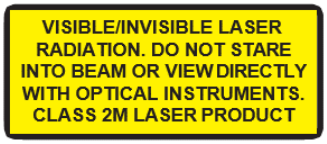
The information in this document is subject to change without notice.

2 Laser safety

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

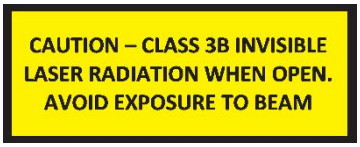
2.1 Void Scanner laser module with red dot laser pointer

The laser classification of the Void Scanner is a Class 2M laser product in compliance with the British and European standards for the safety of laser products BS EN 60825-1: 2007.



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

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



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 Void Scanner. 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 Void Scanner 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 Void Scanner 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 safe to use without eyewear (unless deliberately stared at).

3 Void Scanner system

3.1 System overview

Figure 1 Void Scanner unit

The Void Scanner is a ruggedised field instrument designed to produce fast, efficient 3D laser scans of underground voids where access is limited, dangerous or prohibited. The instrument can be mounted on booms, tripods or user-customised deployment devices. The small, lightweight size of the Void Scanner 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 Void Scanner'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.

Data from the internal pitch and roll sensors are collected in addition to the scan data. This means that all points collected can be accurately geo-referenced and multiple scans can be stitched together. The output data can then be plotted against design drawings or as-built data to help build an invaluable picture of the project site.

The Void Scanner is controlled remotely from a PC or handheld device running **Cavity Profiler – VS** software which plots the data on-screen in real time. **Cavity Profiler – VS** allows the finished scan to be analysed, edited, transformed, combined with other datasets and exported to third-party software.

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

4 Void Scanner hardware

This section details the full range of components that are available in a Void Scanner system.

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

4.1 Void Scanner Probe

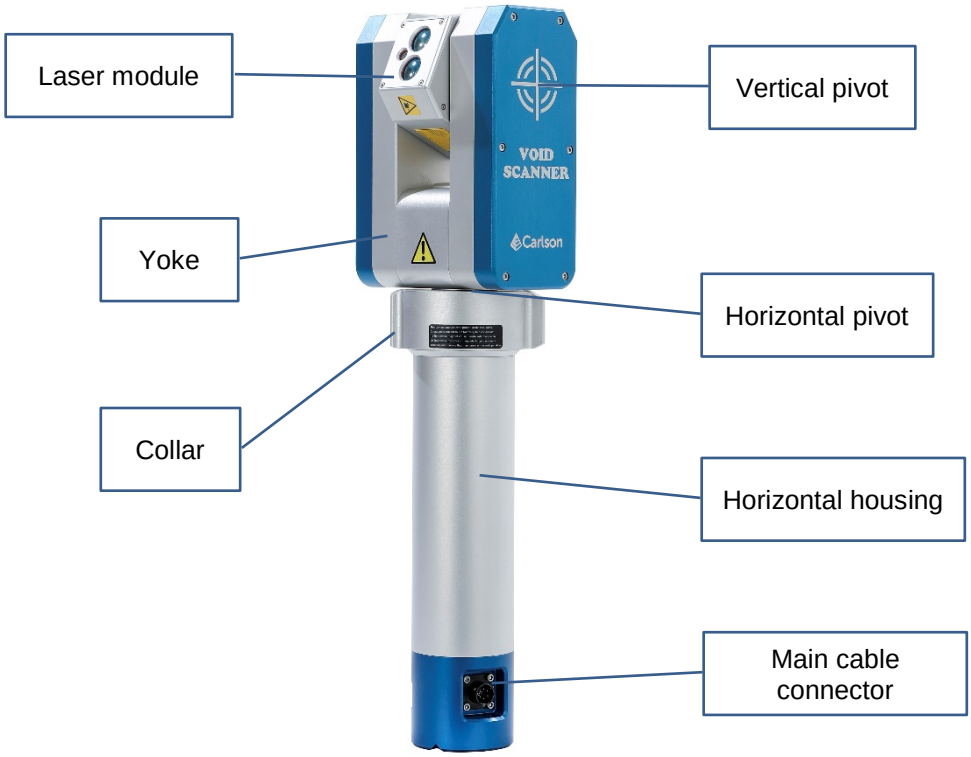


Figure 2 Component parts of the Void Scanner

The Void Scanner instrument consists of a laser module held between two pivots within a yoke. The yoke itself is held on the end of the horizontal housing.

