

### **USERS MANUAL**

### **SCPT-GS2 GEOTECH NOVA**

(Seismic Cone Penetration Testing, 2 Sensor Sets)

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### **1** General Information

#### 1.1 Foreword

This manual contains important information for the proper use and safe operation of seismic add-on equipment to the CPT GEOTECH NOVA System.

Read the manual carefully before you start operating the system. Also read the maintenance instructions before performing any maintenance work. The warranty from Ingenjörsfirman Geotech AB (Geotech) is only valid if the instructions in this manual are followed.

Always keep the manual at the equipment and replace it immediately if it should become wholly or partially unusable. A new copy can always be ordered from Ingenjörsfirman Geotech AB.

#### 1.1.1 Content

The information in this publication is based on information that was available at the time that the publication was written.

The information can change at any time. Geotech reserves the right to change or update the content of the manual without prior notice.

### 1.2 Safety

The operator must be alert to potential hazards. The operator should also have the necessary training, skills, and tools to perform these functions properly.

The important safety messages in this manual are presented as follows:



Indicates a hazardous situation which, if not avoided, will result in death or serious injury.



Indicates a hazardous situation which, if not avoided, could result in death or serious injury.



Indicates a hazardous situation which, if not avoided could result in minor or moderate injury.

This warning identifies important messages in this manual, e.g. information on risk for costly damage. Carefully read the message and inform your colleagues.

### **2 Product Information**

#### 2.1 General Description

Seismic tests are primarily carried out to measure wave velocities in soil. The SCPT method combines the shear wave (S wave) speed information from the seismic test with results from the CPTU probe and will give you a good basis for evaluation of several critical soil properties, e.g., the risk for liquefaction.

The SCPT-GS2 GEOTECH NOVA adapter is equipped with two sets of very sensitive 3-axial seismic sensors that are mounted with a fixed distance from each other (normally 1 meter). Data processing takes place in the down-hole seismic adapter. The data is transferred to the surface equipment on digital form, without test results being affected by noise or cable properties. The well-defined distance between sensors and down-hole analogue/digital conversion gives high accuracy and repeatability.

Please refer to separate literature for detailed information on scientific background and evaluation methods.

GEOTECH NOVA is a modularly designed product family for user-friendly, robust, and accurate CPT, CPTU, Seismic CPT (SCPT), Electric Conductivity CPT and Vane Test soil investigations. This manual concentrates on seismic features. Please refer to separate documents for descriptions of CPT/CPTU, Electric Conductivity CPT and Vane Testing.

The SCPT down-hole assembly typically comprises a CPTU probe, and a seismic adapter mounted on a standard CPT rod. The CPTU probe gives accurate measurements of cone resistance (Qc), sleeve friction (fs) and pore pressure (u). Options for sintered pore pressure filters in u1 and u2 positions as well as slot filters are available.



## Fig. 1 – The CPT NOVA probes are designed for use on land as well as offshore and give accurate measurements of cone resistance (Qc), sleeve friction (fs) and pore pressure (u) (figure shows pore pressure filter in standard position "u2"). In addition, there is a built-in inclinometer.

The seismic wave is normally generated at the ground surface or at subsea applications on the seabed. A modified sledgehammer and a metallic plate form a simple and reliable wave source for use on land:



Fig. 2 – Wave source for use on land based on a modified sledgehammer.

The seismic add-on adapter is to be connected immediately behind the CPT probe. The standard adapter is intended for use together with "NOVA Probe".



### Fig. 3 – The SCPT-GS2 seismic adapter has two sets of 3-axial seismic sensors mounted on 1 m fixed distance. You typically connect it behind the CPT NOVA CPTU probe.

The trigger signal is generated when the hammer is hit against the steel plate. The seismic signal is captured by the two sensor arrays of the seismic adapter, pre-processed, and transferred to the SeismicLog software in the logging computer via the down-hole cable and the SCPT-GS2 interface ("Seismic Box").

After processing in the probe, CPTU data are passed on to the CPT interface, which also receives depth information, from a depth encoder. The CPT software in the logging computer communicates with the CPT probe via the CPT interface and a separate cable. Data are presented simultaneously on the computer screen as graphs and numbers.

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Fig. 4 – Typical system design for a GEOTECH SCPT system. The seismic signal is captured in the SCPT adapter that communicates with the computer via the "Seismic box" (SCPT box) and a USB cable. CPTU data from the probe is passed on to the CPT interface where it is combined with depth encoder input. The CPT interface communicates with your computer via a separate cable.

The seismic system can be delivered as add- on equipment to your existing CPT system or together with CPTU equipment as a complete turn-key plug-and-play package.



Fig. 5 – The SCPT-GS2 add-on system with modified hammer and two "S wave" bottom plates ready for final test before delivery. Refer to separate manual for information on the basic CPTU system (not on picture).

