LISST-Portable

User's Guide
Version 3.11

(Touch panel display, December 2011)



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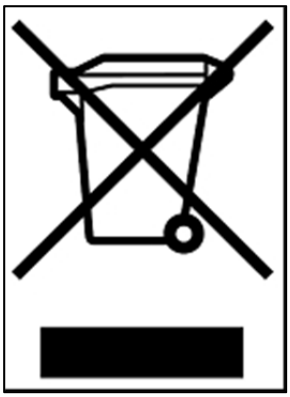
To obtain technical assistance related to your LISST-Portable, please contact your local distributor (a list of our international distributors can be found on http://www.SequoiaSci.com/contact/international.aspx?SectionName=contact) or Sequoia Scientific, Inc. directly.

Please be sure to include the instrument serial number with any correspondence. If you email us any file(s) obtained with the LISST-Portable, please include both .ASC, .DAT and .LOG file(s) in your email.

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Waste Electrical and Electronic Equipment

Smaltimento di apparecchiature elettriche ed elettroniche da rottamare

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1 Introduction

Dear LISST-Portable Customer:

Thank you for purchasing the LISST-Portable Particle Size Analyzer! This instrument delivers the size distribution and volume concentration of particles in a sample of particles suspended in a liquid. The instrument is designed for operation in a stand-alone mode using its internal, rechargeable battery. In this mode the instrument can collect, process, store and display data. The stored data can subsequently be offloaded for display in, for example, Excel spreadsheets. Windows software is supplied for data offloading. If the instrument is used mainly in the laboratory, it can be powered by an external power supply.

The intent with this manual is to get you started using the LISST-Portable as quickly as possible. Sequoia's goal with the LISST-Portable is to make the user interface so friendly that no manual should be required for normal operation, except as a first-time introduction to the instrument. During normal operation, most of the questions that the user will want answered can be resolved from the User's Guide. This double sided laminated document is attached to the inside lid of the instrument. The front side shows the general menu structure and the back side has some additional instructions on using the instrument.

The LISST-Portable was shipped to you in a corrugated plastic box with foam padding. Included in the shipping box are the yellow LISST-Portable, the black Accessory Kit, and the LISST-Portable Software CD. The Accessory Kit contains the Communications and Charging Cable, AC power supply, Drain tube (this attaches to the push-to-connect fitting on the back of the LISST-Portable), funnel for filling chamber, and some test particles. Take the instrument out of the box and place it on a level surface. Locate the drain hose inside the black box and push it into the black push-to-connect fitting on the back of the instrument.

The LISST-Portable instrument is extremely simple to operate. All commands and modes are accessed using buttons on the touch panel display. No PC is required, except for offloading data to a computer.

The LISST-Portable uses the widely accepted method of laser diffraction to measure the size and concentration of particles suspended in water. This method has been employed in a number of laboratory and commercial instruments. The LISST-Portable employs the full Mie theory in its calculations. The instrument delivers the concentration of suspended particles (micro-liters/liter, or µl/l) in 32 log-spaced size classes. Size analysis covers the range from 1.25 to 250 microns or 2.5 to 500 microns, depending on instrument type. The useful operating range of the instrument is defined based on optical transmission of the sample chamber. For clean, clear fluids, when the optical transmission exceeds 98%, weak signals from particles result in noisy measurements. On the other end, when the optical transmission is less than 30%, significant contributions from multiple-scattering bias the size distribution results to lower sizes. For this reason, the recommended operating range is 30-98% for optical transmission.

Sequoia Scientific, Inc. is pleased that you have chosen one of our products. Thank you! We strive to make our instruments rugged, reliable, and simple to operate. If you should have any difficulties or questions regarding this product, please feel free to contact us.

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2 Contents and Technical Specifications



LISST-Portable type B or C
(Part # SS-LPORT-GD-B-US or SS-LPORT-GD-C-US)

15 V Power Supply @ 2.7A
(Part # LPORT-E-0107)

Quick Reference Sheet
(Part # LPORT-M-0097)

Stylus Holder
(Part # LPORT-M-0107)

Sequoia Stylus
(Part # LPORT-M-0110)

2.1 General Features

- Small-angle forward laser light scattering (laser diffraction) @ 670 nm – compliant with ISO-13320-1 standard.
- Touch panel display allows for easy programming and display of data without a PC.
- 175 ml integrated mixing chamber.
- 4.3" graphics display, 480 × 272 pixels (3.75" W × 2.12" H), 16-bit color.
- Self-contained with internal data logger and rechargeable battery pack.
- Programmable data collection.
- All data-processing is performed on board and the data stored in ASCII-format – no post-processing necessary.
- Two models for inversion: Spheres or randomly shaped (natural) particles, selectable from the touch panel.

2.2 Parameters Measured

- Particle Volume Concentration [µl/l].
- Mean Particle Size [µm].
- Standard Deviation [µm].
- Optical Transmission (dimensionless).
- D10, D16, D50 (median diameter), D60, D84, D90 diameters [µm].
- D60/D10 – the Hazen Uniformity Coefficient (dimensionless).
- Surface Area [cm^2].
- Silt Density – the proportion of total particle volume in the silt fraction (< 64 µm) (dimensionless).
- Silt Volume – the Volume Concentration of the particles in the silt fraction [µl/l].
- Particle Volume Distribution in 32 size bins [µl/l].

2.3 Particle Size Specifications

- Size Ranges: Dependent on inversion method
  - 1.25 – 250 µm (type B) or 2.5 – 500 µm (type C) for inversions based on spherical particles
  - 1 – 200 µm (type B) or 1.9 – 381 µm (type C) for inversions based on randomly shaped particles.
- Size Range Resolution: 32 log spaced size classes, 18.09% width.
- Concentration Range: 0.1 to 1,000 mg/l typical. **NOTE:** *The operational limit is based on optical transmission of water remaining above 30%*
- Concentration resolution: < 1 µl/l.
- Concentration accuracy: ± 15%.

2.4 Datalogger Specifications

128 MB storage capacity; equivalent to at least 75,000 size distributions and associated sample information.

- Storage capacity expandable to 4 GB.
- RS232 Interface

2.5 Power Supply

- Battery Powered – Rechargeable NiMH battery pack
- AC battery charger (120/240VAC). The battery charger cannot overcharge the battery pack.

2.6 Physical Dimensions

- 17.8cm × 29.2cm × 44.5cm / 7" × 11.5" × 17.5" (H × D × W)
- Weight: 4.5 kg (10 lbs)

2.7 ASCII (.ASC) Data File Format

The .ASC file is a comma-separated file with 3 rows of text and info before the measurement data. If single sample was chosen as storage mode (see chapter 3.5) only one additional row (#4) will be present. If multiple samples was chosen as storage mode several additional rows, one per sample, will be present in the file.

Row 1	Header identifying file as a LISST-Portable Data File and the date, time and day number of file creation.
Row 2, elements 1-16	Headers used for displaying the data in the enclosed EXCEL spreadsheet.
Row 2, element 17	In the rows containing the actual measurements (row 4 onwards) element 17 will be set to 1 if the Spherical inversion was used (see chapter 3.9 for details).
Row 2, elements 18-49	Midpoint of the size classes for the spherical inversion method (see chapter 3.9 for details).
Row 2, element 50	Header used for displaying the data in the enclosed EXCEL spreadsheet.
Row 2, element 51	Header used for displaying the sample notes.
Row 3, elements 1-16	Units for the headers in row 2.
Row 3, element 17	In the rows containing the actual measurements (row 4 onwards) element 17 will be set to 0 if the Randomly shaped inversion method was used (see chapter 3.9 for details).
Row 3, elements 18-49	Midpoint of the size classes for the randomly shaped inversion method (see chapter 3.9 for details).
Row 3, element 50	Unit for the header in row 2, element 50.
Row 3, element 51	This text string: "Note: a comma in the notes will split the note into separate columns".
Row 4, element 1	Date in MM/DD/YYYY format
Row 4, element 2	Time in HH:MM:SS format
Row 4, element 3	Total Volume Concentration [µl/l]. The Volume Concentration is the total volume of sediment within the size ranges covered by the instrument (see chapters 2.10 and 2.11 for details about the size ranges). It is computed by summing up the volume concentration in each of the 32 size classes.
Row 4, element 4	Mean Size [µm]. This is the mean size of the particle size distribution. See the FAQ (chapter 11) for information about how it is computed.
Row 4, element 5	Standard Deviation [µm]. This is the standard deviation of the particle size distribution. See the FAQ (chapter 11) for information about how it is computed.
Row 4, element 6	Optical Transmission [dimensionless]. The optical transmission is the fraction of emitted laser light power that is passing undisturbed through the sample volume, and which therefore does not contribute to the scattering of light off of the particles.

