

GeoCubeTM

Thermal Conductivity Test Equipment

TM

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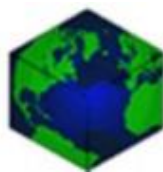


GeoCube w/Optional Anodized Housing and Waterproof Data Logger



The GeoCube in Field Operation

User's Manual for GC3 Model GeoCubeTM



**Precision
Geothermal**

www.precisiongeothermal.com

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GC3 model - GeoCube™ User's Guide

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GeoCube™ User's Manual
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Visit our Web site at <https://www.precisiongeothermal.com>

Commercial Versions Available

Ordering Information:

To order, complete the code number below with the information and call Precision Geothermal at (763) 479-3638 - or - email: sales@precisiongeothermal.com

GC3 - - -

Base Unit Includes:

Aluminum case
Multi-Channel data logger

Depth Capacity:*

500 = 500 ft/150 m depth (7,500 W)
850 = 850 ft/260 m depth (13,000 W)
999 = 1,100 ft/335 m depth (17,500 W)

Piping Connection:

1 = 1" Female Cam-Lock Adaptor
2 = (Option 1) with 3/4" Barbed connection
3 = (Option 1) with 1" Barbed connection
4 = (Option 1) with 1 1/4" Barbed connection
5 = C-Kit** (Add \$100)

Power Requirement:

1 = 240VAC / 60Hz* 2 = 240VAC / 50Hz
3 = 230VAC / 60Hz 4 = 230VAC / 50Hz
5 = 220VAC / 60Hz 6 = 220VAC / 50Hz

Removable Extension Cord:

1 = Yes (available on 500 ft model only)
0 = No

Number of RTD's:

2 = Standard Logger - two sensors
4 = Standard Logger - four sensors (redundancy)
5 = Advanced Logger - four sensors (redundancy)

Conductivity Test Tool Kit:

1 = Yes; 0 = No

H-Valve Purging Assembly:

1 = Yes; 0 = No

Data Logger Configuration:

1 = Standard Data Logger (Base Configuration)
2 = Advanced Waterproof Data Logger

Chassis Finish:

1 = Standard Aluminum Finish
2 = Durable Anodized Aluminum Finish

Booster Pump Option:

1 = Yes; 0 = No

* Standard power ratings stated for 60Hz@240 VAC. Heating Elements adjusted for regional power standard values. Please specify your local power standards.

** C-Kit includes adapters for 3/4", 1" and 1 1/4" pipe with quick coupling connectors for easy use.

Statement of Warranty Policy

PRECISION GEOTHERMAL, LLC., (“PRECISION”), hereby provides to the original purchaser (“**Purchaser**”) of the equipment set forth in the agreement between PRECISION and Purchaser (the “**Equipment**”) the following warranty (the “**Warranty**”). **The Warranty is the sole and exclusive warranty provided by PRECISION relating to the Equipment and any and all parts thereof and contains the sole and exclusive obligation and liability of PRECISION relating in any way to the Equipment and/or any part thereof. Except as provided in the Warranty, PRECISION makes no other warranties, express or implied, and PRECISION specifically disclaims all other express and implied warranties, including, without limitation, the implied warranty of merchantability and the implied warranty of fitness for particular purpose and any warranty relating to infringement or the like.**

WARRANTY

Subject to the other terms and conditions contained in this Warranty, PRECISION warrants to Purchaser that the Equipment and parts thereof will be free from defects in material and workmanship (except minor defects in parts valued individually at \$200.00 or less) for a period of one (1) year after the date of delivery of the Equipment to Purchaser (the “**Warranty Period**”). To be valid, any Warranty claim must (1) be made in writing to PRECISION at 5115 Industrial Street, Maple Plain, Minnesota 55359, (2) set forth the Warranty claim in detail, (3) be received by PRECISION no later than the end of the Warranty Period, and (4) include submission to PRECISION of completed Warranty Activation Checklist prior to initial use of Equipment, and any Warranty claim that fails to meet all the above requirements shall be null and void and of no force or effect. No person or entity, other than Purchaser, shall have the benefit of the Warranty and the Warranty may not be assigned to any other person or entity (whether by operation of law or otherwise) without the written consent of PRECISION and any such assignment shall be null and void and of no force or effect.

NOTICE AND PROCESSING OF WARRANTY CLAIM

PRECISION reserves the right to inspect the Equipment and parts thereof to determine the validity of the Warranty claim and if determined to be valid solely by PRECISION, PRECISION will, at its option, repair or replace the Equipment or parts thereof subject to the valid Warranty claim. **PRECISION’s obligation under this Warranty shall be limited solely and exclusively to repair or replace the Equipment or parts thereof (at PRECISION’s option) and PRECISION shall have no other liability or obligation of any kind.** PRECISION shall repair or replace the Equipment or parts thereof only at PRECISION’s facility in Maple Plain, Minnesota or at any other location directed by PRECISION. Purchaser shall pay all costs relating to the transportation of the Equipment and any part thereof.

Any repair or replacement of the Equipment or parts thereof to any location other than PRECISION's facility in Maple Plain, Minnesota shall be subject to PRECISION's then current charges for off-site Warranty claims which may include, without limitation, all cost of travel and housing of individuals performing the repair or replacement. If Purchaser requests repair or replacement work to be performed outside of the hours of 7:00 a.m. to 4:00 p.m., Maple Plain time, Monday through Friday (excluding PRECISION holidays), then Purchaser shall pay PRECISION's then current charges for overtime Warranty work. Any repair or replacement of the Equipment or any part thereof will continue to be warranted under this Warranty only for the remainder of the Warranty Period.

WARRANTY EXCLUSIONS

Notwithstanding the foregoing, the following are not covered by and are excluded from the Warranty and, as such, PRECISION provides no warranty, express or implied, with respect to the following (the applicability of each shall be determined solely by PRECISION):

1. Components of the Equipment and/or any parts not manufactured by PRECISION ("**Third-Party Parts**") which may include, but not be limited to, data loggers, heating elements, various sensors, circulating pump, switches and other electrical components. If any Third-Party Parts are warranted to PRECISION by the person or entity who manufactured such Third-Party Parts and if PRECISION is permitted by the terms of such warranty to assign such warranty to Purchaser, then PRECISION shall assign such warranty to Purchaser. Purchaser acknowledges and agrees that PRECISION shall be under no obligation to negotiate with or obtain the permission of the manufacturer of the Third-Party Parts to the assignment of such warranty to Purchaser and PRECISION's sole obligation shall be to assign (if assignable by its terms) any such warranty relating to such Third-Party Parts to Purchaser. In the event Purchaser has the benefit of any warranty on Third Party Parts, Purchaser agrees to make any and all warranty claims with respect to the Third-Party Parts directly with the manufacturer thereof (and copy PRECISION) and PRECISION shall have no obligation to assist in such claim or provide any such warranty.

2. Components of the Equipment and/or any parts that are not part of PRECISION's standard design or are supplied pursuant to Purchaser's special requirements.

3. Equipment and/or any part thereof which is subject to wear and tear or consumed by the normal operation or use thereof including, but not limited to, heating elements, circulating pump, and batteries.

4. Any defect in any Equipment and/or any part thereof which arises from the failure of Purchaser to properly maintain and service the Equipment and/or any part thereof.

6. Equipment and/or any part thereof which has been subject to improper use and/or misuse, neglect, abuse, negligent repair or failure to provide reasonable and necessary maintenance, or accident.

7. Equipment and/or any part thereof which has been in contact with corrosive chemicals or corrosive materials.

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PREFACE

Before You Begin

*Note: All new GeoCube customers **MUST** review the warranty and perform the bench testing procedure described in it before continuing. Failure to do so will void the warranty.*

This section describes the typical uses and users of the GeoCube. It also provides a technical description of the GeoCube and what is included with the product. The chapter concludes with a review of important safety considerations prior to using the GeoCube.

Photos and Illustrations in this Manual

The GC3 Model GeoCube™ is available with standard or waterproof model data loggers. Functionally, there are small differences in the interface but the operation is similar. The standard data logger is removable and transportable. The waterproof data logger is permanently mounted to the lid of the GeoCube. We may illustrate one version or the other but the considerations for operations are essentially the same for both versions of data logger.

Introduction: Typical Uses and Users

The GeoCube™ is a durable, portable, safety-enhanced and user-friendly soil thermal conductivity/response test unit for vertical and horizontal ground loop heat exchangers. The unit includes a comprehensive data analysis software suite that enables users to calculate conductivity, estimate diffusivity and share professional, color reports with coworkers and clients. The GeoCube is designed for use by professional geothermal HVAC designers, contractors and engineers that need a quality in-house conductivity and testing capability.

The outer casing of the GeoCube, constructed of high-grade aluminum, offers significant protection from physical and cosmetic field-use wear and tear. The exterior walls and internal dividers are encased in CF-25 insulation, minimizing environmental thermal interference. Interior components provide for great usage flexibility. The unit, capable of generating up to 17,500W of heating power, will test borings up to 1,100 ft / 335 m deep. The HDPE standing column continually purges air from the test loop. The GC3 series GeoCube features a stainless-steel manifold; accessible pressure relief valve and externally serviceable heating elements.

The unit is designed specifically to enable more geothermal professionals to perform more conductivity tests in a wide variety of conditions and at a lower per-test cost. By providing these benefits, the GeoCube can assist in enhancing the overall accuracy of a broad range of geothermal designs.

Technical Overview

This section lists the GC3 Series - GeoCube technical specifications.

Technical Specifications

- 24 in x 24 in x 24 in / 0.61 m x 0.61 m x 0.61 m Exterior Dimensions
- 1 in / 25.4 cm Interior Copper Piping
- Stainless Steel heat exchangers
- HDPE Standing Column
- 1/6 HP Circulation Pump
- 50/60 Hz; 220/230/240 VAC
- Locking Aluminum Case
- CF-25 Insulation on Exterior Walls and Internal Dividers
- 17,500W Maximum Heating Power (varies per model)
- Externally replaceable heating elements
- Data Logger
- Voltage, Amperage, Temperature and Flow Sensors
- ~150-180 lbs / 68-81 kg base shipping weight

GeoCube Kit Contents

The GeoCube comes with a variety of accessories. Please confirm your GeoCube includes the following:

- GeoCube test unit (500ft/150m; 850ft/260m; 1,100ft/335m depth maximum)
- Onset Data Logger

- Micro USB Cable for Data Logger
- HoboWare Pro Software and Manual for data collection
- Onset Limited Warranty
- Software License Dongle/Key for Thermal Conductivity Analysis Module of Ground Loop Design™ program for data analysis and reporting
- Multi Section User Manual and Documentation

Optional Equipment:

- Redundant temperature sensors
- Waterproof Data Logger
- Conductivity Test Tool Kit - includes the essential tools for performing TC tests (hose hook-ups, filtered funnels, grounding lug tools, etc)
- C-Kit (pipe adapter assembly)
- H Valve (purging assembly)
- Booster Pump for high flow requirements
- GLD Premier software - for full loopfield design.
- Removable Extension Cord for Hassle Free Transport (500 ft model, only)
- Visit www.precisiongeothermal.com for other useful equipment.

Safety

IMPORTANT. READ THIS SAFETY INFORMATION PRIOR TO USING THE GEOCUBE FOR THE FIRST TIME. ALSO, WATCH THE TRAINING VIDEO PRIOR TO FIRST TIME USE. THE TRAINING VIDEO CONTAINS IMPORTANT SAFETY INFORMATION.

Thermal conductivity tests have inherent risks associated with them. These risks include but are not limited to the risks of electrocution and physical injury to people and objects. This section describes important safety precautions that GeoCube users should follow while using the GeoCube.

A thermal conductivity test utilizes high voltage/high amperage industrial power generation and testing equipment and therefore requires maximum consideration of safety before, during and after the test. Users should take similar precautions to those taken when working with other high voltage equipment. At a minimum, users must properly ground the GeoCube and the generator prior to use.

The GeoCube is constructed primarily of aluminum and rigid copper and weighs approximately ~150 - 180 lbs / 68 – 81 kg. If improperly moved, stored or handled, the unit has the potential to cause physical injury, death or damage. Users must use

proper handling, lifting, and storage techniques when working with the GeoCube to reduce the risk of physical injury and/or damage.