#### 2.2 Intended use

GEOTECH CPT and SCPT-GS2 equipment is designed for geotechnical site investigations and may only be used for this purpose. All other use is prohibited.



### 2.3 System components overview

Item No.	Item	Illustration	Description
		In the hole equipment:	
See sepa- rate man- ual	Probe CPT NOVA	Lec J	Electronic probe for test- ing soil properties ac- cording to the CPT and CPTU methods. Measures soil data while being pushed through the ground, e.g. point re- sistance (qc), sleeve fric- tion (fs) and pore water pressure (u). Diameter 36 mm.
102397	SCPT-GS2 NOVA Seismic Adapter		<ul> <li>The seismic adapter comprises parts below:</li> <li>Bottom part (Adp1) with one set of 3-ax- ial seismic sensors that connects to Probe CPT NOVA,</li> <li>Distance pipe (Adp2)</li> <li>Internal cable GS2.</li> <li>Top part (Adp3) with one set of 3-axial seismic sensors and permanently mounted cable adapter.</li> </ul>
Included in 102397	SCPT-GS2 NOVA Adp1		Bottom part of seismic adapter with one set of 3- axial seismic sensors. Diameter 36 mm.
Included in 102397	SCPT-GS2 NOVA Adp2		Middle part (distance pipe) of seismic adapter GS2 for 1 meter between sets of seismic sensors. Diameter 36 mm.
Included in 102397	Cable GS2 internal		Cable inside middle part of seismic adapter GS2 connecting top and bot- tom part of seismic adapter.
Included in 102397	SCPT-GS2 NOVA Adp3 with permanently mounted cable adapter	G	Top part of seismic adapter GS2 with one set of 3-axial seismic sen- sors and permanently mounted cable adapter. Conical standard CPT thread.

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Item No.	Item	Illustration	Description
102094	Down-hole cable		Cable, from probe adapter. Green, diameter 10.5 mm. 0.093kg/m. CE conformity according to Low Voltage Directive LVD 2006/95/EC. RoHS.
		Seismic wave generation:	
10504	Hammer with electric trigger function.	A	Hammer with electric trig- ger function. Connector for trigger signal to Seis- mic box. Clamp for earth connection of bottom plate.
10503	Bottom plate, S		Bottom plate for genera- tion of share wave (S wave).
200288	Ground cable for second bot- tom plate.		Ground cable for second bottom plate.
		SCPT surface equipment:	
30027	SCPT-GS2 Interface		"Seismic Box". Connec- tions for trigger pulse, ca- ble from probe/adapter, and connection for CPTU data to CPT Interface. USB cable for connection to computer included.
10850	Cable, acquisition box – in- terface		Cable for connection of the Seismic box to the CPT-interface.
		SCPT data acquisition and	
30028	SeismicLog Software	Medium for software delivery may change without notice	Software for SCPT-GS2. Right to use by named customer on one com- puter, licensed by owner of all rights Ingenjörsfir- man Geotech AB.

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Item No.	Item	Illustration	Description
		Transport case	
200866	Transport case GS2		Sturdy case for transport and storage of the equip- ment. Dimensions:85x44x16cm

The GEOTECH NOVA product range is being continuously developed and improved. We therefore reserve the right to changes of the information above.

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#### 2.4 In the hole equipment

#### 2.4.1 SCPT-GS2 NOVA Seismic Adapter



Fig. 6 – The SCPT-GS2 Seismic adapter consists of several parts and is to be mounted between the CPT probe and the rod. The top part is on the picture attached to the cable adapter for connection to the down-hole cable for power supply and signal transmission.

The SCPT-GS2 GEOTECH NOVA Seismic Adapter is to be mounted between the CPTU probe and the pushing rod. It comprises two sets of seismic 3-axial seismic sensors. Due to the current mechanical design, this first version is not suitable for P wave detection. The distance between the sensor positions is normally 1 meter, but other distance pipes can be produced to customer's specification. S-wave speed measurement is very accurate due to well-defined distance between sensors and accurate electronics. Due to its length, the seismic adapter is delivered in several parts:

- Bottom part (Adp1) with one set of 3-axial seismic sensors that connects to Probe CPT NOVA.
- Distance pipe (Adp2).
- Internal cable GS2.
- Top part (Adp3) with one set of 3-axial seismic sensors. The permanently mounted cable adapter is to be connected to the down-hole cable and 36 mm rod with conical standard CPT thread.



Fig. 7 – SCPT-GS2 NOVA probe assembly. The seismic sensor sets are located inside the SCPT-GS2 adapter (2), 1 m fixed distance apart. Note that the permanently mounted cable adapter is not shown on picture above. Refer to separate document for description of the CPTU probe (1).