Row 4, element 7	D10 [µm] is the 10th percentile of the cumulative percentage undersize by volume of the sediment.
Row 4, element 8	D16 [µm] is the 16th percentile of the cumulative percentage undersize by volume of the sediment.
Row 4, element 9	D50 [µm] is the 50th percentile of the cumulative percentage undersize by volume of the sediment. It is also known as the median diameter.
Row 4, element 10	D60 [µm] is the 60th percentile of the cumulative percentage undersize by volume of the sediment.
Row 4, element 11	D84 [µm] is the 84th percentile of the cumulative percentage undersize by volume of the sediment.
Row 4, element 12	D90 [µm] is the 90th percentile of the cumulative percentage undersize by volume of the sediment.
Row 4, element 13	D60/D10 [dimensionless] is also known as Hazen's Uniformity Coefficient. It is a measure of the range of particle sizes present in a given sample. It is defined simply as D60/D10.
Row 4, element 14	The Surface Area [cm^2] is the total surface area of all particles in the size range covered by the instrument (see chapters 2.10 and 2.11 for details about the size ranges).
Row 4, element 15	Silt Density [dimensionless]. The Silt Density is ***NOT*** the physical density of the silt-sized particles in the samples. It is the proportion (by volume) that particles < 64µm makes up of the total volume (Row 4, element 3).
Row 4, element 16	Silt Volume [µl/l]. The total volume concentration of particles < 64 µm.
Row 4, element 17	Spherical/randomly shaped inversion method flag.
Row 4, elements 18-49	Volume concentration [µl/l] in each of the 32 size bins.
Row 4, element 50	Battery voltage [V].
Row 4, element 51-	Sample note. If a comma (,) was used in the notes when entered on the instrument the note will be separated into several columns. This is useful for sorting data saved in the multiple data storage mode according to e.g. operator or location. See sections 3.5 and 4 for details.

2.8 Binary (.DAT) Data File Format

The binary data file contains the raw, uncalibrated scattering data from the individual measurement(s). This file is used by Sequoia technical personnel for troubleshooting data and should be offloaded and archived responsibly together with the .ASC and .LOG files created by the instrument.

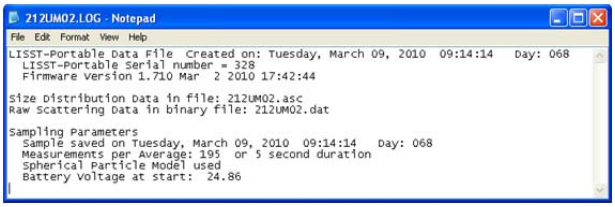
2.9 Log (.LOG) File Format

The log file contains information about instrument settings during sampling.

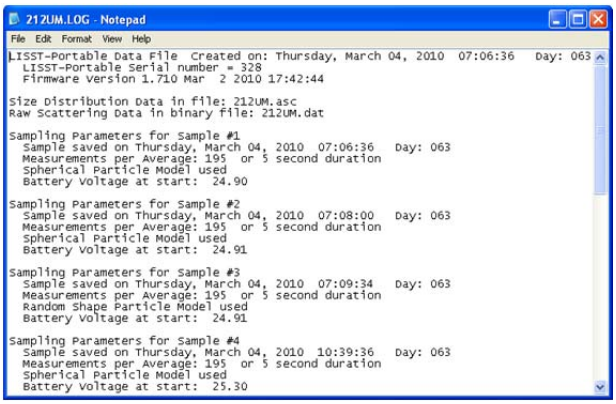
The user can see the average duration, what shape model was selected, instrument serial number, firmware version, file names for processed data and raw data, sampling date and time, and battery voltage.

The log file has a slightly different appearance, depending on what data storage mode was selected during sampling (see chapter 3.5 for details on storage mode).

Single File Storage Mode



Multiple Files Storage Mode



2.10 Size Ranges; SPHERICAL particle inversion method

There are 32 size ranges logarithmically spaced from 1.25 - 250 µm (type B), or 2.5 – 500 µm (type C). In both cases, the upper size in each bin is 1.1809 times the lower.

The table below shows the lower and upper limit of each size bin in µm, together with the median size (also in µm) for each size bin for type B and C instruments.

		Type B			Type C		
Bin #	Ring #	Lower	Upper	Median	Lower	Upper	Median
1	32	1.25	1.48	1.36	2.50	2.95	2.72
2	31	1.48	1.74	1.60	2.95	3.48	3.20
3	30	1.74	2.05	1.89	3.48	4.11	3.78
4	29	2.05	2.42	2.23	4.11	4.85	4.46
5	28	2.42	2.86	2.63	4.85	5.72	5.27
6	27	2.86	3.38	3.11	5.72	6.75	6.21
7	26	3.38	3.98	3.67	6.75	7.97	7.33
8	25	3.98	4.70	4.33	7.97	9.40	8.65
9	24	4.70	5.55	5.11	9.40	11.1	10.2
10	23	5.55	6.55	6.03	11.1	13.1	12.1
11	22	6.55	7.72	7.11	13.1	15.4	14.2
12	21	7.72	9.12	8.39	15.4	18.2	16.8
13	20	9.12	10.8	9.90	18.2	21.5	19.8
14	19	10.8	12.7	11.7	21.5	25.4	23.4
15	18	12.7	15.0	13.8	25.4	30.0	27.6
16	17	15.0	17.7	16.3	30.0	35.4	32.5
17	16	17.7	20.9	19.2	35.4	41.7	38.4
18	15	20.9	24.6	22.7	41.7	49.2	45.3
19	14	24.6	29.1	26.7	49.2	58.1	53.5
20	13	29.1	34.3	31.6	58.1	68.6	63.1
21	12	34.3	40.5	37.2	68.6	80.9	74.5
22	11	40.5	47.7	43.9	80.9	95.5	87.9
23	10	47.7	56.3	51.9	95.5	113	104
24	9	56.3	66.5	61.2	113	133	122
25	8	66.5	78.4	72.2	133	157	144
26	7	78.4	92.6	85.2	157	185	170
27	6	92.6	109	101	185	218	201
28	5	109	129	119	218	258	237
29	4	129	152	140	258	304	280
30	3	152	180	165	304	359	331
31	2	180	212	195	359	424	390
32	1	212	250	230	424	500	460

2.11 Size Ranges; RANDOMLY shaped particle inversion method

There are 32 size ranges logarithmically spaced from 1.00 - 200 µm (type B), or 1.9 – 381 µm (type C). In both cases, the upper size in each bin is 1.1809 times the lower.

The table below shows the lower and upper limit of each size bin in µm, together with the median size (also in µm) for each size bin for type B and C instruments.