The GeoCube includes a number of advanced safety features to reduce the probability and severity of the aforementioned (as well as other potential) risks. These safety features include:

- Grounding: The GeoCube includes an external grounding cable attachment lug for fast and easy grounding prior to use. Note that the unit must be grounded prior to use to ensure safety.
- Thermal Overload Protection: The GeoCube includes an electromechanical switch that de-energizes the unit if the circulating solution temperature exceeds ~130⁰F/55⁰C. This feature protects interior electrical components.
- Water Resistant Unit Controls: Water resistant controls reduce the risk of water entering the electrical system, a situation that could lead to short circuits and other hazardous electrical conditions.
- Water Resistant Casing: Water resistant casing reduces the risk of water entering the electrical system, a situation that could lead to short circuits and other hazardous electrical conditions.
- Electrical Overload Protection: All electrical circuits are fused for overload protection.
- Intrusion Detection: Upon accessing the core internal piping and plumbing area of the GeoCube, the electricity de-energizes so that there is no live electricity within the piping and plumbing area. Note that this area is off-limits to end users and accessing this area automatically voids any and all warranties.
- Durable, Tamper Resistant Case: A locking case protects the unit from tampering. The case's aluminum construction protects the overall unit integrity. The single latch locking mechanism prevents unwarranted access during testing.
- Safety Labelling: Included warning and precaution labels remind users and bystanders to maintain adequate safety measures when using or interacting with the GeoCube.
- Booster Pump with Detachable Cord: The optional booster pump may be detached and uses a covered connection that is controlled by the GeoCube.
- Optional Detachable Extension Power Cord: An optional detachable extension power cord for units up to 500 ft / 150 m reduces the risk of physical damage to users and equipment.

WARNINGS

Unit is rated for a maximum voltage of 240V. Exceeding 240V could permanently damage internal components.

Use two separate grounding lugs for the grounding rod- one for GeoCube and one for generator.

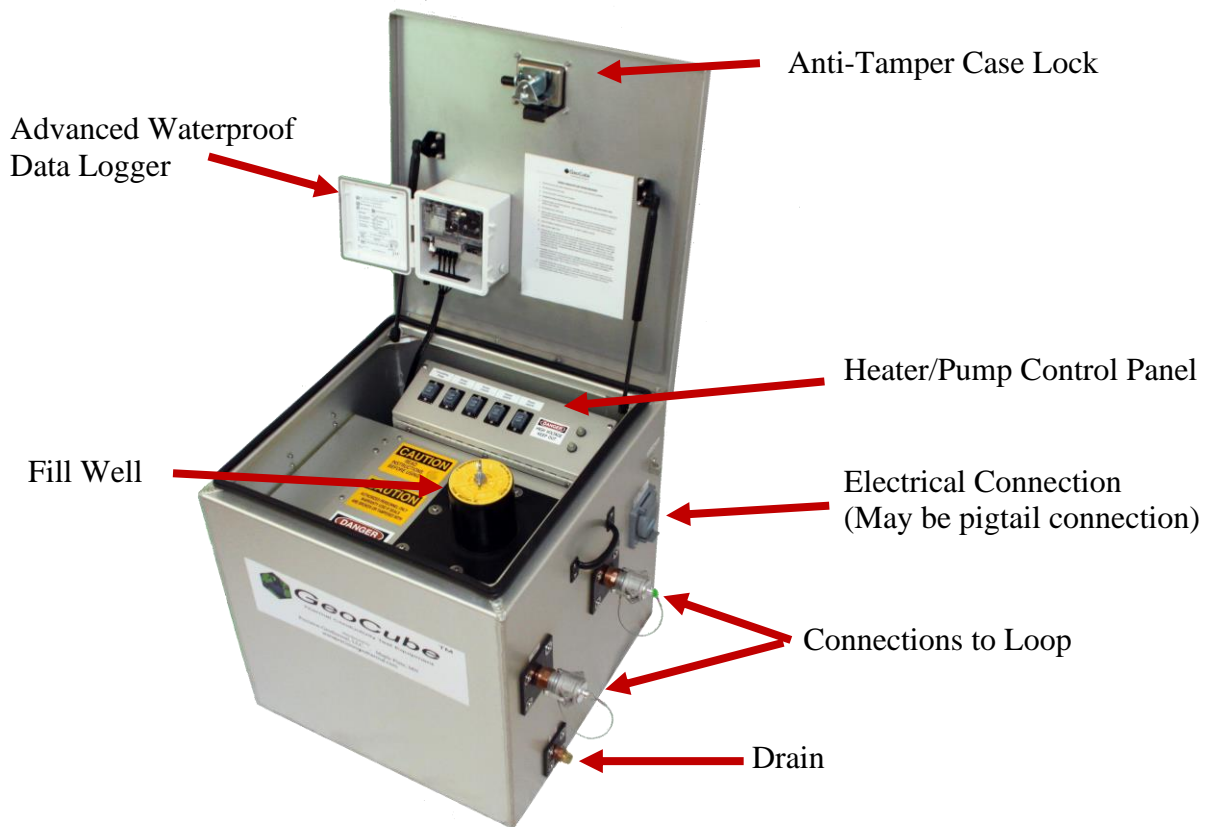
THE GEOCUBE OPERATES UNDER HIGH VOLTAGE AND IMPROPER USAGE CAN RESULT IN DAMAGE, INJURY OR DEATH. IN NO EVENT WILL PRECISION GEOTHERMAL, LLC OR ITS SUPPLIERS BE LIABLE FOR ANY LOST REVENUE, PROFIT, OR DATA, OR FOR SPECIAL, INDIRECT, CONSEQUENTIAL, INCIDENTAL, OR PUNITIVE DAMAGES HOWEVER CAUSED AND REGARDLESS OF THE THEORY OF LIABILITY ARISING OUT OF THE USE OF OR INABILITY TO USE THE GEOCUBE EVEN IF PRECISION GEOTHERMAL, LLC, OR ITS SUPPLIERS HAVE BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.

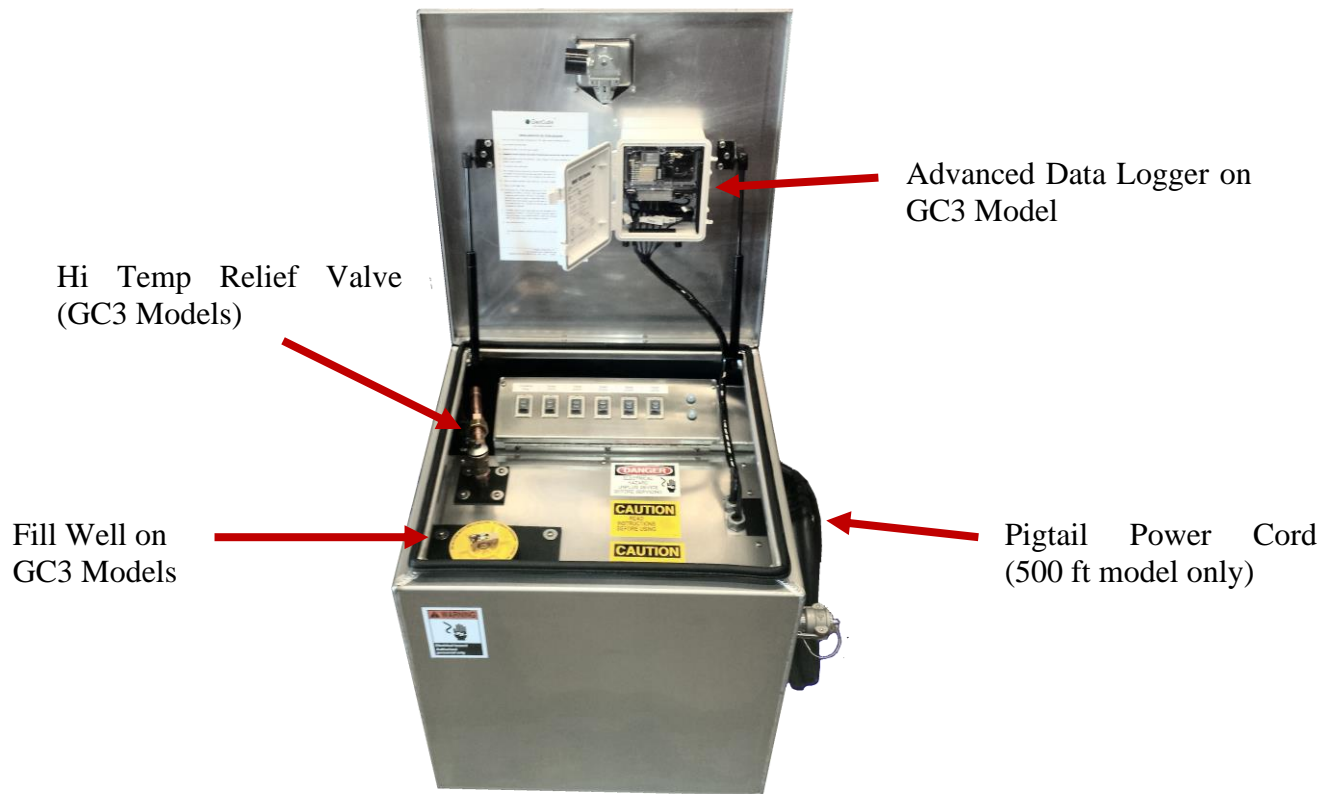
CHAPTER 1

Your GeoCube

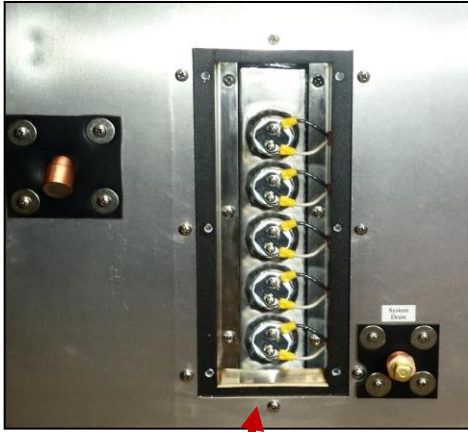
Congratulations, the GeoCube™ is the industry-leading TC/TRT testing unit designed to be used by contractors, drillers, engineers and professionals in the Geothermal HVAC industry. The GeoCube features all of the tools that you will need to correctly analyze and generate reports for the conductivity characteristics of your geothermal project site.

While there are many configurations of GeoCube, they all feature some elements in common. Below are some photos with descriptions of the features. These photos cover some of the major models. Note: Your GeoCube may have slightly different appearance depending on when it was made and which options were ordered when the unit was produced. Your unit may have a mix of the features shown in the photos:





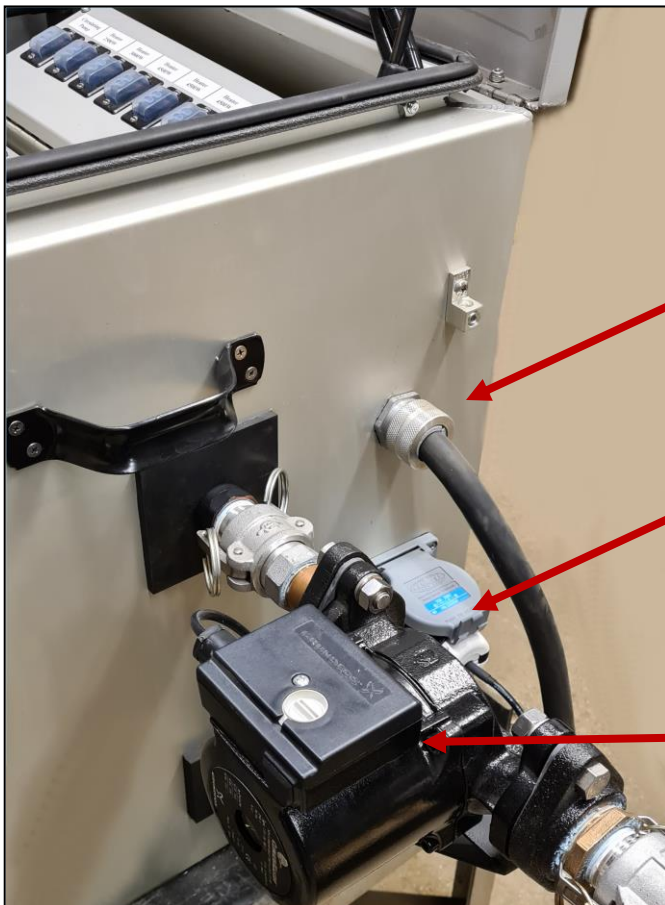
CHAPTER 1 – Your GeoCube



Exposed Access Panel for Heaters on GC3 Model



Time/Electrical Convenience Meter
(NOT for data acquisition!!)