Fig. 8 – SCPT-GS2 NOVA Adp1. Bottom part of seismic adapter with one set of 3-axial seismic sensors to be connected to "probe NOVA". Diameter 36 mm.



Fig. 9 – SCPT-GS2 NOVA Adp2 and internal cable. This middle part (distance pipe) of seismic adapter GS2 will give you 1 meter fixed distance between the two sets of seismic sensors. Diameter 36 mm. The cable inside the middle part of seismic adapter GS2 connects top and bottom part of the seismic adapter.

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Fig. 10 –The top part of the seismic adapter comprises one set of 3-axial seismic sensors. The cable adapter is permanently attached to the top part of the seismic adapter. It is to be mounted on a standard 36 mm CPT rod and connected to the down-hole cable.

#### 2.5 Data collection equipment

#### 2.5.1 SCPT-GS2 Interface "Seismic Box"



Fig. 11 – Connection of cables to the SCPT-GS2 Interface. Note that the old "Seismic Box" is not compatible with the GS2 version (upgrade is possible).

#### 2.5.2 CPT Interface cable

Note that the cable between the SCPT-GS2 Interface and the CPT Interface must have internal connection to all pins (some "microphone cables" might not be fully connected). The signals from the CPTU probe are passed on to the CPT interface without processing in the "Seismic box". Old interfaces might need to be upgraded.

<u> </u>	
CPT Inter-	Function
face con-	
nector pins	
Α	Power +12V
В	Signal
С	-
D	Ground
E	Reserved
F	-

#### 2.5.3 Trigger cable (hammer)

The trigger input is normally open. A trigger pulse (closing) from the hammer will initiate the SCPT test.

Trigger con- nector pins	Function	
А	Trigger upon grounding	
В	Ground	





#### 2.5.4 SeismicLog Software





#### Fig. 13 – SeismicLog Software. Medium for software delivery is subject to change without notice.

The SCPT-GS2 down-hole equipment and the SCPT-GS2 interface interact with the SeismicLog Software, installed on your logging computer. The software has functions for setting up the system, performing tests and presenting test results. For details, please refer to separate manual.

The software is licensed to the named customer with right to use on one computer by owner of all rights Ingenjörsfirman Geotech AB.

#### 2.6 Wave generation

#### 2.6.1 Sledgehammer

The hammer has one cable for connection to the SCPT-GS2 Interface and one cable with a clamp for grounding in the bottom plate.



Fig. 14 – Wave source for use on land based on a modified sledgehammer. Connections to SCPT-GS2 Interface and for grounding in bottom plate.

#### 2.6.2 Bottom plate "S wave"

Target and grounding clamp surfaces should be cleaned from possible paint, rust and dirt.



Fig. 15 – Bottom plate for S wave.

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### 3 Preparations

Please refer to the "Installation" chapter below and separate software manual for information about setting up the equipment. Note that details may change depending on soil conditions, applicable standards, and end customer demands. Refer to separate manual for setting up the CPTU functionality.

Prepare and saturate the CPTU probe according to separate manual.

#### 3.1 Cable from probe/cable adapter

The connection between the adapter and cable demands caution. Make sure that connectors fit to each other properly before tightening. Before the other end of the cable is connected to the SCPT-GS2 Interface, the LEMO adapter should be mounted on the connector.



Fig. 16 – The connection between the cable and the seismic adapter: Make sure that connectors fit to each other properly before tightening.



Fig. 17 – Before the cable is connected to the SCPT-GS2 Interface, the LEMO adapter should be mounted on the connector.

#### 3.2 Assembly of adapter and probe

Assemble the SCPT-GS2 adapter and the CPTU probe. For best performance check that the seismic sensors are aligned:

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Fig. 18 – The red dot inside the bottom part and the mark on the top part indicate the "x" direction of the seismic sensor arrays.

#### 3.3 Preparations for shear wave testing (S wave)

Apply two bottom plates as indicated in the illustration below and press them firmly into the ground, e.g., under the wheels, tracks or foot of the site investigation rig or vehicle. The plates are equipped with transversal "teeth" to improve the contact with the ground. Do not to apply the plates too close to the rod string (recommended 1 to 3 m).

Sledgehammer blows parallel with the ground surface will give polarised shear waves. If you want to apply two oppositely polarised S waves, the sledgehammer blows should be directed towards the rod string from two opposite points, at the same distance from the rod. Typically, it would be from both sides of the drill mast.

Try to isolate the rod string from the parts of rig or vehicle affected by sledgehammer blows.

In order to provide a repeatable source for seismic attenuation analysis, you might like to use a hydraulic or pneumatic piston, or a sledgehammer swinging around a fixed point.



Fig. 19 – SCPT-GS2 Acquisition Setup.

### 4 Performing a test

Start the SeismicLog software and pre-set the acquisition parameters as described in the SeismicLog software manual.