		Type B			Type C		
Bin #	Ring #	Lower	Upper	Median	Lower	Upper	Median
1	32	1.00	1.18	1.09	1.90	2.25	2.07
2	31	1.18	1.39	1.28	2.25	2.65	2.44
3	30	1.39	1.64	1.51	2.65	3.13	2.88
4	29	1.64	1.94	1.79	3.13	3.69	3.40
5	28	1.94	2.29	2.11	3.69	4.35	4.01
6	27	2.29	2.70	2.49	4.35	5.14	4.73
7	26	2.70	3.19	2.93	5.14	6.06	5.58
8	25	3.19	3.76	3.46	6.06	7.15	6.59
9	24	3.76	4.44	4.09	7.15	8.44	7.77
10	23	4.44	5.24	4.82	8.44	9.96	9.17
11	22	5.24	6.18	5.69	9.96	11.8	10.8
12	21	6.18	7.29	6.71	11.8	13.9	12.8
13	20	7.29	8.61	7.92	13.9	16.4	15.1
14	19	8.61	10.2	9.35	16.4	19.3	17.8
15	18	10.2	12.0	11.0	19.3	22.8	21.0
16	17	12.0	14.1	13.0	22.8	26.9	24.8
17	16	14.1	16.7	15.4	26.9	31.8	29.2
18	15	16.7	19.7	18.1	31.8	37.5	34.5
19	14	19.7	23.2	21.4	37.5	44.2	40.7
20	13	23.2	27.4	25.2	44.2	52.2	48.0
21	12	27.4	32.4	29.8	52.2	61.6	56.7
22	11	32.4	38.2	35.2	61.6	72.7	66.9
23	10	38.2	45.1	41.5	72.7	85.7	78.9
24	9	45.1	53.2	49.0	85.7	101	93.1
25	8	53.2	62.8	57.8	101	119	110
26	7	62.8	74.1	68.2	119	141	130
27	6	74.1	87.4	80.5	141	166	153
28	5	87.4	103	94.9	166	196	181
29	4	103	122	112	196	232	213
30	3	122	144	132	232	273	252
31	2	144	169	156	273	322	297
32	1	169	200	184	322	381	350

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3 Instrument Settings and Options

3.1 Introduction

This section is designed to give the new user an introduction to all of the procedures, functionality, and settings of the LISST-Portable. The experienced user may find this section useful for a quick review of the various procedures. Once all the settings have been reviewed and/or changed to desired values, the user is ready to make the first measurement. The measurement procedure is described in detail in chapter 4.

It is not necessary to install any software to go through this section and become familiar with the instrument and its operation. Information on how to install and use the software designed to offload the data from the instrument can be found in chapter 8.

3.2 Power up

The LISST-Portable is a self-contained instrument. If the battery is charged, you do not need a power supply or PC to obtain, process, store, or display particle size distributions. The LISST-Portable only requires a PC to offload this data; see section 8.4 for details.



There is an ON/OFF button at the top of the panel of the LISST-Portable, which is used to control the main power of the instrument. Once the power has been turned on, all control of the instrument is via the touch panel display.

The only exception to this is the drainage of the instrument, which is done using the lever in the bottom right corner of the sample cell, and offloading of data, which is done via the serial connector to the right of the power button; see chapter 8 for details.



Switch on power by pushing down the power button.

The power indicator below the switch will turn green, indicating that the main power is on, and the instrument will go through its start-up routine, loading and initializing data files.

After a few seconds, the touch panel display will display the Main Menu screen and the task bar at the bottom.

3.3 Main Menu / Setup Menu



There are four main buttons on the Main Menu screen: Measure, Display, Info, and Setup.



The Measure button guides the user through the measuring process in 6 steps.



The Display button lets the user scroll through the memory of the instrument, selecting and displaying previously analyzed samples.



The Info button displays information about the instrument's serial number, type, and current settings.



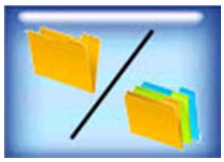
The Setup button opens up the Setup Menu, where the instrument's settings can be changed via six buttons.



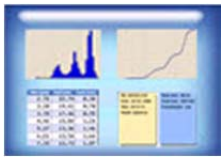
The six buttons on the Setup Menu are Average Duration, Single/Multiple measurements per file, Default Display, System Setup, Base Name, and Shape Model selection



The Average Duration button lets the user select the duration over which scattered light is measured from the sample. Selectable between 5 and 120 seconds; the default duration is 5 seconds.



The Single/Multiple button lets the user select how processed data are stored. Results can be stored in separate files (Single) or appended to one file (Multiple). It is possible to toggle between the modes from sample to sample. The default is Single Sample.



The Default Display button lets the user select if processed data are to be displayed first as the volume distribution, the cumulative distribution, a table format or as a statistics summary. The default is Volume Distribution.



In System Setup, the user can set the clock, delete files one by one (for multiple file deletion we recommend using the Windows® software), set the backlight and mixer time-out (1-16 minutes, defaults are 5 and 10 minutes, respectively), and set screen brightness.



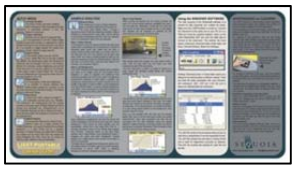
The base name button lets the user input a base name with a maximum length of 6 characters, e.g. 'Sample'. If Single Sample is chosen, the LISST-Portable will subsequently add the sample number to the base name (e.g. Sample01.asc, Sample02.asc), up to 99. If Multiple Samples is chosen, the instrument will store each new sample in a new line in the file (Sample.asc).



The Shape Model button lets the user choose between two different mathematical models for inversion of the raw data when computing the size distribution: Spherical and Random Shape. The default setting is Spherical Shape.



The Quick Reference Sheet on the inside of the instrument lid shows all the possible options that can be chosen from the start-up screen. We encourage the user to explore the sheet in order to become comfortable with the structure and layout of the menu system, as well as with the feel and operation of the touch panel display.



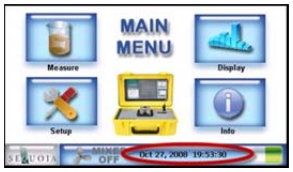
Please note that the Quick Reference Sheet has a backside as well, with more detailed information about the main menu options, as well as maintenance and cleaning tips and tricks.

When navigating the menus, simply press the cancel button to return to the previous menu without making any changes.

The Sequoia button in the bottom left hand of the task bar serves as a home button. Press this at any time to return to the Main Menu without making any changes.

3.4 Set Date and Time

Before we start any measurements, let's make sure that the instrument date and time is correct and adjust it in case it is not.



The current instrument date and time is always visible at the bottom of the task bar. In this example, it is October 27, 2008 19:53:30 (7:53:30 PM).

The clock is a 24 hr clock - this cannot be changed.



In order to set the date and time, press the Setup button on the Main Menu in order to access the Setup Menu.



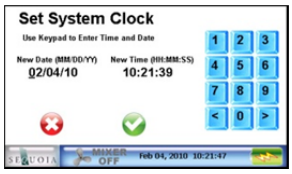
In the Setup Menu, press the System Setup button.



In System Setup, press the Set Clock button to access the Set System Clock screen and keypad.



When using the keypad and keyboard options on the instrument, it is often easiest to use the Sequoia pen that shipped with the instrument. It is installed in a clip inside the lid of the instrument and has a black stylus on one end.



Set the clock using the keypad. The cursor underlines the number that you will change if you push one of the number buttons. In the example shown, the '0' (zero) will be changed if you push a number on the keypad.

Use the < and > buttons to skip the numbers that you do not want to change.

Push the ✓ button when you are done to return to the System Setup Menu.



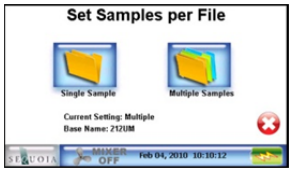
Push the ✗ button to return to the System Setup Menu without saving any changes.

3.5 Data Storage Mode

Your measurements can be stored in separate files with one measurement per file (single sample storage mode), or appended to a file containing multiple measurements in the same file (multiple sample storage mode). The default setting is Single Sample. This step lets you select your preferred data storage mode. Please note that you can toggle between these storage modes from sample to sample if you wish.



From the Setup Menu, push the Single/Multiple button.