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 which represent 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 aiming of the Void Scanner distance measurement laser. The pathway of the visible and infrared lasers is co-linear, but not co-axial.

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

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

Figure 3 The Void Scanner laser module

The combination of the two axes of rotation gives the Void Scanner 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.

The horizontal housing incorporates four threads which provide flexibility in the method of deployment used and the mounting position of the prism. Two 5/8 in threads – one on the base of the unit and one on the underside of the collar – allow the boom adaptor bracket to be attached to the unit.

One other 5/8 in thread, together with an M6 × 1 thread, are located along the topside of the horizontal housing and allow two alternative positions to mount a prism during horizontal boom deployment. See section 4.8.

Power and data communications with the Void Scanner are via a 13.6 m Void Scanner power/data cable. The cable connects to a 6-pin connector on the side of the probe's horizontal housing. A 4-pin connector on the other end of the cable connects directly to either an interface box or a Wi-Fi box.

Figure 4 Connector port location with boom adaptor

Figure 5 Threaded hole locations for choice of prism mounting location

Figure 6 Threaded hole locations on the underside of the Void Scanner used for the supplied boom adaptor or other mounting devices and booms

4.2 Interface box

The Void Scanner unit is supplied with an interface box. This box acts as a power/data splitter.

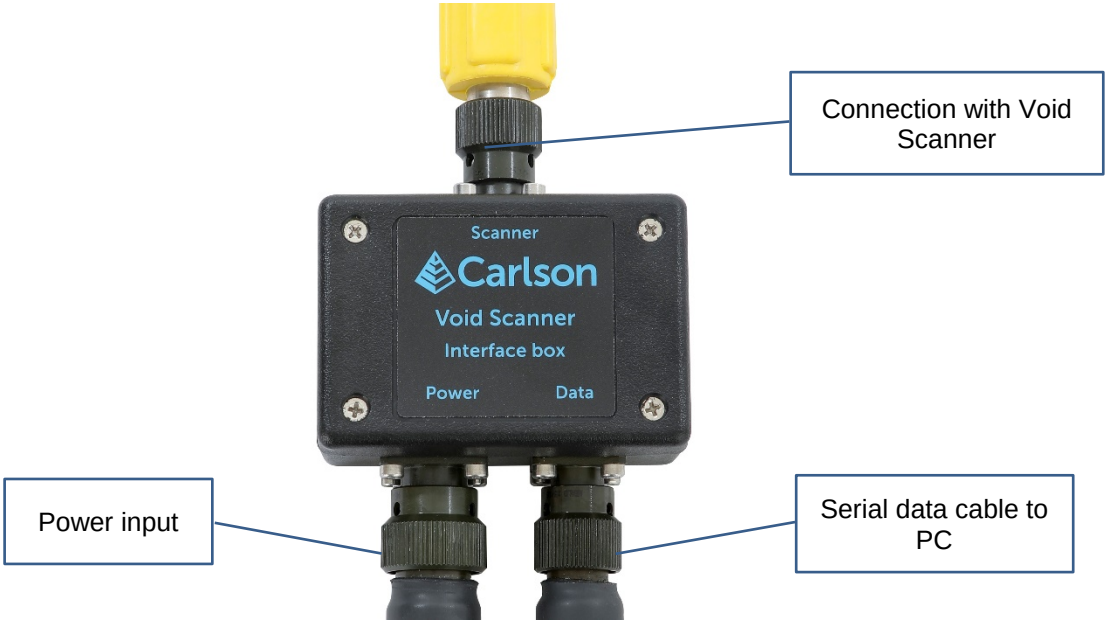


Figure 7 Void Scanner interface box

The interface box has three bayonet lock connectors:

- A 4-pin connector labelled **Scanner** which connects to the Void Scanner data/power cable. This cable delivers power to the Void Scanner and also enables two-way data communications between the Void Scanner and the controlling PC.
- A 6-pin connector labelled **Power** which accepts power, either from the dc power cable with crocodile clip battery connectors, or from an ac source with the power supply unit (PSU). See section 4.5.
- A 3-pin connector labelled **Data** which connects to the supplied serial data cable, which in turn connects to the operating PC serial port to establish serial-based communications. See section 4.3.