Main GeoCube
Power Cord

Detachable Booster
Pump connection

Optional
Booster Pump

The Convenience Meter

The convenience meter was introduced by user request as a way to easily look at the status of test after it has been started and verified by computer. It is **NOT** part of the logging system and does **NOT** record data. You can use it for tracking the time and general operation of the generator and test. **NEVER** use the convenience meter as a substitute for actually checking the logger status!!

The convenience meter is a handy tool for monitoring the ongoing test and can measure Voltage, Amperage, Wattage, Timed Power (KWh), Elapsed or cumulative operating time.



Figure 23. Control Panel with Convenience Meter

The convenience meter is a handy tool for monitoring the ongoing test and can measure Voltage, Amperage, Wattage, Timed Power (KWh), Elapsed or cumulative operating time.



Voltage: Reads voltage input from the generator to the GeoCube. Range displayed is from 80.00 ~ 264.00VAC



Current: Reads current flow to the GeoCube. Range displayed is from 0 ~ 100.00A.



Timed Power: Displays cumulative power from 0 to 9,999.99 kWh.



Power: Displays the present power load from 0 ~22,000 W.



Time: Displays running or cumulative time from last reset. Range displayed is 0 ~9,999:59 hours



Buttons: Used to switch between modes and to reset the accumulated data

Up Button: In normal operation, Time, Current, Total Power, Power, Voltage, will be displayed by short presses to move between readings.

Down Button: Similar to the Up Button, but will move in reverse order. Up and Down Buttons will rotate fully between all items and repeat the sequence.

Set Button: During the cumulative power or time display, pressing the set button for (3) seconds will reset the convenience meter to zero.

OK Button: In regular operation, a short press will turn the backlight on or off.

Remember, this convenience meter is in NO WAY connected to the logging function and is to be used for convenience only. If the meter is never reset, it will record the total operating time of the GeoCube under power. While the meter is protected inside the closed lid, it should be protected from unnecessary moisture, rain, and etc. The meter will function with input frequencies of 45~65 Hz so should be suitable for all generators.

The First TC Test

This chapter describes how to perform your first thermal conductivity test with the GeoCube. The chapter follows a step-by-step format. It starts with a “before your first test” section, continues with the set-up and testing procedure and concludes with the take down procedure.

Before the First Test

PRIOR to bringing the GeoCube out to the test site for the first conductivity test, there are several preliminary steps that must be taken to ensure that the test runs smoothly and to ensure that your warranty is active. *Note that the results of this initial system check need to be recorded on the Warranty Activation Checklist (included in your sales contract) and submitted to Precision Geothermal, LLC prior to the first test to ensure that the Warranty is not voided. The below instructions are identical to those in the warranty.*

Initial System Check

Upon receipt of your Equipment, it is essential that you perform several preliminary steps to ensure that the Equipment is completely functional and was not damaged in transit. Contact PRECISION immediately if you encounter any problems during this procedure. Failure to follow this procedure prior to first use will void the Warranty of your Equipment.

Software Installation and Logger Communications Check

Install the HoboWare Pro software on your PC if you have not done so already. This software either came on a CD with the GeoCube or was downloaded. Information about installation can be found at www.onsetcomp.com. At the same time, download the Ground Loop Design (GLD) Premier Edition software from the following website:
https://www.groundloopdesign.com/GLDs_commercial_download_request.html.

You will need to fill out the form on the webpage and then hit the "Submit" button to initiate the download. After you have finished installing both the HoboWare Pro software and the GLD software, please continue with the following steps:

1. Attach the Data Logger directly to the PC via a serial port cable. If your PC does not have a serial port, use the included serial port-to-USB cable to facilitate the transfer. If you need to use the included serial port-to-USB cable, you will need to first install the drivers so that your computer can use the serial port-to-USB cable. These drivers can be found on a CD that came with your serial port-to-USB adaptor. If you are using the serial port-to-USB cable, it will look something like this:

(Standard datalogger (left), Waterproof model (right) uses USB cable)

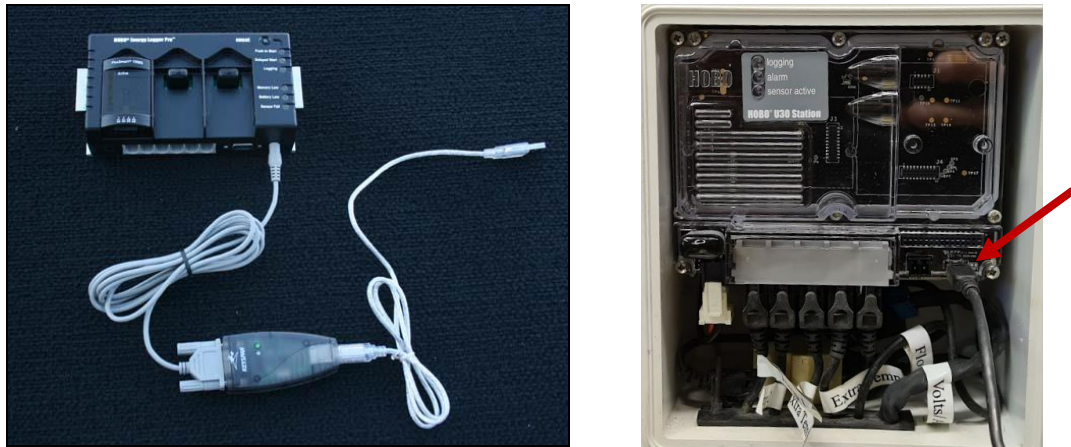


Figure 1: The standard Data Logger Attaches to the Computer Via a Serial Cable and a Serial-to-USB Cable. The Waterproof Datalogger uses a mini USB Cable

2. With the Data Logger attached to the PC, run the HoboWare Pro software.
3. Launch the Data Logger by pushing the Launch Device button as seen in Figure 2 below or with the Hoboware application on the computer.

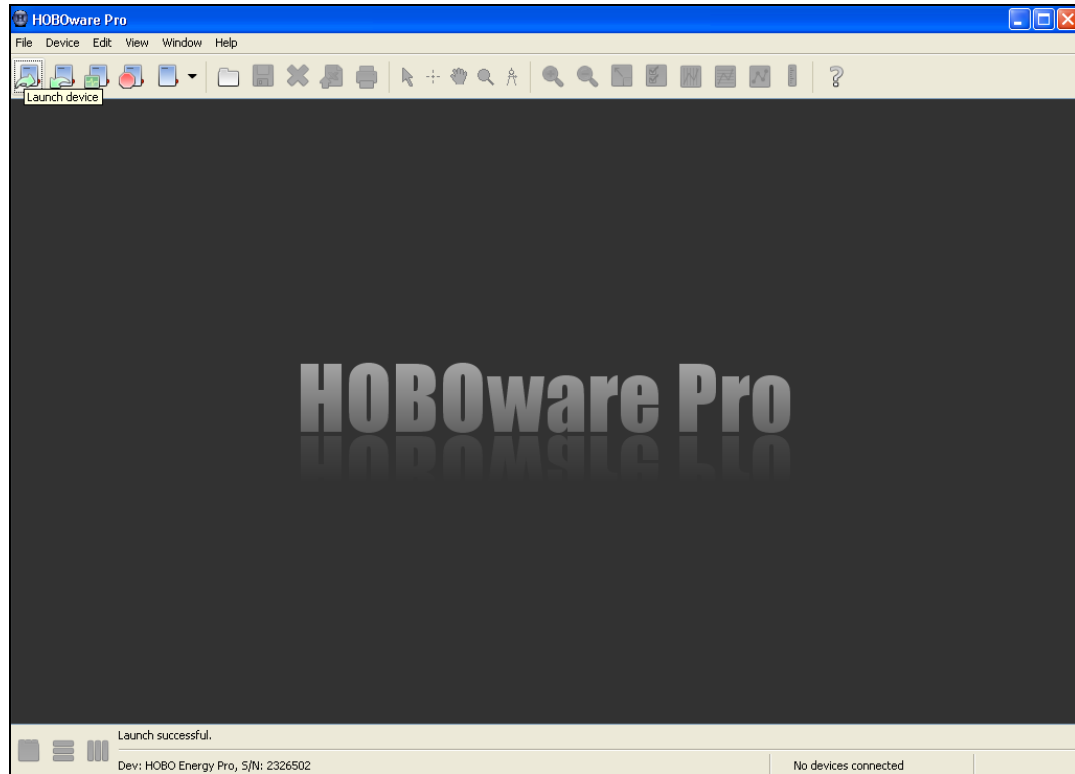


Figure 2. Launching the Data Logger by Pushing the Launch Device Button

4. After a few seconds, the software will recognize the Data Logger as seen in Figure 3 below. Select the Data Logger and hit 'OK'.

If you do not see HOBO Energy Pro, please go to the 'File' dropdown menu at the top of the program. A menu with several options will drop down. Please select "Preferences" at the bottom of the list. A new window will open. In that window, select 'Communications' and then find a "Serial Ports" button. Hit the 'Serial Ports' button and then you will see a list of communications ports. Hit the "Select All" option and then hit "OK". Close the Preferences window and try launching the logger again as we did in step 2 above. If you do not see your Hobo Energy Pro as it appears in Figure 3 below, you will need to close the HoboWare Software and then re-launch it. The waterproof U30 Data Logger uses a USB connection and does not require serial port selection.

If you continue to have problems getting your Data Logger to connect to your computer, please call Onset directly at 1-800-564-4377 and ask for tech support.

NOTE: Data Logger Software from Onset may change as updates are introduced and some of the images shown here may not exactly match your screen. The labelling should be easy to identify, regardless of the software version.

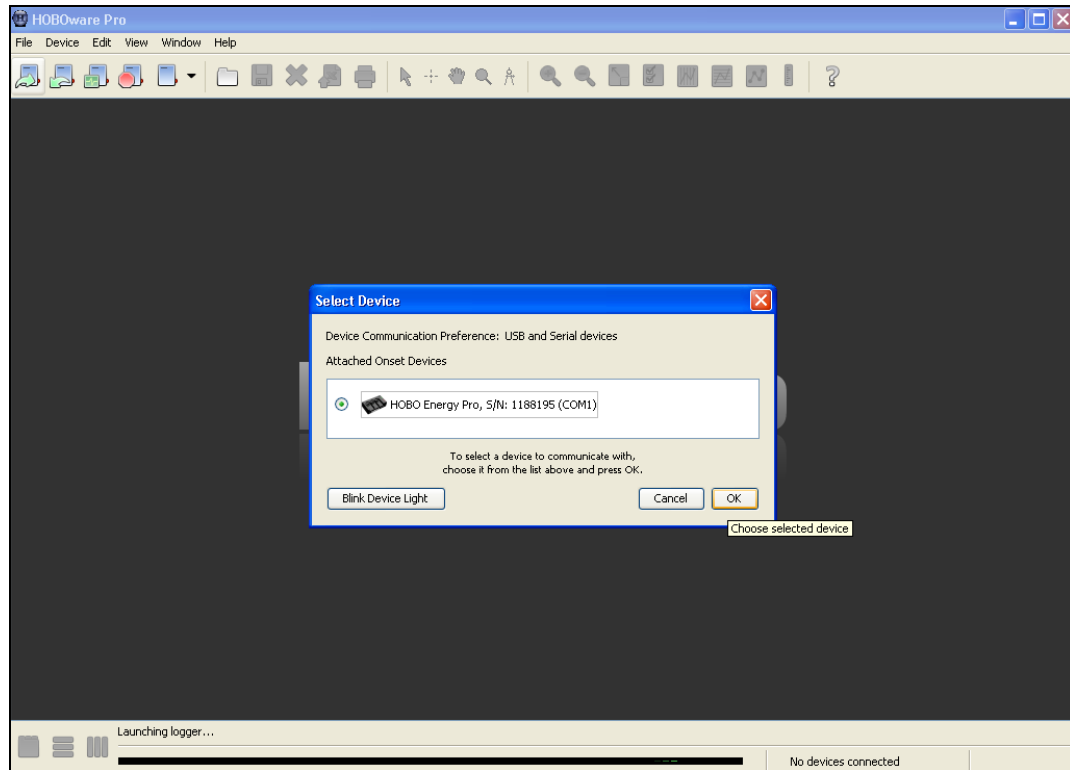


Figure 3. Selecting the Data Logger

5. A Data Logger Launch window will open up as seen in Figure 4 below. Adjust the logging interval to 20 seconds. *For test purposes, 20 seconds is sufficient. Your actual test will need the interval to be set to 2 minutes. Don't forget to change it to 2 minutes when the initial bench check is complete.* In the launch options box (the big white box at the bottom of Figure 4), confirm that the "Trigger: Push Logger Button" is selected. Doing so confirms that data logging starts only after you push the start button (explained later in the user manual). Push the "Launch" button at the bottom of the window after doing so.