The current storage mode is displayed together with the base name. In this case the storage mode is multiple samples per file with base name 212UM.

Push the Single Sample button to store the results from each individual measurement in separate files and return to the Setup Menu.

Push the Multiple Samples button to store several measurements in the same file and return to the Setup Menu.

Push the ✗ button to return to the System Setup Menu without saving any changes.

Push the SEQUOIA button if you do not wish to make any changes to the data storage mode and return to the Main Menu.

Please note that you can toggle between these storage modes from sample to sample if you wish.

3.6 Data File Base Name

Now it's time to select the base name for the data files being created.



From the Setup Menu, push the Base Name button to access the keyboard and the Set Base Name screen.



The current base name is displayed, in this case 212UM.

Enter a base name with a length of maximum 6 characters, e.g. 'Sand'. The instrument will subsequently add the sample number to the base name if the data storage mode has been set to Single Sample (e.g Sand01.asc, Sand02.asc), up to 99. If Multiple Samples was chosen as storage mode, the instrument will store each new sample in a new line in the file (Sand.asc). Avoid numbers at the end of a base name (e.g. use 212UM instead of UM212).



The bk button is the backspace button.

Push the button when you are done to return to the Setup Menu.

Push the button to return to the System Setup Menu without saving any changes.

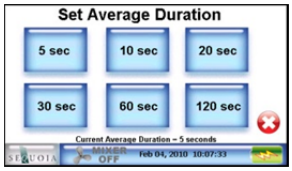
Push the button if you do not wish to make any changes to the current base name and return to the Main Menu.

3.7 Averaging Duration

Next set the averaging duration. This is the duration during which the laser light scattering off of the sample is being averaged while it is circulating in the mixing chamber.



From the Setup Menu, push the Average Duration button.



The current average duration is displayed at the bottom of the screen. For most samples, the default setting of 5 seconds will be suitable. However, for samples with low concentration, choose a longer duration as this will decrease the influence of random noise on the result. Select the desired averaging duration by pushing the appropriate button and return to the Setup Menu.

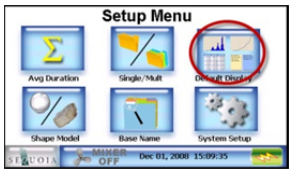
Push the button to return to the Setup Menu without making any changes.

3.8 Default Display

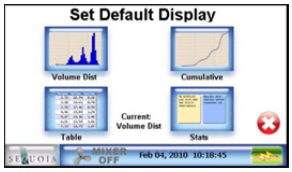
The processed data can be viewed in four different ways:

1) as a graph showing the volume distribution
2) as a graph showing the cumulative distribution
3) in a table format
4) as a statistics summary.

The user can select which of these four options will be shown **first** when the results are being displayed after being measured and processed (the other three options will always be accessible through a tabbed display).



From the Setup menu, push the Default Display button.



The current default display is shown at the bottom of the Set Default Display screen. In this case volume distribution is selected.

Select the desired default display by pushing the appropriate button and return to the Setup Menu.

Push the button to return to the Setup Menu without making any changes.

3.9 Shape Model

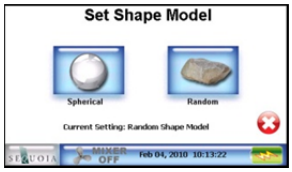
Once a sample has been measured and the laser light scattering pattern detected, it must be processed in order to yield the size distribution and volume concentration.

The LISST-Portable from Sequoia offers 2 different models for processing the data: Spherical particle model and a randomly shaped particle model.

The randomly shaped particle model enables the LISST-Portable to measure the size distribution as if it were a sieve size distribution.



From the Setup Menu, push the Shape Model button.

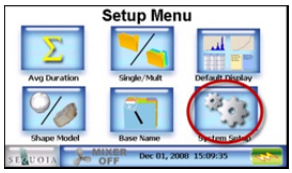


The current selection is displayed at the bottom. In this case the random shape model is selected.

Push the desired button to select the spherical or the randomly shaped model for inversion.

See the FAQ (section 11) for more information on how to choose the appropriate shape model.

3.10 Mixer Timeout



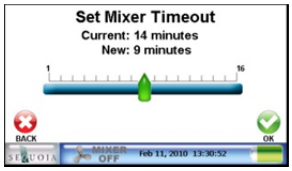
From the Setup Menu, push the System Setup button.



From the System Setup, push the Mixer Timeout button to access the Set Mixer Timeout screen.



The current timeout is shown, in this case 14 minutes.



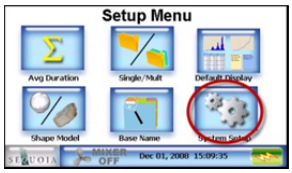
If you wish to change the timeout, press and hold the green slider while you drag it across the slide bar. In the example to the left, a new timeout of 9 minutes is chosen.

Push the OK button if you wish to change the timeout to the new value (9 minutes in this case) and return to the System Setup.

Push the BACK button if you wish to keep the current timeout value (14 minutes in this case) and return to the System Setup.

Push the SEQUOIA button if you wish to keep the current timeout value (14 minutes in this case) and return to the Main Menu.

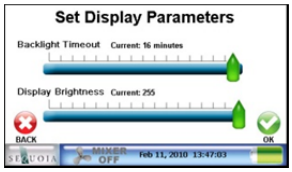
3.11 Backlight Timeout / Display Brightness



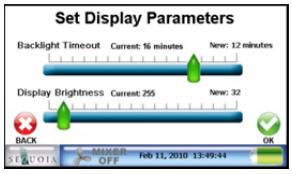
From the Setup Menu, push the System Setup button.



From the System Setup, push the Display button to access the Set Display Parameters screen.



The current values for the backlight timeout and display brightness are shown, in this case 16 minutes and 255, respectively.



If you wish to change the backlight timeout and/or display brightness, press and hold the appropriate green slider while you drag it across the slide bar. In the example to the left, a new backlight timeout of 12 minutes and a display brightness of 32 are chosen.

Push the button if you wish to change the timeout and brightness to the new value(s) and return to the System Setup.

Push the button if you wish to keep the current timeout and brightness value(s) and return to the System Setup.

Push the button if you wish to keep the current timeout and brightness value(s) and return to the Main Menu.

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4 Measuring a Sample



This section guides the user through the measuring process. There are 6 steps in measuring a sample – see the upper left corner of the Quick Reference Sheet. These 6 steps are detailed in the following.

Before you start you should make sure that you have the following:
1) Particle-free water (e.g. de-ionized, milli-Q, steam-distilled) for background measurements.
2) Funnel for filling the mixing chamber.
3) Sample suspended in an appropriate liquid[1] in a beaker.
4) A proper vessel for draining the mixing chamber and the sample.



From the Main Menu, push the Measure button.



Note that the Step 1 screen also indicates the data storage mode (single/multiple samples in a file).

The first step is to make sure that the mixing chamber is clean and that all traces of a previous sample has been flushed out.

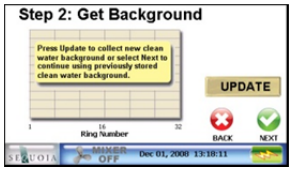
Lift off the mixing chamber lid and make sure the drain lever is in the closed position. The lid might be on tight – turning it so you can use the corners to wriggle it might help. Then fill up the chamber approximately half with clean water, put the lid back on and push the mixer button in order to start pumping water through the sample cell and the optical system – note that the button changes to to show that the mixer is active.

Let the clean water circulate for ~5 seconds, open the drain lever, make sure the water drains completely out of the chamber (~5-10 seconds), close the drain, and push the mixer button to turn off the mixer – note that the button then changes to .

It may be necessary to repeat this cleaning procedure if the previous sample was very turbid and the mixing chamber therefore is very dirty.

Once you are satisfied that the mixing chamber is clean, push the button to proceed to step 2: Get Background.

Push the button or the Sequoia button if you wish to return to the Main Menu.