Start the CPT logging software. After having read the zeroes of the CPTU channels, start the CPTU test as described in separate manuals.

Stop the penetration at desired depth and perform dissipation test if required.

Thereafter:

Go into PAUSE (see CPT logging software manual). To reduce noise, you are recommended to turn off the engine of the penetrometer or drill rig. In addition, try to isolate the rod string from the drill rig or penetrometer.

Perform settings and activate the software as described in the software manual.

Press "Start" and the system is ready to collect data.

Hit bottom plate with the sledgehammer or activate the remotely controlled wave source. At the same level perform S-Wave test (horizontal strokes) from left and right.

Directly after the acquisition is finished the graph will be displayed in the graph window.

Repeat until you are satisfied and save.

Go back to the CPT logging software, press Start and resume the CPTU test.

Do the next seismic test in the same way as described above.

At the end of the test, go into PAUSE mode with the CPT logging software, pull back the rods and read the zeroes of the channels of the CPTU probe.

For details on software handling, please refer to separate software manuals.

### 5 After test

#### 5.1 Immediate actions

Wipe dry the equipment and store it in a controlled environment with low humidity between jobs.

- 1. Clean and wipe dry the probe assembly directly after test and before disassembling.
- 2. Disassemble the probe from the adapter. Inspect the O-ring for damages and confirm that the internal parts of the joint are dry. If any water should be detected, the equipment must not be used until the root-cause has been identified and eliminated, all parts of the equipment are completely dry, and the functionality has been tested.
- 3. If necessary, clean the internal threads of the adapter. Dirty or corroded threads might cause voltage drop affecting the functionality of the system.



Make sure that the equipment is clean and dry after each shift.

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### 6 Installation and system maintenance

#### 6.1 Installation

#### 6.1.1 Hardware installation

The standard system is delivered with dedicated cables for connection of the different system components. Hence the electrical installation is normally a simple plug-and-play operation. Please refer to product information above.

#### Cable between Seismic Box and CPT Interface

Note that the cable between the Seismic Box and the CPT Interface must have internal connection to all pins (some "Microphone cables" might not be fully connected).



Fig. 20 – Block diagram for connection of a complete SCPT system.

#### Cable to SCPT-GS2 adapter

Connect the cable to the SCPT-GS2 cable adapter, thread the cable through the rod segments and connect it to the Seismic Box, using the cable adapter. Prepare the CPTU probe according to instructions in separate manual. Mount the SCPT-GS2 NOVA adapter on the cable adapter and the CPTU probe.

#### Trigger cable

Connect the sledgehammer cable to the SCPT-GS2 Interface and the grounding cable to the bottom plate, using the crocodile clamp. Make sure to remove paint and/or rust for best electrical contact between plate and clamp. You may use the additional grounding cable to connect a second bottom plate.

#### USB cable

Connect the USB cable to the SCPT-GS2 Interface and the computer.

Prepare CPT interface, depth encoder and other CPTU parts as described in the Geotech CPTU manual.



#### 6.1.2 Software installation

Normally the system is delivered without logging computer. Standard Windows PC is to be sourced locally by the customer. Please refer to separate software manual for installation instructions. Note that separate drivers might be required.

#### 6.2 Authorized Workshops

For support, calibration and repair please contact:

Ingenjörsfirman Geotech AB Datavägen 53 SE- 436 32 Askim SWEDEN

info@geotech.se +46 31 289920

For customs reasons, please declare **serial number** of probes etcetera when sending equipment for service.

#### 6.3 Trouble Shooting

The trouble shooting table below is not complete, nor subject to any quality assurance, and thus published as indication only. Please feel free to revert with additional questions and suggestions.

Issue:	Possible causes/ Trouble shooting:	Actions:
	<u> </u>	
No reaction upon hammer stroke.	Seismic box broken?	Disconnect the trigger cable from the Seismic box. Prepare a jumper wire and test by manually short-circuiting pins A and B.
	No trigger signal received by Interface?	Check cable from sledgehammer and grounding to bottom plate. Make sure that polarity is correct if repair should be necessary.
	Down-hole cable damaged?	Test by connecting SCPT-GS2 adapter directly to the Seismic box.
No signal from SCPT-GS2 adapter.	SCPT-GS2 adapter or cable from probe assembly dam- aged?	Test by connecting SCPT-GS2 adapter directly to the Seismic box.
No test results from CPT probe (q <sub>c</sub> , f <sub>s</sub> , u).	Cable mode not set in CPT logging software.	Select "Cable mode" in CPT logging software "Probe Characteristics".
	Poor connection between Seismic box and CPT Inter- face?	Make sure that you are using the right cable type, that it is undamaged and properly connected.
	Probe assembly or cable from probe assembly damaged?	Test by connecting SCPT-GS2 adapter with CPT probe directly to the Seismic box.

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### Notes



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