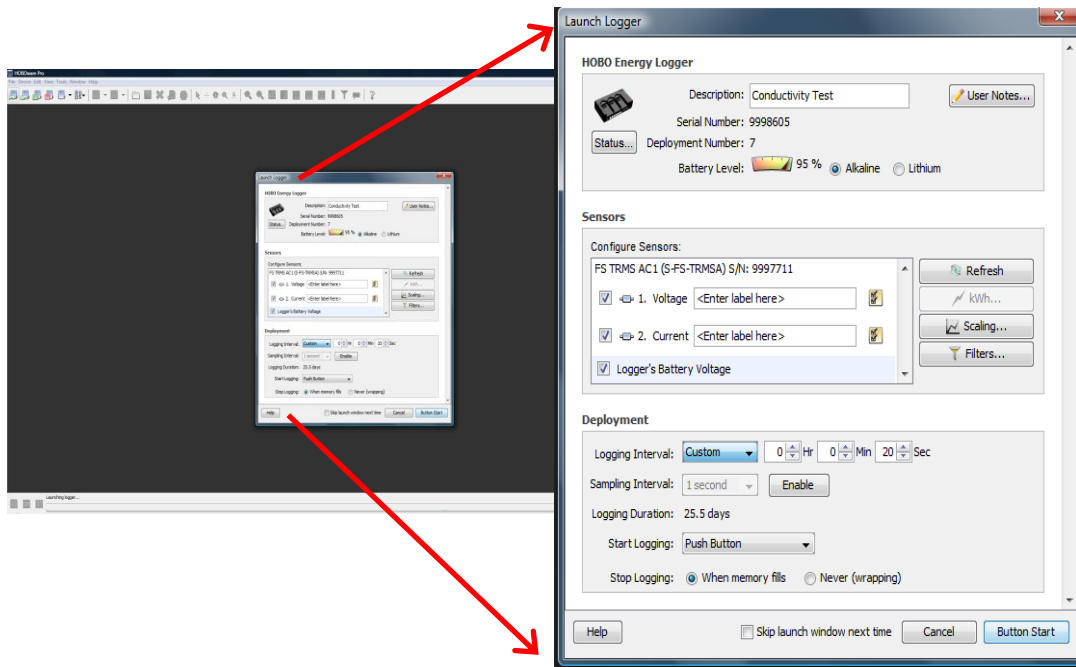


Figure 4. Adjusting the Logging Interval

6. After you hit the 'Launch' button, the Data Logger will be configured with the new logging interval as seen in Figure 5.

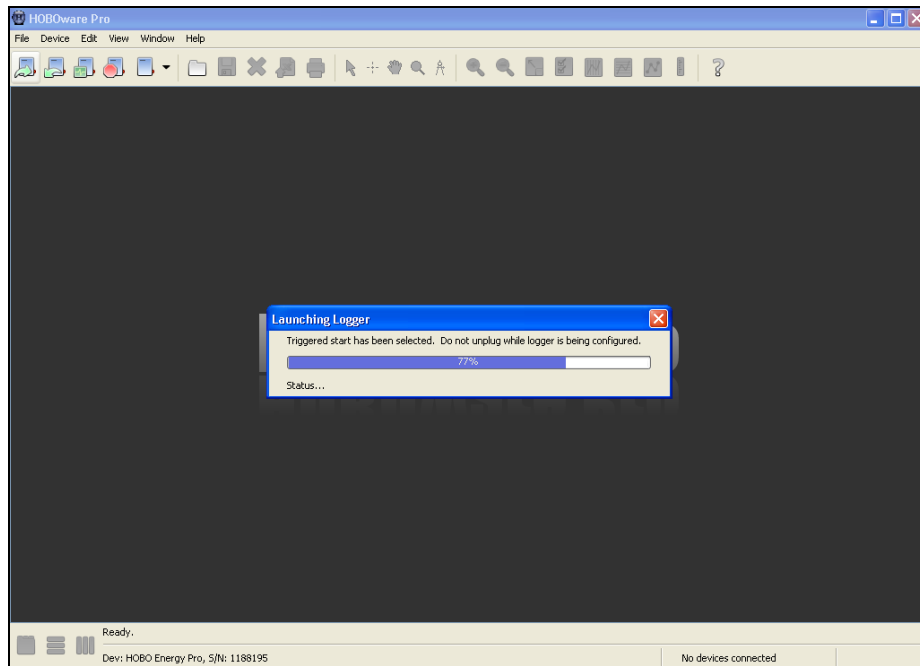


Figure 5. Configuring the Data Logger with the New Logging Interval

7. When the configuration is complete, it is safe to detach the data logger from the PC, or you may leave it connected to observe until you confirm everything is running correctly. The data logger should now have a green blinking light next to the "Push to Start" label on the logger. Confirm that the light is blinking and then proceed with the pump check.

Pump Check

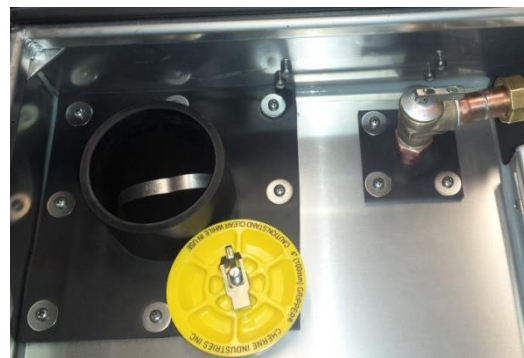
Pump Check

Check the circulation pump to make sure that it turns on and runs properly.

1. Attach the inlet and outlets together with a 1 inch / 25.4 cm diameter and approximately 2 ft / 0.61 m long jumper hose. (Create short closed loop)
2. Remove the standing column plug and add approximately one to three gallons of water (model dependent) into the GeoCube via the standing column. It is recommended that you use a filtered funnel when adding the water to avoid spilling fluids in the GeoCube control panel area. Wipe any spillage immediately. The open standing column can be seen in Figure 6.



Base GeoCube Example



Extended Capacity GeoCube Example
Showing fluid filter in well and pressure relief valve

Figure 6. Remove the standing column plug, open pressure relief valve (on applicable models) and then add water. Filters in the standing column may be left in place during this step.

3. To minimize the chance of splashing, place the plug loosely on top of standing column.
4. Plug the GeoCube into a stable power supply with a minimum voltage of 208V. **It is OK to use shore power for the unit pre-test.** Note: DO NOT use shore

power for an actual TC test! You must use a well-regulated generator of 1.5-2x the GeoCube power rating to meet the minimum power stability requirements.

5. To purge air from system, run the pump for a few seconds by flipping the pump switch on and off. The pressure relief valve in the GC3 GeoCube may be momentarily opened to clear any air trapped in the heat exchanger manifold.
6. Add more water to the standing column and repeat step 5 until water level is maintained approximately 2 in to 3 in / 50 cm to 75 cm below cap.
7. Once all air has been purged, allow circulation pump to circulate throughout the Heating Element Check below.

Heating Element Check

Next, check each heating element to confirm that each is working properly. To perform this test quickly and accurately, the Data Logger default measurement time interval (two minutes) needs to be changed to twenty seconds (we did this already in Step 5 of the Software Installation and Logger Communications Check section above). **For this heating element check, the 20 second time interval is critical because with the minimal water volume used in the test, the water heats up very quickly and can result in automatic safety shutdown (~120°F / 49°C). Note that under normal testing conditions, the interval should be set to 2 minutes. This 20 second interval is used only for the bench testing.**

Please follow this procedure to check the heating elements:

1. Put the Data Logger into the GeoCube and attach the sensor leads. See Figure 7A.



USB Data
Port for
Computer
connection.

Figures 7A. Attaching Sensor Leads to the Data Logger

2. Attach the Data Logger to a computer. (Use the appropriate serial or USB cables, depending on the Data Logger version – waterproof or standard data logger.

3. Turn the Data Logger on by pushing the 'Push To Start' button on the Data Logger or in the HoboWare application. You should now see a green, blinking light next to the "Logging" Label or behind the plastic panel on the waterproof model.
4. Use the computer and HOBOWare software to make sure that all of the sensors are present and being monitored. The sample period will determine the frequency of how often the display is updated.
5. Activate the Pump by switching the pump switch from the off position to the on position as seen in Figure 9: (Optional Booster Pump controlled by main pump switch)

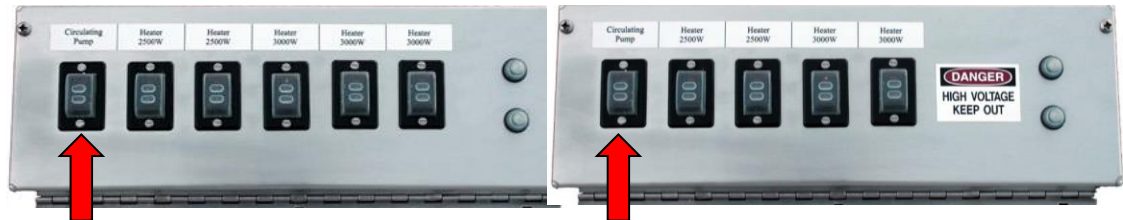


Figure 9. Turning on the pump (Control panel may vary)

6. Turn on the lowest wattage heating element (the switch immediately to the right of the pump switch) and monitor the current. Look for a greater than 5-amp draw. The exact amperage will depend on the voltage of the power supply but it should be greater than 5-amperage. All elements are rated at 240 volts; any voltage setting less than 240V will yield less wattage from each element. Since the Data Logger is set to record data every 20 seconds, data will be output every 20 seconds. The user needs to refresh screens to see the sensors again.
7. Turn off the first heating element and then turn on the second heating element. Monitor the current and voltage for 20 seconds and confirm the amperage is greater than 5-amperage.
8. Turn off the second heating element and then turn on the third heating element and repeat.
9. Turn off the third heating element and then turn on the fourth heating element and repeat.

10. On the computer, there is a section called "Counts". "Counts" refers to 1 gallon per logging interval. For example, since our logging interval is 20 seconds, you multiply the counts by three (3) to calculate the flow rate in gallons-per-minute. Note that during a TC test, the logging interval is two (2) minutes so that during a test, you divide the counts by two (2) to calculate gpm. Note: The software will work with English or Metric units.
11. If the unit shuts off during this test it is because the water reached too high of a temperature and the built-in safety mechanisms kicked in. In such a case, turn off and unplug the GeoCube, drain the water out of the GeoCube via the drain plug (which is located on the same side of the unit as the inlet and outlets), and then repeat the steps in the Pump Check section.
12. When the test is complete, confirm that all four heating elements are turned off, turn off the pump and drain the GeoCube.
13. The final step is to reset the Data Logger so that it records data at 2-minute intervals. Follow the procedure outlined above to do so.

Failure to set the Data Logger back to the 2 minute interval will result in post-test data analysis failure.

14. Remember to submit your Warranty Activation Checklist to PRECISION GEOTHERMAL.

Equipment and Tool Checks

Be sure to bring all of the appropriate tools and equipment that you need for your test. We recommend the Precision Geothermal TC Toolkit which is available at www.precisiongeothermal.com. Included with this kit is comprehensive documentation on conductivity tests developed from many years of experience.