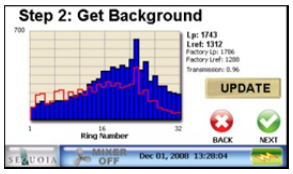


It is necessary to make a background measurement to make sure the optics are clean. Pour clean water into the mixing chamber until it is almost full to the rim and put the lid back on. Turn on the mixer for a couple of seconds, then off again. This ensures that bubbles get flushed out of the optical cell.

If you have made a previous background measurement (e.g. from the last sample), that you would like to use again, push the next button to continue to step 3 and use the existing background.

If you wish to make a new background measurement, push the update UPDATE button.

[1] **DO NOT** use any other liquids than water (fresh or salt water), ethanol, isopropanol (isopropyl alcohol) or non-corrosive oils for suspending particles! **Solvents such as acetone, toluene etc. will permanently damage the instrument and immediately void the warranty!**

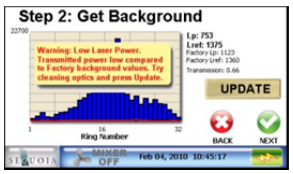


After pushing the update UPDATE button the current background will be displayed in blue bars. The factory background will be shown as a thin red line.

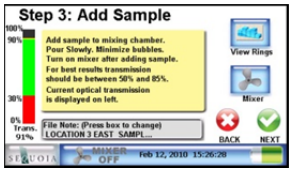
Compare the measurements to evaluate if the quality of the current background is good enough to be used (see the FAQ).

Push the next button if you want to store and use the current background and proceed to Step 3: Add Sample.

If you want to repeat the background, push the update UPDATE button. If you wish to make a new background in clean water, drain and re-fill the mixing chamber, then update.

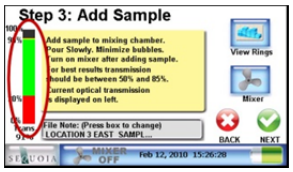


A warning message will appear if the laser power is too low. This may indicate that the windows are dirty and need cleaning. If this is the case, drain the mixing chamber and clean the windows with a Q-tip (see chapter 4: Cleaning and Maintenance).



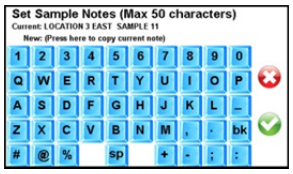
Make sure the drain lever is in the closed position and then add the sample from your beaker to the mixing chamber. You can use the funnel to pour the sample through the hole in the center of the mixing chamber, or you can remove the lid and pour the sample in directly. Make sure that your sample is well homogenized and suspended before you pour it in so that you are not introducing bias into your results.

The optimum concentration range is shown as percent optical transmission in the optical bar chart on the left. Ideally the transmission values should range from 30 to 90% (green part of the bar).



If your sample causes the transmission to drop to below 30% (red part of the bar) you must dilute the sample – see the FAQ in chapter 11 for more information.

If your sample concentration is so low that the transmission is in the yellow part of the bar, above 90%, you should increase the averaging time, see chapter 3.7.



If you press the grey 'File Note' box the keypad will appear, and you can enter a note with a maximum length of 50 characters. The note will be appended as text to the end of the data file when the sample is processed. Use the stylus to enter your note.

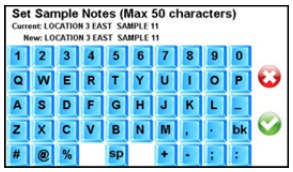
The sp button is the space bar, and the bk button is the delete button.



The , button is used to separate elements of the note. For example, the following note "Location 3, Sample 11, Winnie" will separate the note into 3 columns when imported into a spreadsheet as a comma-separated file. This is useful if you would like to sort your data in the spreadsheet according to e.g. sample location (Location 3), sample number (Sample 11), and operator (Winnie).

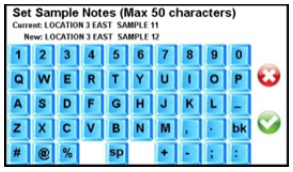
Push the button when you are done to save the new note and return to step 3.

Push the button to return to step 3 without changing the note.

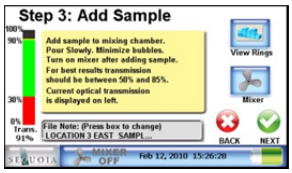


If you press in the section marked (Press here to copy current note) (see above), the current note will copy as a new note.

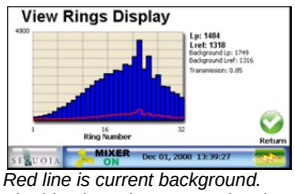
This is useful in many cases, for example where you have many samples from one location, and only need to change the sample number from sample to sample.



In this example, the sample number was changed to 12 simply by copying the existing note, pressing the bk button once and then enter the number 2.



Once your sample note has been entered, you should make sure that the lid is securely in place, and then turn on the mixer by pushing the mixer button. This ensures that the sample is well-mixed and fully suspended before the measurement average is being acquired.



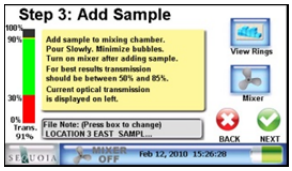
Red line is current background. The blue bars the current signal on the ring detectors. The View Rings Display updates every second..

Note the View Rings button on the Step 3 screen. Pushing the View Rings button will bring up a display of the current signal on the detector rings (in digital counts) compared to the current background.

In the View Rings Display the red line is now the current background measurement, and the blue bars the current signal detected by the ring detector. The higher the bars, relative to the red line, the better the signal-to-noise ratio.

In the example to the left it is evident that there is a very strong signal relative to the background, and thus an excellent signal-to-noise ratio.

Push the Return button to return to the Step 3 screen.



Once you are satisfied with the sample note and, perhaps, the evaluation of the view rings display, continue by pushing the button in order to proceed to acquire the measurement average.



If you did not turn on the mixer, a warning message will appear, asking you to confirm if you really do not wish to turn on the mixer.

Push the button to turn on the mixer and continue.

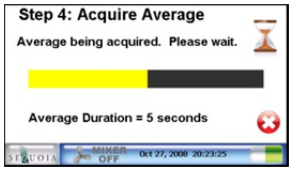
Push the button to continue without turning on the mixer.

Note: It is HIGHLY recommended that you always turn on the mixer. Otherwise your results will be unreliable, as the particles in the mixing chamber will settle out and only be partially measured, or not measured at all!



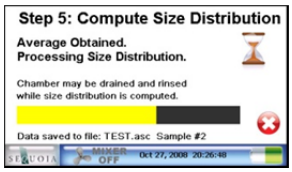
If the optical transmission is below 5% a warning message will appear.

If you wish to continue, push the button, otherwise push the button and try diluting the sample.



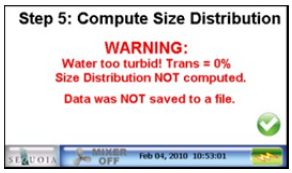
The instrument will then automatically acquire an average at an internal sampling rate of 25Hz while displaying a yellow progress bar.

The average duration is displayed below the progress bar; in the example shown here it is 5 seconds.



Once the measurement average has been obtained, the instrument will compute the size distribution from the averaged data.

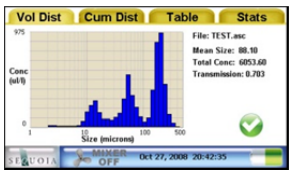
Note that it takes ~ 3 times as long to compute the size distribution if the randomly shaped computation has been selected, when compared to the spherical particles.



If the transmission is below 5% the warning message to the left will appear, and the size distribution will not be computed from the measurement, nor will any data be saved to the file.

If this message appears you must dilute your sample prior to measuring it again.

Push the button in order to return to Step 1.



After the data has been processed, they are automatically displayed. Push the tabs buttons in order to cycle through the various displays.

Push the button in order to return to Step 1: Rinse Chamber and prepare for another sample.

Push the button if you wish to return to the Main Menu instead.