The interface box is not required if the optional Wi-Fi box is used. See section 4.10.

4.3 Data cable

The Void Scanner is operated and controlled via a PC or handheld device operating **Cavity Profiler – VS** software. A cable is supplied to connect the PC to the interface box or to the battery pack.

Figure 8 PC to interface box RS232 data cable

A 9-pin D-type connector interfaces with the serial communications port on the PC. A 3-pin bayonet connector then fits to either the interface box Data port or the battery pack Data port.

A USB-serial adaptor is also supplied in case no serial port is available on the PC. If this adaptor is used, the accompanying driver should be loaded before it is used: see the Cavity Profiler – VS software and operations manual for details.

Figure 9 USB-serial adaptor

If using the optional Wi-Fi box, data communications occur wirelessly, so the data cable is not required.

4.4 Battery pack

The Void Scanner requires a 12 Vdc power source to operate. A dedicated 12 Vdc battery pack is supplied with the system. The sealed lead acid battery pack is rated to 7 Ah, and will allow continuous operation for up to six hours before recharging, depending upon the type of operations conducted.

Figure 10 Battery pack and battery pack charger

The battery pack is supplied with two bayonet connectors: one with three pins and one with four pins. The 4-pin connector is labelled **Power/Scanner**. This will accept the main Void Scanner cable which runs from the Void Scanner probe. It is also the port to which the mains battery charger is attached when recharging the battery. The 3-pin connector is labelled **Data**. This will accept the supplied serial data cable which runs from the PC.

When the battery pack is used to operate the Void Scanner, the interface box is not required.

Figure 11 Power and data connection when using the battery pack instead of the interface box

A separate battery charger is supplied, which plugs directly into the mains and connects to the battery pack through the 4-pin Power/Scanner connection. A fully discharged battery requires around 8 to 12 hours to fully recharge from the mains supply. The battery charger is supplied with a selection of plug types to fit mains sockets around the world. An LED on the charger will show an amber light while charging and a green light when the battery is fully charged.

All batteries contain highly reactive, poisonous and corrosive chemicals, which are hazardous if released due to physical damage. Should the battery or battery charger approach end-of-life, become non-functional or damaged, stop using it and procure a replacement unit from a Carlson-approved source.

4.5 Alternative external power connections

As well as the supplied battery pack, the Void Scanner may be powered from any 12 Vdc battery using the blue cable supplied. This cable incorporates two crocodile clips with which to connect to the positive (red) and negative (black) terminals of the battery.

A mains power supply unit (PSU) is also supplied which is rated for use at 110 Vac – 240 Vac. A standard 'kettle' cable connects the PSU to the mains socket.

Both the dc and mains cables are supplied with 6-pin connectors that connect to the Power port on the interface box.