Undisturbed Soil Temperature - Analysis Methods

Before performing a conductivity test that thermally alters the near field ground temperature, it is a good idea to determine the undisturbed ground temperature. For these methods to be accurate, the fluid filled pipe should sit undisturbed for at least 5 days or in accordance with ASHRAE guidelines. While there are many methods for doing so, some popular and straight-forward methods are as follows:

Method 1: Drop a temperature sensor into the loop pipe and take readings at 25-50 foot increments until maximum depth. The average temperature reading is a good approximation of the undisturbed soil temperature.

Method 2: After setting up the GeoCube, launch/start the logger and turn on the pump. **RUN THE PUMP FOR 10 MINUTES BEFORE TURNING ON ANY HEATERS.** The GeoCube sensors will record the temperature of the water that is mixed from the complete length of the loop and GeoCube. The mixed water temperature will be identified by the analysis software as the undisturbed temperature and will automatically calculate the undisturbed temperature. After this step is completed, the heaters may be turned on to continue the TC Test.



Figure 10. Inserting the Temperature Probe into the Standing Column

Method 3: After setting up the GeoCube, insert a probe into the standing column. Be sure to measure the temperature immediately after you start running the pump and **BEFORE** you turn on the heating elements. After the temperature stabilizes (normally takes only a few minutes), record the temperature. Note: *Typically, after 10-15 minutes, the heat from the circulation pump will begin heating up the water be sure to complete your undisturbed temperature analysis quickly.*

Set-Up and Testing Procedure

Establish Location

Place the GeoCube on stable, level ground. Be sure the GeoCube is close enough to the loop ends so that it is easy to attach the loop ends to the GeoCube.



Figure 11. Place the GeoCube on Stable Ground

Fill the U Tube with Water

If the U tube is not already filled with water, fill it. Please note that if you are filling the tube immediately before the test you will not be able to measure the undisturbed ground temperature via water temperature measurements since it may take several days for the water temperature to stabilize.

Connect Loop Ends to Unit with Hose Clamps or Cam Lock Connections

To facilitate purging, hook up inlet pipe first and fill GeoCube via the standing column until water exits the outlet port of the GeoCube. Once water is coming out of the outlet port, hook up outlet pipe to outlet port.



Figure 12. Attach the Loops to the Inlet/Outlets and Secure Them
(Your Unit/Connections May Look Different)

Insulate the Loops

It is essential to properly insulate the loops to minimize heat loss and maximum data accuracy. It is recommended that users insulate the exposed loop pipes with plumbing pipe wrap and duct tape. In extremely cold weather other measures may be necessary.



Figure 13. Insulate the Loops

Install the Ground Rod

The grounding rod is a critical safety feature. Users should co-locate the GeoCube and the generator grounds on the same grounding rod. General grounding rod recommendations suggest that the grounding rod should be driven in 3 to 4 feet / 1 to 1.5 meters below grade.

After the grounding rod is in place, connect the GeoCube to the grounding rod. To do so, first connect the grounding wire to the ground lug which can be found on the outside back of the GeoCube case. Connect the other end of the grounding wire to one of the grounding rod lugs on the grounding rod.

Connect the generator to the grounding rod in a similar fashion, being sure to use a second grounding lug on the grounding rod. *You will need two grounding lugs on the grounding rod: one for the GeoCube and one for the generator.*



Figure 14. Grounding the GeoCube and the Generator

Connect and Start the Generator

Connect the GeoCube to the generator and then start the generator. The generator should be set for 240 Volts or the voltage appropriate for your region. *Regardless of region, the maximum voltage is 240 Volts!*

- **NEVER exceed 240 Volts.**
- **Never drop below 208Volts.**



Figure 15. 240V Maximum Setting

Fill the Standing Column with Water

Now that the all of the attachments are in place, the standing column should be filled with water in anticipation of purging the air out of the system.

Remove the J plug from the standing column and add approximately 1-3 gallons of water into the column. Use a filtered funnel like the one available in the TC Toolkit to ensure that a) there is no spillage into the control panel area of the GeoCube and b) no debris gets into the standing column. Add enough water so that there is a 2 in to 3 in / 50 cm to 75 cm air gap at the top of the column.



Figure 16. Fill the Standing Column for a 2-3 in/ 50-75 cm Air Gap at the Top

Purge the Air Out of the Pipes

With the standing column cover off, intermittently turn the pump on and off by toggling the circulation pump switch on and off.



Figure 17. Toggle the Pump

Turning the pump on and off protects the pump from cavitating (the formation of unwanted air bubbles) and drylock. Toggle the pump on and off to evacuate any air trapped in the loop. Depending on the volume of air in the loop, it may take 15-20 minutes or longer to fully purge the system. Add water as necessary into the standing column to obtain a level 2-3 inch / 50-75 cm below the top of column. Use the pressure relief valve on GC3 models to purge the internal heater manifold.

When the purging process is complete, attach the standing column cap/J plug and tighten it. To ensure a tight fit, consider using pliers or other tools as necessary.

Set Up the Data Logger

Plug all sensor connections into the data logger and place the data logger in its cradle. The connections to the waterproof data logger are generally left in place after each use. Next, turn the data logger on by pushing the 'On' button. Look for a faint flashing LED light next to the word "Logging" that indicates that the unit is turned on.

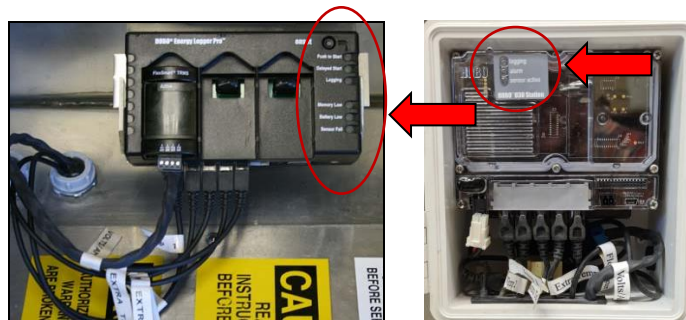


Figure 18. Turning the Data Logger on while it is Sitting in its Cradle

Turn On the Pump

Now the data logger is plugged in and turned on. Turn on the pump by flipping the switch on.

NOTE: After starting the datalogger, immediately run the pump for 10 minutes, with NO heaters, at the beginning of each test to collect the Average Undisturbed Ground Temperature!



Figure 19. Turn on the Circulation Pump

Select Heat Settings

Typical test specifications call for 15 watts minimum / 25 watts maximum per vertical foot or 49-82 watts per vertical meter of bore hole. The five heating elements in the GC3 GeoCube provide for great testing flexibility. *Depending on your model, the heater sizes will vary.* Compute the necessary power before starting your test! As seen in the table below, at 240V the first element provides 1500W and the other three elements each provide ~2000W. At 208V, each element de-rates by approximately 500W. *Note that you should NEVER exceed 240V.*

Element	500 ft / 150 m Units		850 ft/260 m Unit		1,100 ft/333 m Unit	
	240 Volts	208 Volts	240 Volts	208 Volts	240 Volts	208 Volts
Element 1:	1500W	~1000W	2000W	~1500W	2500W	~2000W
Element 2:	1500W	~1000W	2500W	~2000W	3500W	~2700W
Element 3:	1500W	~1000W	2500W	~2000W	3500W	~2700W
Element 4:	1500W	~1000W	3000W	~2500W	3500W	~2700W
Element 5:	1500W	~1000W	3000W	~2500W	3500W	~2700W

Below is an example of how to select which elements to use for a 200 ft / 61 m borehole:

The optimal power range for a 200 ft / 61 m borehole is the following:

Min: 200 ft x 15 watts/ft ~ 3,000W or Min: 61 m x 49 watts/m ~ 3,000W
 Max: 200 ft x 25 watts/ft ~ 5,000W or Min: 61 m x 82 watts/m ~ 5,000W

It is reasonable to select an intermediate value of 4,000W to achieve a flux of ~ 20 w/ft or ~ 65.5 w/m. At 240V, users can select Element 2 (2,000W) and Element 3 (2,000W) for a combined 4,000W. Users can

also select Element 3 (2,000W) and Element 4 (2,000W) or any other combination of elements that add up to the desired 4,000W.

Users could also combine Element 1 (1,500W) and Element 2 (2,000W) for a combined 3,500W (17.5w/ft or 57.4w/m.) This is within the range of 15-25 watts/ft or 49-82 watts/m, which are the desired power range.

Confirm Wattage Via Computer or Convenience Panel Meter

Confirm the wattage (and heating element activation) prior to conducting the full test. *Use the computer to confirm that all readings are being correctly received by the Data Logger.* **Failure to confirm correct readings may cause invalid test data recordings and require retesting!**

Use the computer to assure that all sensors are being read and that your power selection provides the expected power wattage. **If you can't read the sensors, you're NOT capturing the data for a successful test!**

The Panel Convenience meter **does not** guarantee that the data logger is receiving the data, but it will confirm the correct power that is being drawn by the heating elements. Remember that the panel meter is for convenience only! Step through the display of the convenience meter to see the voltage, amps and the power being used.

With the computer, confirm the wattage via this simple equation:

$$\text{Voltage} \times \text{Amps} = \text{Wattage}$$

Divide this wattage by your borehole length as follows:

$$\text{Wattage/borehole length} = \text{w/ft. or w/m.}$$

Once again, the optimal range is 15-25 watts/ft. or 49-82 watts/meter.

As you observe the sensor outputs on the computer, you may also notice that the temperature is increasing, as it should.

Close and Secure GeoCube For Test

Now that the unit is running smoothly, you can lock it down until test completion. By securing the unit properly, you help ensure that the test proceeds without interruption from interested third parties.

Close the lid carefully and lock it with the included key.



Figure 22. Locking the GeoCube

It is recommended that you securely attach the GeoCube to the generator or generator frame using a cable lock mechanism such as a bike lock, etc. In addition, it is reasonable to lock the generator as well to prevent accidental movement, theft, etc.

Take Down Procedure

When the test is complete, follow this sequence of steps to safely end the test:

- 1) Unlock and open the GeoCube.
- 2) With the computer, check all sensors to confirm that volts, amps and counts (flow) are the same as they were when you started the test. Check temperature sensors to confirm that they are providing expected results.
- 3) Shut down all of the active heating elements.
- 4) Shut down the pump.
- 5) You may directly download the logger data to the computer. Attach the USB cable to the computer to stop the data logger. After doing so it is a straightforward process to transfer the data from the logger. **See the data logger instructions for more details.**
- 6) Be sure to shut off the Data Logger as per the Data Logger instructions to preserve the battery life. Note that the easiest way to shut off the Data Logger is by attaching it to your computer, running the Hoboware software and turning off the unit. While this procedure may seem cumbersome, the purpose is to protect the user from running a test with a dead Logger.
- 7) Disconnect the computer and logger and store them in a safe place.

- 8) Disconnect the Waterproof datalogger battery!



- 9) *Shut off the generator.*
- 10) Disconnect the GeoCube power cord from the generator.
- 11) Disconnect the grounding rod from the generator and the GeoCube.
- 12) Disconnect the ground loop from the GeoCube.
- 13) Wipe out any condensation inside the GeoCube.
- 14) Recap the loops.
- 15) Drain the GeoCube by opening the drainage plug which is located below the inlet and outlets.
- 16) After the unit is drained, replace the drain plug.
- 17) Return the GeoCube to its storage location for its next use. *Store in a dry area, leave top of GeoCube open and store logger separately if your unit does not include the waterproof logger option.*
- 18) Perform routine maintenance on the GeoCube as required. Add approximately 1 gallon or 3.78 liters of RV antifreeze to keep the pump and motor clean.

CHAPTER 3

Data Transfer and Analysis

This chapter begins with a general overview of how to analyze the GeoCube test data. It then goes into detail, beginning with directions for how to install the two required and included software programs (HoboWare Pro and Ground Loop Design). The chapter continues by describing how to move the collected data from the data logger directly to the PC. The HoboWare Pro software will manage the transfer. Finally, the chapter covers how to transfer the data into the Ground Loop Design™ software thermal conductivity module for the thermal conductivity analysis and diffusivity estimation.