5 Displaying a Saved Measurement



The upper right corner of the Quick Reference Sheet explains how to display an already processed and saved measurement.

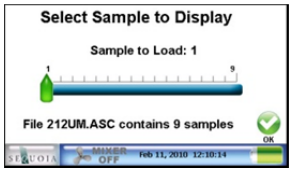


If you wish to display an already saved measurement, push the Display button on the Main Menu.

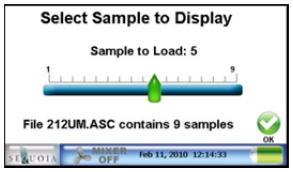


If more than 10 files are stored you will need to use the arrows to scroll up and down the pages until you come to the page with the file you want to display. Use the stylus to tap the filename you want to display. The selected file will be highlighted.

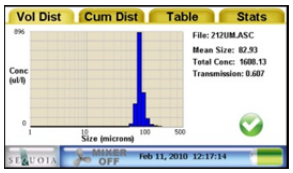
Push the button in order to open up the selected file and display the data in it.



If you had selected multiple files as storage mode, you will have to select the sample to load. For example, for file 212UM.ASC, there are 9 samples in total in the file.



Push down and drag the green slider across the bar to select the sample number you want to load and display. In this case sample number 5 will be loaded. Once you have selected the sample number, push the button in order to open up the sample and display it.



The sample is displayed and you can click the tabs to display the sample in other ways, e.g. as a cumulative distribution, in a table format or as a statistics summary.

Push the button in order to return to the Main Menu.

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6 Deleting Files



There are two ways to delete file(s) on the instrument: Using the touch panel display, or using the Windows software provided with the instrument.

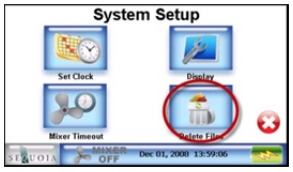
This section explains how you can delete single files using the touch panel display. Section 8.5 explains how to delete single or multiple files using the Windows software.



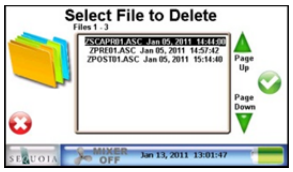
From the Main Menu, push the Setup button.



From the Setup Menu, push the System Setup button

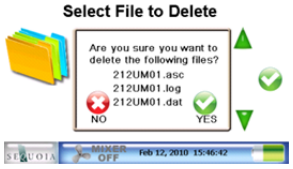


From the System Setup, push the Delete Files button.



Use the arrows to page through the list of files. Use the stylus to select the file you wish to delete. The selected file will be highlighted.

Then push the button in order to delete the file.



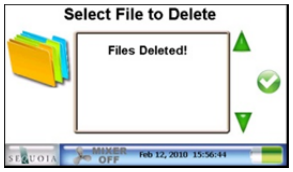
You will be asked to confirm that you wish to delete the file.

Push the button in order to delete the file and associated data (.log and .dat files).

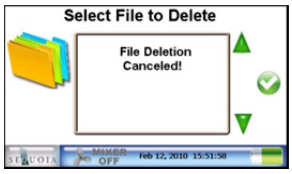
Push the button if you do not want to delete the files.

Please note that every time the LISST-Portable creates a new file, 3 separate files are created: An .ASC file with the processed data as comma separated values, a binary .DAT file and a .LOG file with information about instrument settings. All these files will be completely deleted and cannot be recovered.

Please note that if you have multiple samples in a file (if multiple storage mode was selected), all samples in that file will be deleted. It is not possible to delete a particular sample within a file that has multiple samples.



If you pushed the button a Files Deleted confirmation message will appear once the files have been deleted, and the instrument will automatically return to the System Setup after 5 seconds.



If you pushed the button a File Deletion Canceled message will appear, and the instrument will automatically return to the System Setup after 5 seconds.

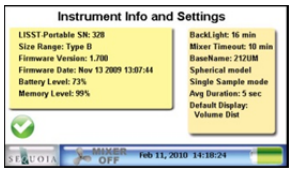
7 Reviewing Instrument Info and Settings



The current instrument settings can be reviewed quickly.



From the Main Menu, push the Info button.



The instrument info and settings screen will appear, displaying the current settings, as well as instrument serial number, size range, firmware version and date, and battery and memory level. No changes to the instrument settings can be made from the info screen.

Push the button or the button to return to the Main Menu.

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8 Installation and use of the Windows Software

8.1 Software Installation

Included in the shipping box with the LISST-Portable is the LISST-Portable Software CD

Load the software by installing the CD into the computer. The install program should start automatically. If it does not, run the SetupPortable.EXE program on the CD.

After installation the software can be started from the Start Menu. The path is Start > Programs > Sequoia Scientific > LISST-Portable.

After installation, the executable (LisstPort.exe) is located in C:\Program Files\Sequoia\LISST-Portable for 32-bit Windows machines and C:\Program Files (x86)\Sequoia\LISST-Portable for 64-bit Windows machines.

8.2 Establish Connection

Make sure that the LISST-Portable is turned on.

Connect the serial cable between the instrument and the serial port on your computer.



Open up the LISST-Portable program.

Click the traffic light to establish connection to the LISST-Portable. Connection to the LISST-Portable is via a serial port, 9,600 baud with a File Offload Baud Rate at 115,200 baud.



As the traffic light changes to green, the display on the LISST-Portable changes to show that the External interface has been activated.

In this mode the instrument does not respond to the touch panel, until you have clicked the stoplight in the Windows software and changed it back to red.



When connection has been established the traffic light turns green and all he icons become active.

8.3 Setting Date and Time

Make sure that connection has been established (see chapter 8.2).



Click the clock icon in order to set the clock.



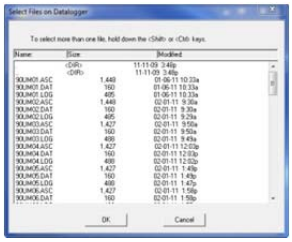
The instrument time will be set to the computer time, and a status message displayed.

8.4 Offloading Files

Make sure that connection has been established (see chapter 8.2).



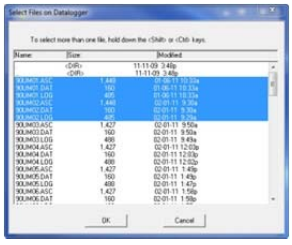
Click the offload icon in order to display the files on the instrument.



A list of files on the data logger onboard the instrument is displayed.

Select the files you wish to offload. Select multiple files by holding down the <Shift> or <CTRL> key while selecting.

NOTE: You should always offload corresponding .ASC, .DAT and .LOG files. The .ASC files are the processed data in a comma-separated format (for display in e.g. spreadsheets), the .DAT file is a binary data file containing the raw data (to be used by Sequoia for troubleshooting data), and the .LOG file is a file displaying instrument info and settings.

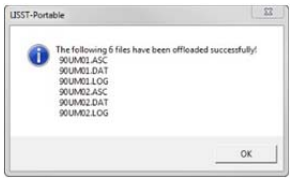


Here, 2 files (90UM01 and 90UM02) have been selected for offloading. Note that a total of 6 files are selected, as each sample generates a .ASC, .DAT and .LOG file.



Next, specify an offload destination. Also specify if existing files with the same file name should be automatically overwritten.

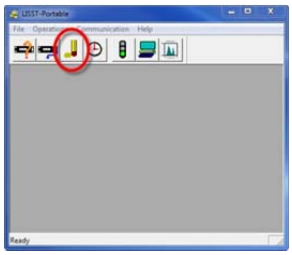
Click the OK button and the files will subsequently offload to the specified folder.



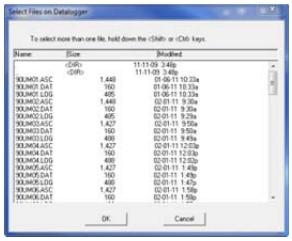
After offloading a status message is displayed. Click the OK button to continue.