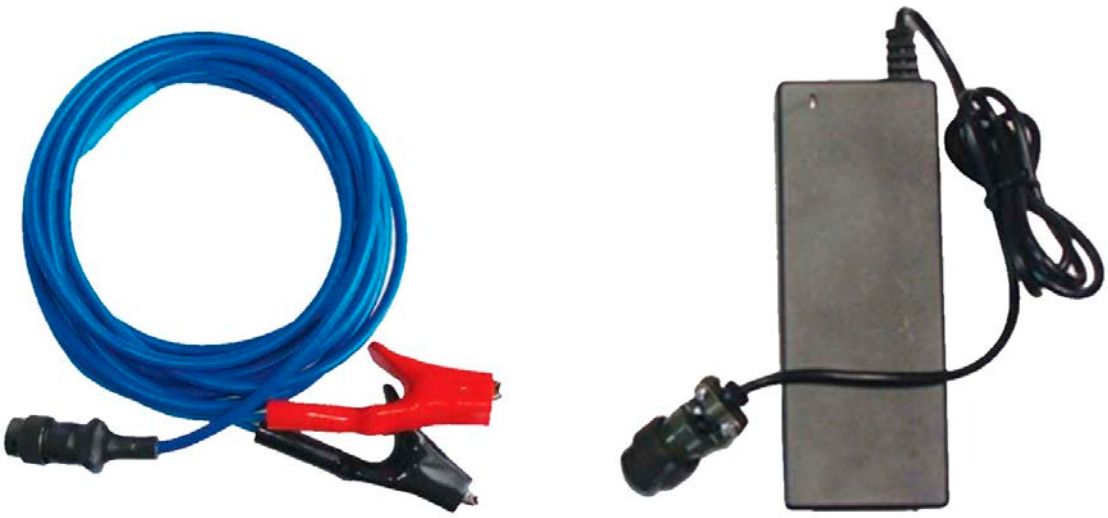


Figure 12 Blue dc power cable and black mains cable

Any voltage source connected to the Void Scanner and/or any accessory must be from a regulated supply, and must be within the specified voltage range. This includes car batteries as an acceptable stand-alone power source but does not include a car battery connected to a powered vehicle, or a dc power generator.

4.6 Main Void Scanner cable

The Void Scanner is supplied with a 13.6 m toughened power/data cable. The cable incorporates a right-angled 6-pin bayonet connector which attaches to the Void Scanner probe.

At the other end of the cable is a 4-pin bayonet connector which attaches to the interface box, the battery pack, or

the Wi-Fi box, depending on how the unit is being used.

Figure 13 Main cable

4.7 Boom adaptor and spigot

A boom adaptor is supplied to allow the Void Scanner probe to be deployed on various platforms, e.g. a boom or standard survey tripod. The boom adaptor is in two parts: the main bracket and a separate cylindrical spigot.

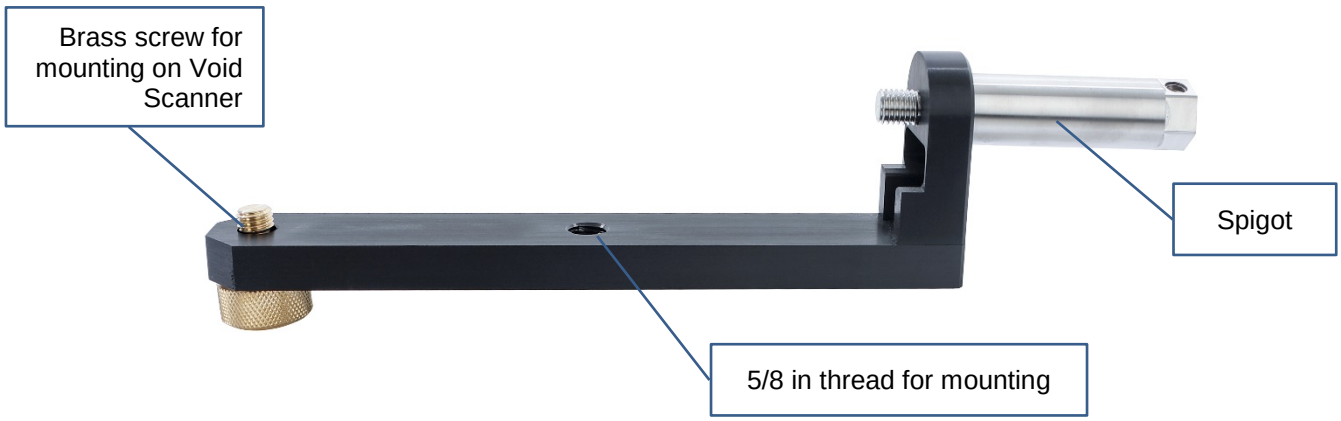


Figure 14 Boom adaptor and spigot

The main bracket incorporates a brass screw which connects to the 5/8 in thread on the underside of the Void Scanner probe. The accompanying spigot screws into the back of the boom adaptor and then into the 5/8 in thread on the base of the Void Scanner horizontal housing.