Overview

At the end of a conductivity test, the data from the GeoCube's sensors are stored on the Data Logger. These data need to be transferred to a PC for data analysis. The data transfer can be accomplished via two methods:

- 1) The data can be transferred directly from the Data Logger to the PC via a serial port or via a serial port and a serial-to-USB adaptor cable. In Figure 1, the Data Logger is connected to a serial cable which in turn is connected to a USB adaptor.

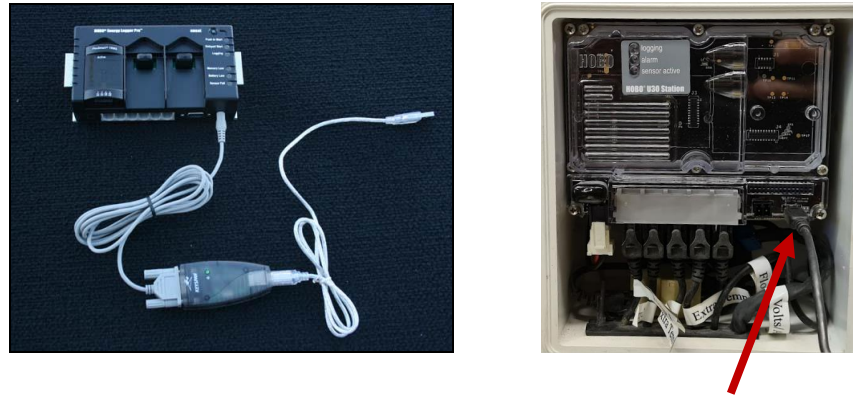
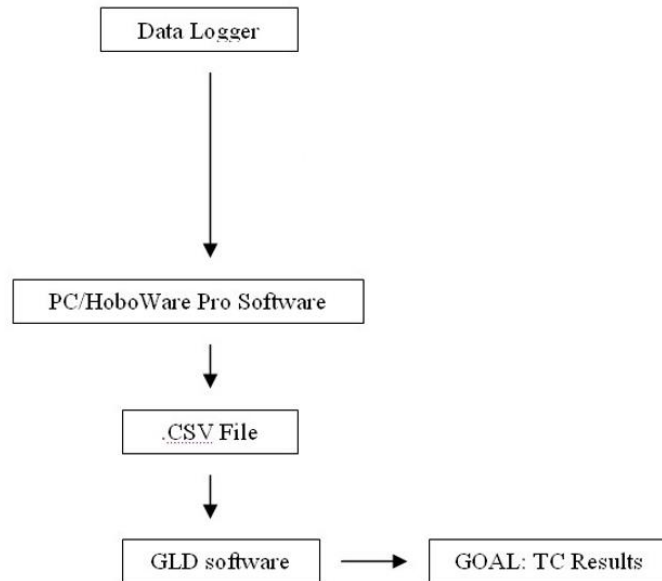


Figure 1. The Data Logger is Ready to Be Connected to the PC

Data is transferred to the PC using the Data Logger software program, HoboWare Pro. The data is then exported from HoboWare Pro into a Microsoft Excel .csv (comma separated value) file. In the last step, the Ground Loop Design™ thermal conductivity module can import the .csv file and calculate the soil thermal conductivity and estimate the diffusivity, which is the ultimate goal of this data transfer and analysis process.

Below is a visual overview of the data transfer process options:



Hoboware Pro Software

Hoboware Pro Software Installation

The HoboWare Pro software CD and an instruction manual are included in the GeoCube package. Install the HoboWare Pro software following the included instructions. If you have any difficulties with the installation process, please contact Precision Geothermal, LLC.

Ground Loop Design (GLDs) Software

Hardware Requirements

A full installation has the following minimum hardware requirements:

- 2 GB RAM (4 GB recommended)
- 300 MB hard disk space (500 MB recommended)
- Intel i3 Processor or newer

Software Requirements

GLD has the following software requirements:

- System running under Windows[®] W7, W8.x or W10, W11*
- Google Chrome, Microsoft Edge, or Mozilla Firefox

Operating System Requirements

GLD will operate under Windows[®] W7, W8, W10, W11*. GLD will operate under Apple Macintosh Parallels as well for certain MAC's.

***Note: Windows 10 requires GLD2014 build 8.0.11 or newer**
Windows 11 requires GLDs build 10.x.x or newer

Internet Browser Requirements

An Internet browser is required only for viewing the data reference files, and not for general program operation. To access the data reference files, at least one of the following browsers is necessary:

- Microsoft Edge
- Chrome Browser
- Mozilla Firefox Browser

Most any modern browser will work. When reference file pages are opened, the default browser in the user PC will be used to view the pages.

Installation Procedure

If you have problems installing GLD, please visit the support page at www.groundloopdesign.com or contact your distributor. Note that you can also download GLD from the internet at the following web address: https://www.groundloopdesign.com/GLDs_commercial_download_request.html. The downloadable version always will be the most recent release.

Initial Installation

For CD versions of GLD, installation should start automatically. If not, the software may be installed by clicking on the **Setup.exe** file included on the disk.

The program is set to install in the folder:

(Main Drive):\Program Files (x86)\Gaia Geothermal\GLD

If desired, the user can specify a different location during the installation process.

The example above is for a 64-bit Windows OS installation such as Windows 7 or Windows 10. In a 32-bit windows installation, "Program Files (x86)" will be replaced with "Program Files"

Program Licensing

This section describes the USB dongle and license transfer options available in GLD.

Software License Dongle

Your GLD Thermal Conductivity module software license is stored on the USB dongle that came with your GeoCube. This dongle enables you effortlessly to transfer operation of GLD from one computer to another. Please be careful not to misplace this dongle. ***Lost dongles cannot be replaced without the purchase of a new license.***

If the dongle is not attached to your computer, GLD will function as a trial version, which is or evaluation only and visualizing the interface.

When you insert the dongle into a free USB port on your computer for the first time, your computer most likely will recognize the dongle and after a few seconds, the dongle light will turn on. When it turns on, your license will activate. However, if your computer indicates that the dongle is “new hardware” you have two options for installing the dongle driver:

How to Install the Dongle Driver:

Windows users with internet access:

If your computer has access to the internet, your computer can automatically install the drivers. Follow along with the Windows new hardware wizard to install the drivers. The process takes a few minutes. When the installation is complete, the dongle light will turn on.

All other users:

Via Windows Explorer, navigate to:

(Main Drive):\Program Files\Gaia Geothermal\GLD\Extras

The example above is for a 32 bit Windows OS installation such as Windows 7 or Windows 8. In a 64 bit windows installation, “Program Files” will be replaced with “Program Files (x86)”

In the Extras folder you will find a HASPUserSetup.exe program.

Run the program to install the dongle driver. When the installation is complete, the dongle light will turn on.

After Dongle Installation is Complete:

Now that the dongle is installed, you can access the full functionality of the GLD version that you purchased. If you remove the dongle, the program will revert to demo mode. If you reattach the dongle, the program will reactivate again.

How To Transfer the Program Between Computers

The dongle licensing system allows the user to install software on multiple computers. If a user decides to switch from one computer to another, all he or she has to do is the following:

- Install GLD onto the target computer.
- Attach the dongle to the target computer. If the computer is connected to the internet, the drivers for the dongle will automatically download and install. If not connected to the internet, follow instructions regarding dongle driver installation in the preceding sections.

Transferring Data from Data Logger Directly to HoboWare Pro Software

For personal computers that have serial ports or USB ports, data can be transferred directly from the data logger to HoboWare Pro via the following process:

- 1) Attach the data logger directly to the PC via a serial cable (included or via a serial cable and serial-to-USB adaptor (included). Use the USB cable for Waterproof dataloggers.

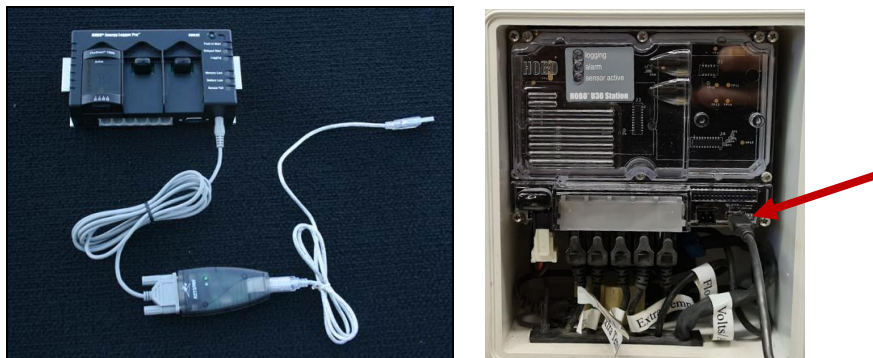


Figure 3. The Data Logger to Serial Cable to Serial-to-USB Adaptor on the standard datalogger or the Micro USB cable on the Waterproof Datalogger Enables the User to Connect the Data Logger to the Computer

- 2) Launch the HoboWare Pro software on the computer.
- 3) Choose 'Readout' from the Device dropdown menu as seen in Figure 4, below.

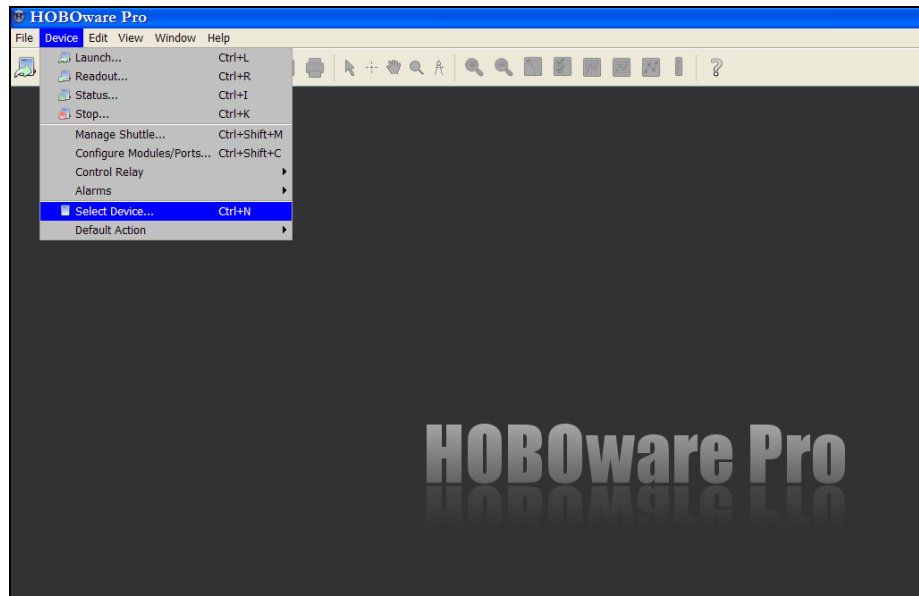


Figure 4. Choose 'Readout', the second option from the top.

4) In the window that opens up, select the Data Logger and push 'Ok'. See Figure 5 below. It may take a few seconds for the software to recognize the unit.

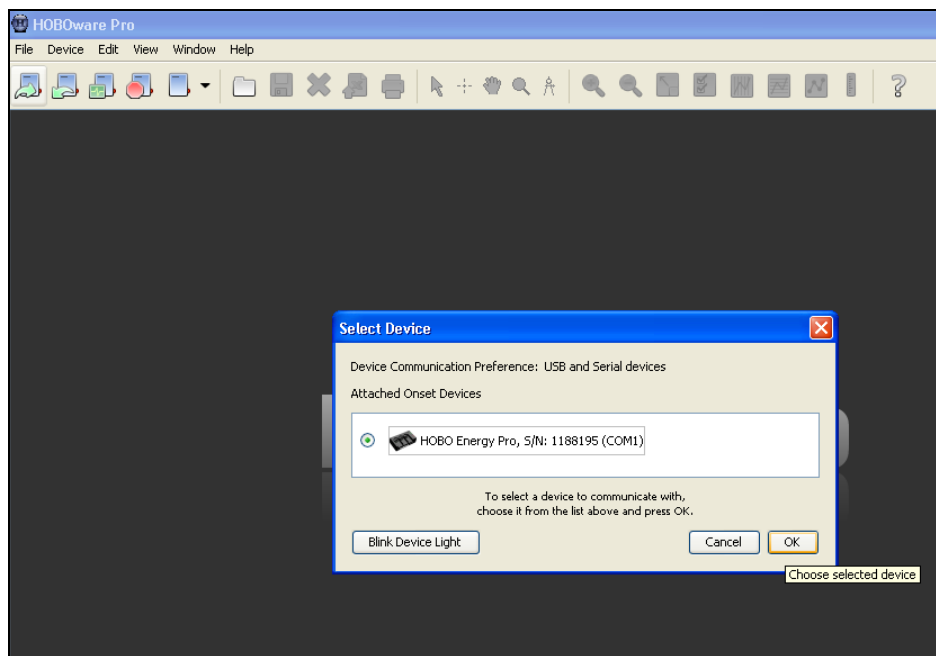


Figure 5. Select the Data Logger

5) After the file is transferred automatically to the computer, you will be asked to save the file. Note: you should save the file as your project name so you can find it later if necessary. Then hit 'Save'.