8.5 Deleting Files

Make sure that connection has been established (see chapter 8.2).



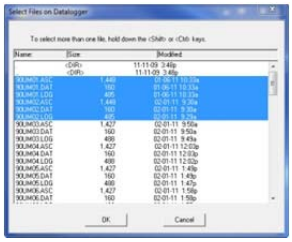
Click the delete icon in order to display the files on the instrument.



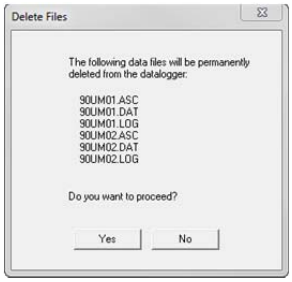
A list of files on the datalogger onboard the instrument is displayed.

Select the files you wish to delete. Select multiple files by holding down the <Shift> or <CTRL> key while selecting.

NOTE: You should always delete corresponding.ASC, .DAT and .LOG files, but not until you are sure that they have been properly offloaded and saved in a secure location.



Here, 2 files (90UM and 90UM02) have been selected for deletion. Note that a total of 6 files are selected, as each sample generates an .ASC, .DAT and .LOG file.



A file deletion confirmation box appears. You must confirm file deletion by clicking the Yes button and the files will be deleted.

8.6 Query Instrument

Make sure that connection has been established (see chapter 8.2).



For troubleshooting purposes, Sequoia may ask you to query the instrument. Click the query icon.



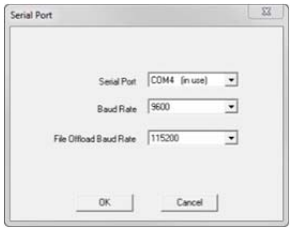
A window displaying the LISST-Portable serial number. Firmware version and other status info show. Click the OK button to close.

8.7 Change Serial Port Settings

Make sure that connection has been established (see chapter 8.2).



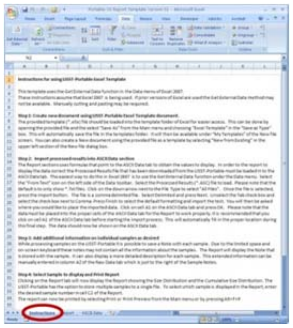
In order to change the offload baud rate, select display serial port settings.



The Select Port window will open up. On the drop down menu, select the appropriate serial port and baud rate. If you experience offload problems, try to minimize the Baud Rate (NOT the File Offload Baud Rate), and make sure the serial port you have selected is the one used by the instrument.

9 Report Creation Using Excel

The enclosed EXCEL 2007 template spreadsheet will load an .ASC file created by the LISST-Portable. Once loaded, the user can then select which sample to display, and a size distribution and cumulative curve will be plotted on a report sheet, together with sample statistics.



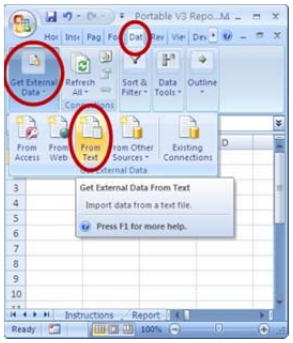
Open up the EXCEL spreadsheet named 'Portable V3 Report Template.xltx' and click the Instructions  tab if you wish to read the instructions.

Alternatively, you can follow the instructions here.

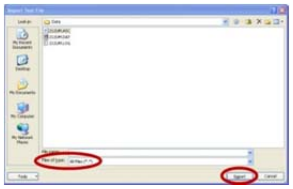


In order to import data to the spreadsheet, click the ASCII Data  tab at the bottom of workbook to make the ASCII Data worksheet active.

Click in Cell A1 in the ASCII Data worksheet to make that cell active.



In the Data  tab on the top of the workbook, on the Get External Data  ribbon on the left, select From Text  in order to import external data from a text file.



Navigate to the folder on your computer where your LISST-Portable data are stored. In order to see the files you must select All Files (*.*) as Files of Type in the dialog box: .

Now select the .ASC file you wish to import and click the Import  button.



There are 3 steps to importing a file into EXCEL 2007.

As the first step you must select the 'Delimited'  radio button, and then click the  Next button



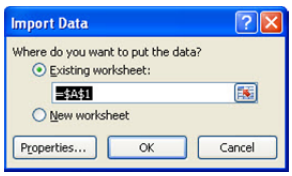
As the second step you must select the delimiter used to separate the data into columns.

Check the 'Comma' ☑ Comma box, uncheck all other boxes, and then click the Next > Next button.



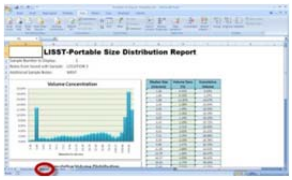
As the third step you must select the data format for the imported data.

Click the 'General' ◉ General radio button, and then click the 'Finish' Finish button.

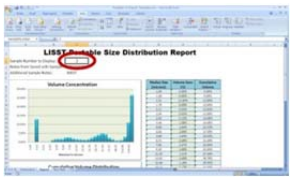


Confirm that you are importing the data file to cell A1 in the Existing Worksheet by clicking the OK OK button.

NOTE: The report display will not work properly if you do not import the file into cell A1 in the ASCII Data tab.

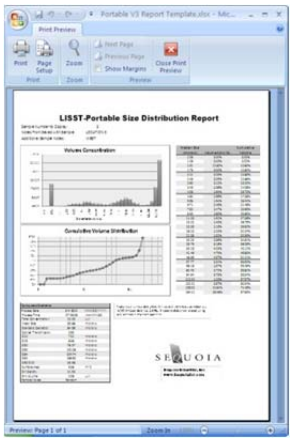


Click on the Report Report tab at the bottom of the workbook to display the report.

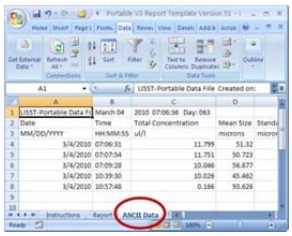


If your sample was stored using the multiple samples storage mode (i.e. more than one measurement is stored in each file), you can select the sample to display by entering the sample number in cell C2 on the Report worksheet.

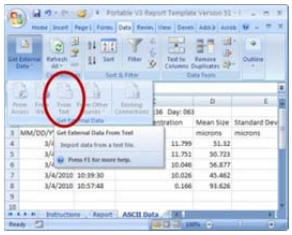
In this example the sample displayed has been changed to sample number 3 by entering the number 3 into cell C2.



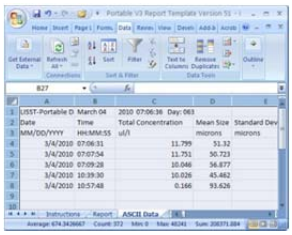
Click Print Preview (or CTRL + F2) to review the final layout and appearance of your report before printing it out.



If you wish to load and print data from another file, you must click the ASCII Data tab to make the ASCII Data worksheet active



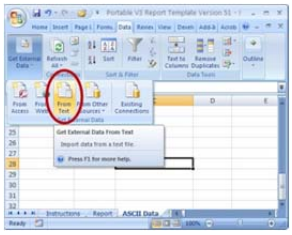
Notice that the From Text button in Get External Data has been grayed out.



Select all data in the ASCII Data worksheet by selecting the worksheet and pressing <CTRL> + a in order to select the data in the worksheet. Then press the <delete> button on your computer.



A dialog box will appear, asking if you want to delete both the query and the range. Click the Yes button.



The From Text button is now available and you can load a new file for display.

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10 Handling, Cleaning, Maintenance and Storage

10.1 Handling

When handling the instrument, at all times please remember that the LISST-Portable is a high-precision optical instrument.

Avoid mechanical shocks and impact to the housing, as this may cause misalignment of the optical parts.

Avoid scratching the touch panel display.