To attach the boom adaptor to the Void Scanner probe, locate the probe on the bracket and screw the spigot into the 5/8 in thread located on the base of the probe. Then screw the single brass screw on the bracket into the 5/8 in thread on the underside of the probe.

The boom adaptor itself has a single standard 5/8 in female thread to enable the probe to be mounted horizontally on a survey tripod or boom.

The spigot can be used to mount the Void Scanner on a number of third-party booms and customised deployment devices.

4.8 Prisms

The Void Scanner 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 a 5/8 in thread at one end and an M6 × 1 thread on the other end. These match with a 5/8 in thread on the collar of the probe and an M6 thread on the end of the horizontal housing.

A surveyor can target the prism on the Void Scanner to establish the position of the unit. A second prism may be attached to the far end of the deployment boom. Shooting to both prisms will then give the azimuth of the deployment. Functionality in Cavity Profiler – VS software can assist with these calculations.

The position where the prism is mounted on the Void Scanner is configured in Cavity Profiler – VS software to ensure the coordinates of the instrument are correctly calculated. The origin of all angle and range information from the unit is a position in the centre of the vertical axis of rotation inside the laser module.

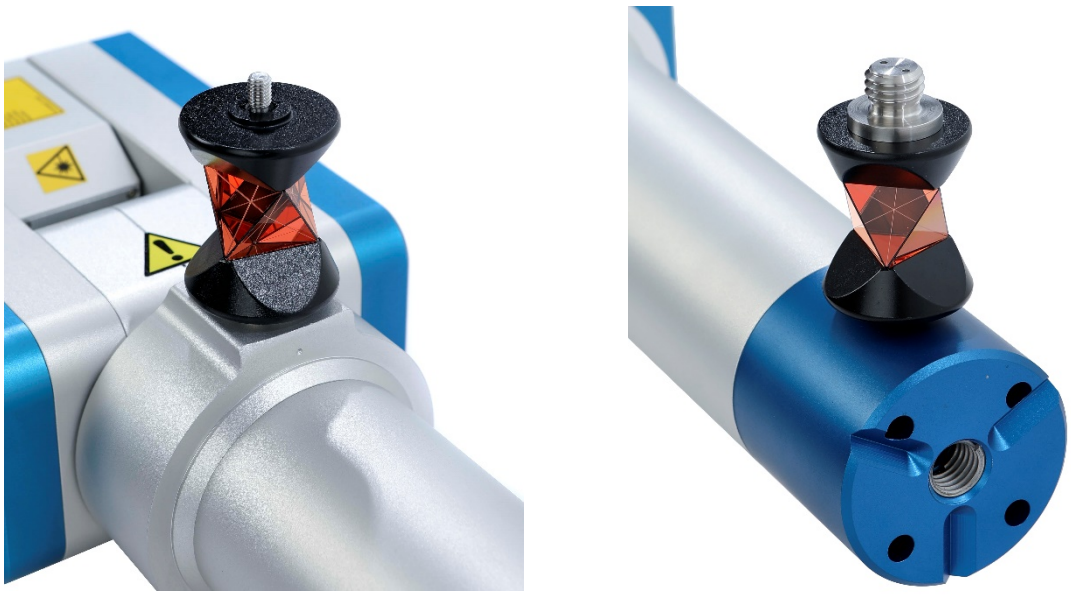


Figure 15 The 360° prism mounted on different locations on the Void Scanner

4.9 Transit case

The Void Scanner 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. It is recommended that the transit case be used at all times when transporting and storing the equipment.

Take care to dry the Void Scanner probe and accessories before packing them into the transit case.

Figure 16 System transit case

4.10 Void Scanner Wi-Fi box

The Void Scanner Wi-Fi box is an optional accessory that houses a rechargeable battery and wireless module. The Void Scanner Wi-Fi box negates the need for a separate battery pack, power cable, data cable and interface box.

The Void Scanner Wi-Fi box can be used to allow personnel to retreat further from the scanner. The unit may also be attached to the probe boom that is extended into the unsafe area, or placed on an unmanned vehicle that is remotely driven into the unsafe area. You can be situated in a safe area nearby, receiving scan data wirelessly, directly to your laptop.