6) A Plot Setup screen will open. Push the 'Plot' button as seen in Figure 6.

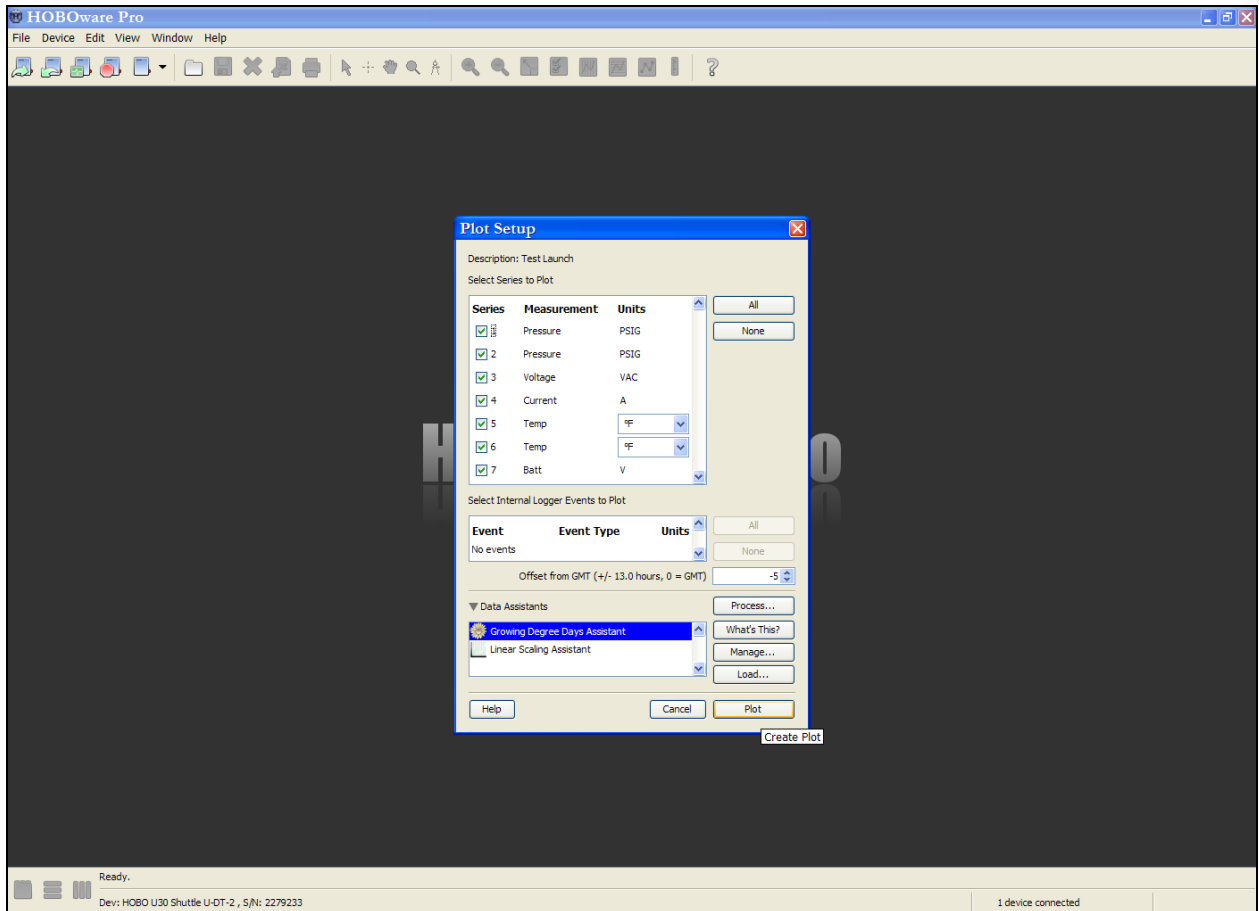


Figure 6. Plotting the Data

VERY IMPORTANT: GLD requires that all of the items above are present in the data file. If any are missing, the data analysis by GLD will fail or give an error message with invalid results!

7) A screen similar to the one in Figure 7 can now be seen. Push the 'Export Table Data' button.

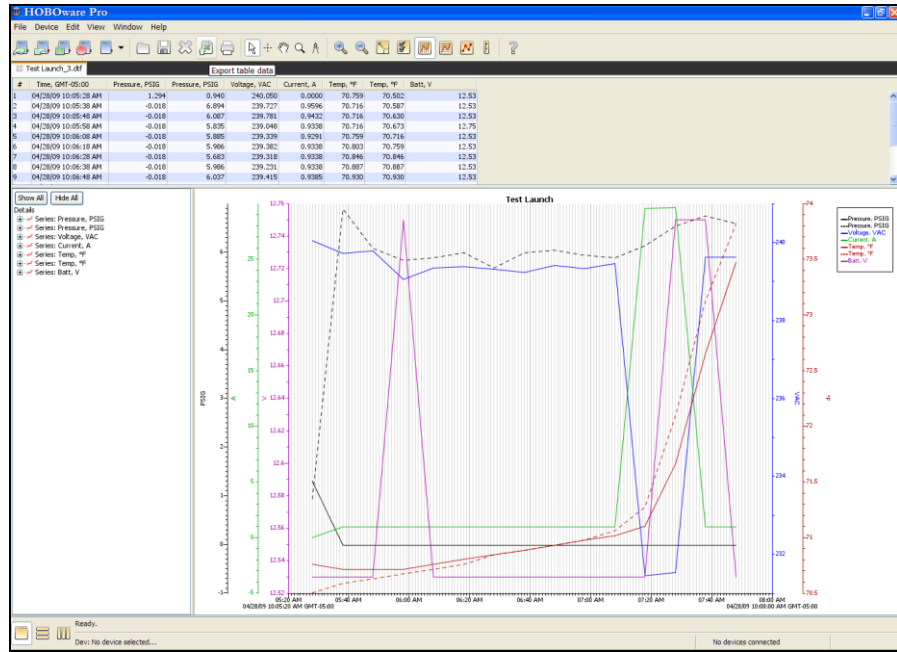


Figure 7. Prepare to Export the Table Data

8) Choose 'export to a single file' and click 'OK' as seen in Figure 8.

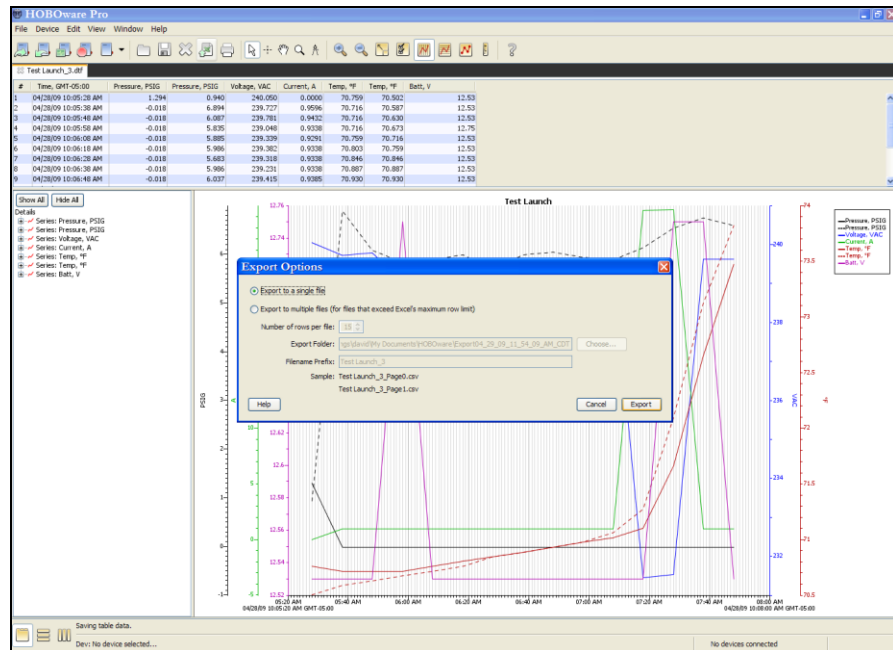


Figure 8. Select an Export Option

CHAPTER 3- Data Transfer and Analysis

9) In this last step, name the file to be exported and choose an export location. Choose the following folder:

MAIN DRIVE: \Users\{User Name}\Documents\GLDesign\Thermal Conductivity\Thermal Conductivity Data Files

Click the 'Save' button.

By exporting/saving the file to the above folder, GLD can easily find and import the data into the Thermal Conductivity analysis module as illustrated in Figure 9.

If the file is not saved to this folder, the analysis software may not function properly. You may save a copy of the file elsewhere for archive purposes.

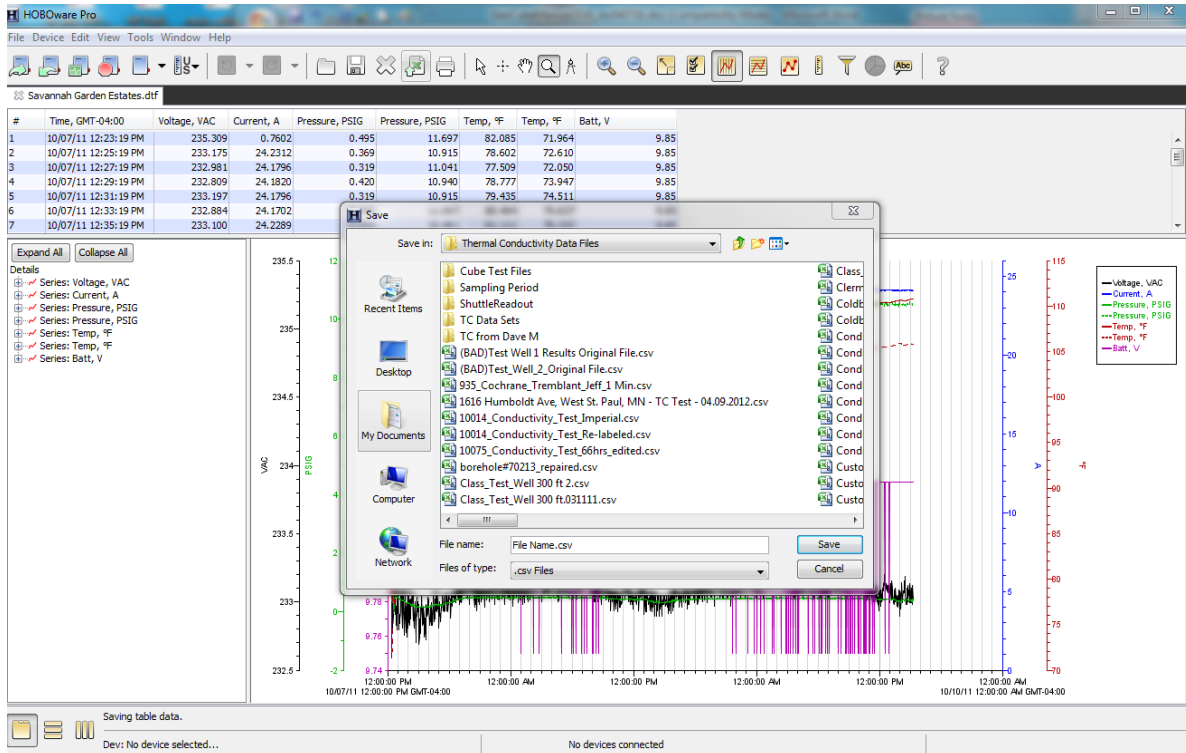


Figure 9. Saving the csv File in the Thermal Conductivity Data Files folder

Previous versions (prior to GLD2016) used different locations and instructions. Please refer to the earlier manuals for information.