The Void Scanner Wi-Fi box connects to the Void Scanner probe via the standard 13.6 m power/data cable, or via the 1.5 m power/data cable supplied with the box. Connection to the PC is then via wireless data communications.

A separate Void Scanner Wi-Fi box manual is available which contains set-up and operational instructions together with full hardware specifications.

Figure 17 Void Scanner with Wi-Fi box

4.11 Booms and deployment devices

The Void Scanner is designed to be deployed on a boom for surveys of stopes and inaccessible areas. Carlson can offer a standard boom as an optional accessory with the unit. Alternatively, 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 boom adaptor may be required.

Figure 18 Void Scanner mounted on a boom

Due to the wide range of possible ways of deploying the Void Scanner, this manual does not describe any method of attachment in detail. For further advice and information, contact your local Carlson-approved service and support centre.

If you wish to design your own customized deployment device, the relevant drawings and dimensions of the probe and the boom adaptor are reproduced below.

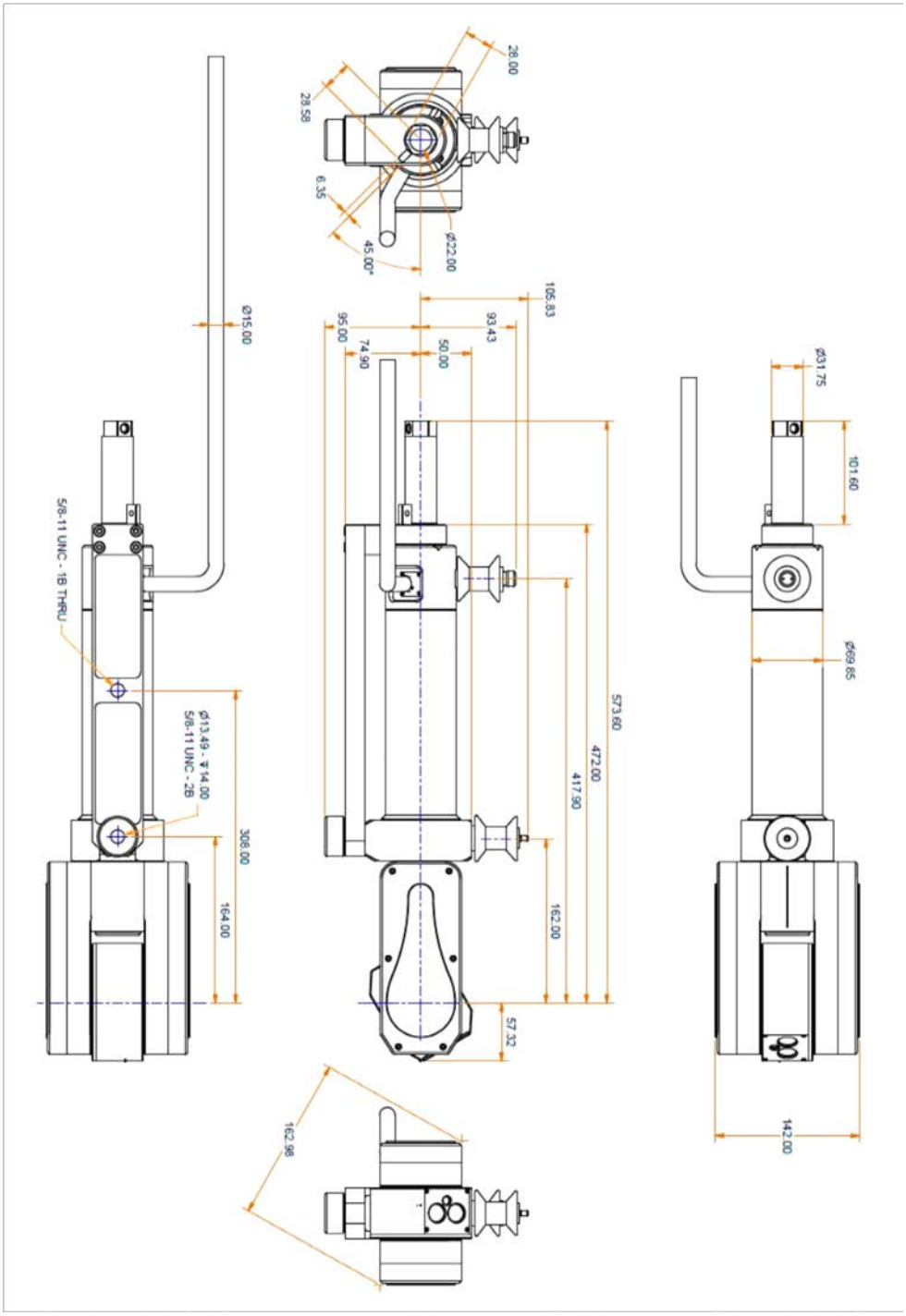


Figure 19 Void Scanner probe and boom adaptor dimensions

5 Maintenance and care of the Void Scanner

5.1 General

Attempts to dismantle or repair the Void Scanner 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, 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 Void Scanner 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 Void Scanner software and operations manual. For other issues, contact Carlson or a local Carlson representative for further assistance.

5.2 In use

Avoid directing the Void Scanner 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 Void Scanner from the boom or tripod and carry the two items separately.

The supplied battery pack will benefit 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.

5.3 Cleaning the Void Scanner

Always ensure that the Void Scanner 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 Void Scanner in water. The Void Scanner 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 Void Scanner 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 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 Void Scanner. 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 Void Scanner 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.

5.4 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 Void Scanner 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.

6 Cavity Profiler – VS software

The control and processing software for the Void Scanner is known as Cavity Profiler – VS. Cavity Profiler – VS enables the Void Scanner to be controlled remotely during field operations. It allows real-time viewing of collected data, analysis and editing of all datasets, the integration of further scans and the exporting of data to third-party packages.

Full details of the software, together with basic operation guidelines, are outlined in the accompanying Cavity Profiler – VS software and operations manual.

7 Void Scanner Specifications

Laser module		
Laser classification BS EN 60825-1:2007 (21 CFR 1040.10 and 1040.11 except for deviations pursuant to Laser No. 50, dated 24 June 2007)		Class 2M*
Infrared laser module		
Type		InGaAs laser diode
Wavelength (typ)		905 nm
Maximum energy per pulse		1.06 µJ
Beam divergence		2.76 × 1.5 mrads
Resolution		1 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 (typ)		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		0.02°
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°
Construction		
Probe		Machined aluminium and stainless steel
Environmental		
IP degree of protection (probe)***		IP68 (pressure rated to 30 bar, equivalent to 300 m water depth)
Operating temperature		−10 °C to +45 °C
Storage temperature		−20 °C to +70 °C

Physical	Weight	Dimensions
Probe (including batteries)	3.2 kg	710 mm × 40 mm (L × Dia)
Rods (individual)	400 g	1000 mm × 30 mm (L × Dia)
PDA (including batteries)	280 g	155 mm × 83 mm × 24 mm (L × W × D)
Power		
External power input	10 Vdc to 15 Vdc and 110 Vac to 240 Vac	
Power consumption during scan	9.6 W (typically)	

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

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

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

8 Product information

Trademarks

CARLSON and the symbol used in the CARLSON logo are registered trademarks of Carlson in the United Kingdom and other countries. 'Breaking new ground' and names and designations of other Carlson products and technologies are trademarks of Carlson or its subsidiaries.

All other brand names and product names used in this document are trade names, trademarks, or registered trademarks of their respective owners.

Changes to Carlson products

Carlson reserves the right to improve, change or modify its products and documentation without incurring any obligation to make changes to equipment previously sold or distributed.

Carlson has made considerable efforts to ensure the content of this document is correct at the date of publication but makes no warranties or representations regarding the contact. Carlson excludes liability, howsoever arising, for any inaccuracies in the document.

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 Void Scanner 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 Quarryman Pro 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 Rodded Boretrak 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 Void Scanner 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.