Note that you may save archive copies of the data file exported from the HoboWare logger software to other locations for future reference.

Analyzing the Data in GLD

Now that the raw data has been downloaded onto the PC and exported/saved as a .csv file, the GLD software can analyze the data and calculate the thermal conductivity value. To perform this analysis, please see GLD Thermal Conductivity Software Module User's Manual. This manual provides an overview of the GLD software as well as a description of how to use GLD for analyzing conductivity test data. In GLD version 2016 and later, the software will automatically detect redundant sensors and select the pair based on stability of the data. It usually does not matter which pair is used since the results are ideally the same between the pairs. (Note: GeoCube owners may always update their license to the latest version of GLD at no additional charge!)

International Considerations and File Formatting

Every effort has been made to provide tools that allow tests and analysis to be performed anywhere in the world. There are some steps that need to be considered if you are working in a computer environment where the operating system default language is set to a language other than English. The language itself is not an issue but the standard units and punctuation can vary depending on the region of the world. While dates, units, currency and other items may seem interchangeable in everyday use, the computer systems and software are not always aware of the differences and we must provide exact formats for data to be transferred between software programs.

A standard engineering practice for exchange of data files involves the use of files that are referred to as .CSV, which stands for "Comma Separated Values". Many software tools and programs use the CSV file as the standard for interchange, including GLD and Hoboware, which are provided with your GeoCube. The data export from Hoboware to GLD is in the form of a CSV file and the process to transfer data is generally very straight-forward. There have been issues with computer systems that are set up for some regions of the world where the formatting that is controlled by the operating system (Windows, Linux, etc) substitutes a different symbol other than a comma for list separation. When a user is working on a system that has different default units, the data transfer to a CSV file will contain data separators that are not recognized by GLD and an error will occur that may look like the following:

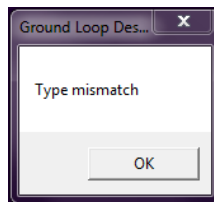


Figure 12: File Formatting Error Dialog Box

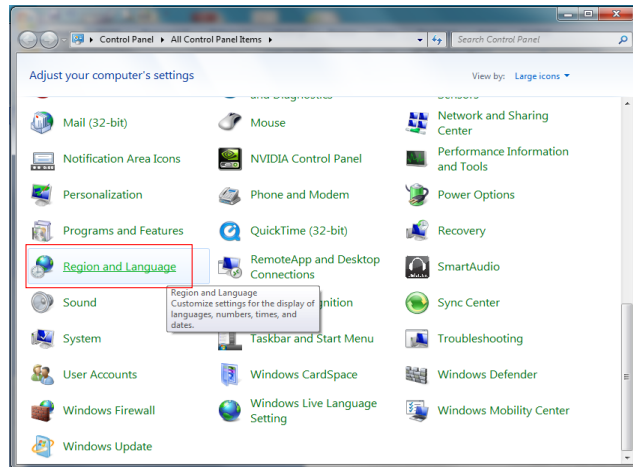
There are a couple ways to eliminate the “file format” issue.

Method 1: Set the default language of the computer OS to “US English”. This has obvious drawbacks if the user is not native English speaking but resolves the issue of file formatting.

Method 2: Change the default list separator value of the computer operating system to use commas as the default. This is generally an easier long term correction.

In the figures below, screenshots of a typical Windows system illustrate how to make these changes:

Open the Control Panel (your appearance may vary based on the computer OS)



Choose the Region and Language Settings. The following dialog boxes appear:

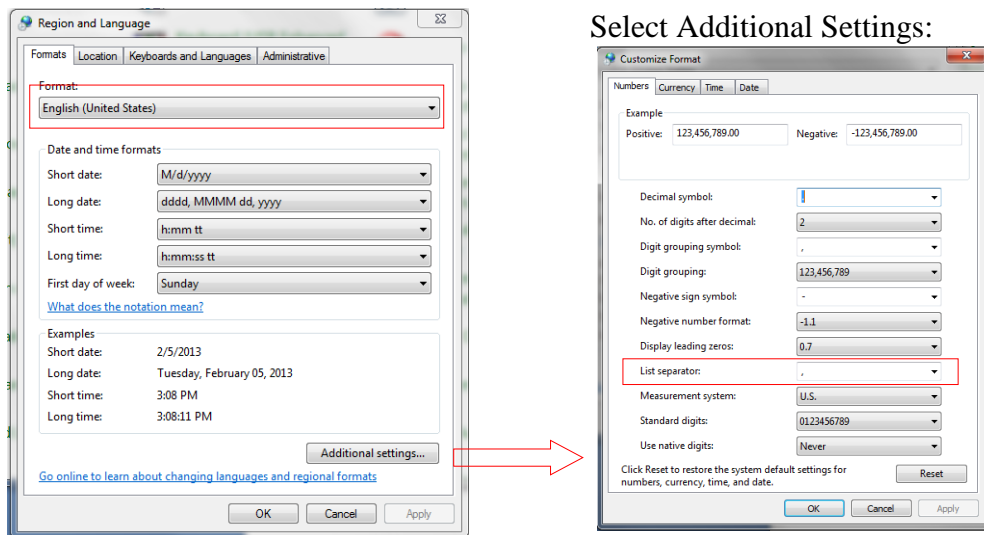


Figure 13: Region and Language Settings in the Control Panel

In the first box, you can select a language. This can be used for Method 1. If you want to retain a different native language, then you can set the “list separator” option in the additional options dialog box to be a comma, as suggested for Method 2.

Once a file is created, the formatting is defined in the file headers and cannot be changed. The file must be re-exported with the correct settings in the OS to change the list separator values.

File Data Formatting

Once the computer system has the proper language and/or separator options selected, there are still a couple other considerations for the exchange of data between HoboWare and GLD. The column headings in the CSV file have values that allow GLD to determine the meaning of the data and the columns may be arranged in any order.

*(Note: GLD2014 and later have been updated to interpret the column headings and appropriately rename the headings as needed. Users of previous versions of GLD will still need to observe the column headings. Users should download the latest version of the software. Your license key will need to be updated in order to use a newer version of GLD. **This is a free upgrade for GeoCube customers**)*

Here is an example of correctly formatted column headers in the CSV file. Values may be Imperial or Metric:

	A	B	C	D	E	F	G	H	I	J
1	Plot Title: Conductivity Test									
2	#	Date Time, GMT-05:00	Voltage, VAC	Current, A	Temp, °F	Temp, °F	Temp, °F	Temp, °F	Counts, #	Batt, V
3	1	3/21/2011 13:19	243.93	0.9948	50.18	49.516	48.538	48.762	20	12.64

Figure 14: Headers of Correctly formatted CSV data file for GLD Import

If the column headers contain any extraneous information, the import process into GLD could experience the following error:

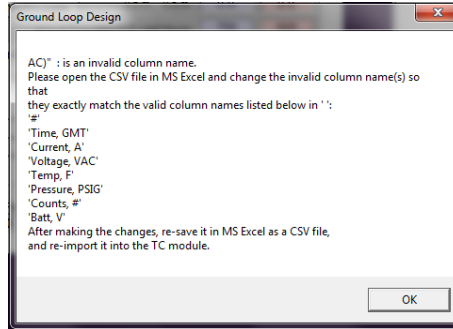


Figure 15: Error Dialog for Improper Column Headers

This can occur if the user has customized the labels inside of Hoboware when the data is read and the CSV file is exported. Here is an example of incorrect column headers that cause the error shown in Figure 15:

	A	B	C	D	E	F	G	H	I	J	K
1	Plot Title:	10014 Conductivity Test									
2	#	Date	Time	Counts, #	Voltage, V	Current, A (LBL: Current,A)	Temp, °C	Temp, °C	Temp, °C	Temp, °C	Batt, V
3	1	#####		239.029		0.3801	12.316	12.292	12.268	12.195	12.1

Figure 16: Example of Improper Column Headers

In the above Figure 16, the label for column E has been expanded to illustrate a label that contains extraneous information the user has introduced through Hoboware. When the data is retrieved from the data logger, the plot dialog box should not contain any extra data labels.

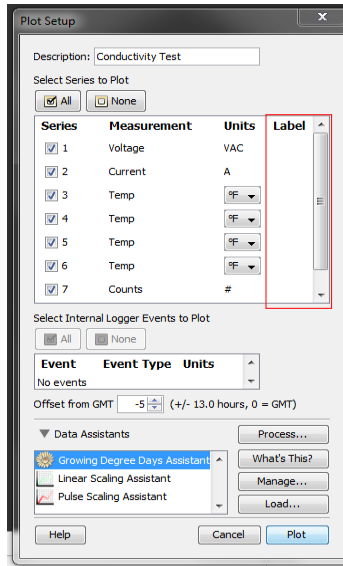


Figure 17: Example of Correct Plot Setup in Hoboware

Note in the above example that the Label column does not contain any additional data. This is the correct way to set up the Hoboware software for plotting the data and exporting the CSV file. This column MUST be left blank or an error will occur when importing the file to GLD.

CHAPTER 4

GeoCube Maintenance

This brief chapter describes the routine maintenance that will keep the GeoCube functioning smoothly.

Maintenance

Maintaining the GeoCube is a fairly straightforward process. Maintenance consists of three primary activities: cleaning the unit, corrosion inhibition and confirming unit integrity.

Notice:

Under no circumstances should the user open up any of the interior panels. Doing so will void any warranties. If anything beyond routine maintenance is necessary, contact the manufacturer.

The GC3 GeoCube is the only model with externally replaceable heating elements. These may be field replaced. Please contact PRECISION GEOTHERMAL for instructions and replacement elements.

Cleaning The Unit

Cleaning the GeoCube's exterior after use enhances unit longevity. Add approximately 1 gallon / 3.78 liters of RV antifreeze to keep the pump and motor clean.

Corrosion Inhibition

After every 5th test, circulate FERNOX F3 cleaning fluid through the unit for one hour after connecting the supply and return together via a 1" hose. After circulating FERNOX F3 for one hour, drain the unit.

FERNOX F1 is a special liquid of corrosion inhibitors and chelators designed for the protection of closed heating and cooling water systems. FERNOX F1 will protect both ferrous and non-ferrous metals and should be used in water systems where there is little or no make-up water. FERNOX F3 is Non toxic, and environmentally friendly

FERNOX F1 and FERNOX F3 are available from: <https://www.fernox.com>.

Integrity Check

Periodically check to confirm that screws are tight.

Cold Weather Storage

Be sure to fully drain the unit when it will be stored in freezing temperatures. Failure to fully drain may result in damage if the fluid freezes and expands.

Waterproof Logger Battery

Want to avoid premature dead battery? Always disconnect the battery between tests! If left connected, it will drain. Batteries are good for a few years before replacement is necessary. The Waterproof data logger battery is 4.0v, 10AH.



UPDATES

Revisions

February 2023

- Start-up and operation screenshot updates

December 2022

- Modified Manual for current GC3 Models of the GeoCube
- Removed references to discontinued data shuttle

May 2022

- Added optional Booster Pump illustrations
- Updated safety information
- Updated references for W11 requirements

April 2020

- Updated tables for GC3 Model information
- New configuration table

December 2018

- New recommended cleaner and conditioners for cleaning and storage
- Updated references to GLD v10.x.x and later

October 2017

- Updated screenshots
- Updated methods of acquiring the undisturbed ground temperature

September 2016

- Updated HASP driver references for W10
- Added note to run pump for 10 minutes, with no heaters, after starting logger
- Added note for W10 compatibility requirements for GLD2014 v8.11 and later.

April 2016

- Updated software references for GLD2016
- Updated file location instructions

November 2015

- Added details for Convenience Meter
- Added “Your GeoCube” photos and section to Chapter 1

August 2015

- Added Metric references

UPDATES - Revisions

- Added CE marking on labels
- Updated information for Windows 10

July 2014:

- Misc Clarifications for fixing security on file folders
- Additional warnings regarding checks before running field TC test

March 2014:

- Added additional references to Extended Capacity GeoCube models
- Updated references to software changes and revisions

February 2013:

- Added section on International use and file formatting considerations