To charge the LISST-Portable, plug the jack connector into the DB-9 connector on the power cable, connect the power cable to the LISST-Portable and connect the power supply to a 110/220V source.

If you use the power supply that ships with the LISST-Portable you cannot over charge the internal battery.

10.2 Cleaning

Clean the panel using only lukewarm water, a mild soap (e.g. liquid hand soap) and a soft cloth.

Do not use any abrasive cleaners.

If you have been using liquids with a high viscosity (e.g. oils) and need to rinse them out, try to first circulate ethanol or isopropyl alcohol through the system. Then try lukewarm water with a mild soap solution. Then finish off with just lukewarm water.

NEVER use solvents such as toluene or acetone for cleaning the instrument – sensitive optics parts will be damaged if you do so and the warranty will be immediately voided!

If you have been analyzing cement powders, make sure that you rinse out the system thoroughly using isopropyl alcohol, so that no cement is left inside the instrument.



For cleaning of the windows, rinse out the mixing chamber with clean (filtered or de-ionized) water several times in order to flush out all particles from the mixing chamber and the mixing system.

Now gently wipe the windows in the optical cell with a cotton swab dipped in a mild soap solution (e.g. liquid hand wash soap). Then rinse several times with clean water and check the background again.

10.3 Storage

For storage for more than a few days, clean the windows as described above, and put the lid on the mixing chamber to avoid dust falling into it. Store the instrument in a dry location between 5 and 45°C.

The instrument is powered by rechargeable batteries. If charged with the supplied power adaptor they cannot be overcharged.

The battery should be fully charged before long term storage.

11 FAQ's

What is a shape model and which should I choose?

The Spherical particle model performs the mathematical inversion under the assumption that the particles that scattered light are all spheres. Sequoia employs the so-called full Mie solution when using this approach. The Mie solution is a generalized solution to the scattering of light from spheres and is being used as the standard inversion method by all laser manufacturers.

However, sediment particles in aquatic and industrial environments are rarely, if ever, perfect spheres. Consequently Sequoia provides an option to invert the scattering pattern under the assumption that the particles are randomly (or irregularly) shaped particles. The exact details of how this inversion takes place is described in a scientific paper[2], which can be downloaded from the library section on Sequoia's website (www.SequoiaSci.com). The paper is also included on your ship disk. A brief version of the method is described in this News article on Sequoia's website: http://sequoiasci.com/Articles/ArticlePage.aspx?pageId=133

So what method should you use? Unless you know for a fact that your particles are spherical you should choose the randomly shaped model. The only exception to this would be if you have to do a lot of comparisons with outputs from other laser particle sizers, for example a laboratory particle sizer. The reason for this is that no other laser manufacturer provides a randomly shaped particle model for inversion, so there will be nothing to compare to if you select the randomly shaped model.

If you choose the randomly shaped model, the LISST-Portable will return a size distribution that is directly comparable to a sieve size distribution.

Please note that the size ranges changes a little, depending on what inversion model you choose to use. For details about why this is so, please consult the paper[2].

How do I dilute a sample?

Pour clean water (~175ml) into the mixing chamber and do a background measurement. Confirm that the background measurement in clean water is OK. Drain out the water.

Take the suspended sediment sample and pour it into the mixing chamber so that it is full to the top of the lid. Use the funnel to top of the chamber through the small hole at the top of the lid, if necessary. Seal the hole in the top of the lid with the black fitting. Start the mixer. Observe if the instrument gives you a warning that the concentration is too high.

If this is the case, use a pipette to siphon off 50 ml of the sample, while it is circulating, then add 50 ml of clean, particle free water and let it mix for 5-10 seconds with the mixer pump running.

Observe if the concentration is still too high. If it is, siphon off another 50 ml, and add 50 ml of clean water. Repeat this procedure until the concentration is in the correct range, then add a note about how many dilutions have been carried out, and proceed with the analysis.

When you offload the data, you must use the number in the note to correct your volume concentrations to the actual values. Because the sample was diluted, the data file will contain the concentration for the diluted sample, but you want the concentration for the un-diluted sample.

The volume of the mixing chamber is 175 ml. If you had performed 2 dilutions, and each time siphoned off 50 ml, then the original, undiluted concentration (VC_org) can be computed from the measured concentration after dilution (VC_dil) as follows:

$$\mathrm{VC_org} = \frac{\mathrm{VC_dil}}{\left(1 - \frac{50}{175}\right)^2}$$

A more general formula would be

$$\mathrm{VC_org} = \frac{\mathrm{VC_dil}}{\left(1 - \frac{\mathrm{SV}}{175}\right)^{\mathrm{N}}}$$

Where SV is the volume (in ml) you have siphoned off for each dilution and N is the number of

[2] Agrawal, Whitmire, Mikkelsen, Pottsmith (2008): Light scattering by random shaped particles and consequences on measuring suspended sediments by laser diffraction. Journal of Geophysical Research 113, C04023, doi:10.1029/2007JC004403

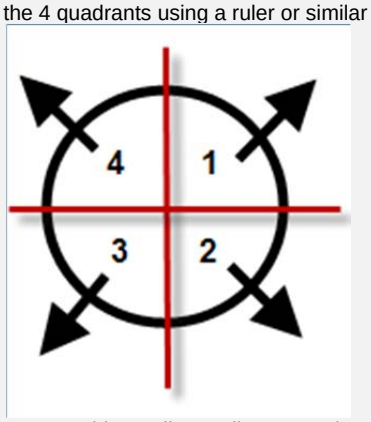
dilutions you have performed.

Note that the above equations only work if the mixing chamber is filled completely to the top and if the volume siphoned off is the same each time.

How do I take a representative subsample?

This is a more fundamental question that everybody involved in particle size analysis will have to consider at some point. There is no universal answer, but the following can be considered guidelines.

If you have a sediment sample from, say a dry grab sample or a dry soil sample, you can pile it up into a cone-formed shape. The figure illustrates the cone as seen from above. Divide it into the 4 quadrants using a ruler or similar and move them apart from each other.

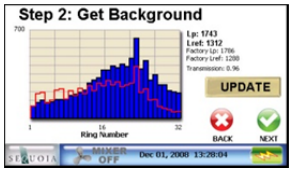


Now combine 2 diagonally opposed quadrants (e.g. 1 and 3) into a new and smaller cone shaped pile, and then repeat until your sample is small enough to be suspended and analyzed.

This procedure obviously doesn't work if you have a sample that is already suspended in a liquid. In that case you can either go ahead and pour the sample into the instrument and measure it. Then, if the concentration is too high you can dilute the sample as per the description in the 'How do I dilute a sample?' FAQ.

However, if the volume of your sample is already larger than the volume of the LISST-Portable mixing chamber, then you must split the sample first. Wet-splitting a sample requires specialized laboratory equipment - do a Google search for 'Wet sample splitter' or 'Wet sample divider'.

How do I evaluate the background measurement?



Upon obtaining a background, the red line shows the factory background and the blue bars show the current background. They should be close together, and the optical transmission should be in the range from 0.95 to 1.

Strongly increased values on the middle and outer rings (ring numbers 8-32) suggest dirty windows. Increased values on the inner rings (1-8), together with a transmission value significantly below 1 suggests that the optics has become misaligned. Consult Sequoia for a diagnostic of how serious the problem is and how to proceed.

The figure to the left suggests that the windows are slightly dirty (increased values on the middle rings compared to factory values), but not extremely dirty (the transmission is at 0.96, so above 0.95). There is no indication of misalignment, which would be seen as increased scattering on rings 1-8.

Can I reprocess a set of data obtained with the spherical model using the randomly shaped model?

No. At the moment this is not possible to do onboard the instrument. However, it is possible to first process a sediment sample in the mixing chamber using one shape model, e.g. spherical, then change the shape model to randomly shaped in the Setup Menu, and then measure the sample again, retaining the same zscat as for the first sample.

MATLAB scripts are available for computing the size distribution using both methods from the .DAT files. Contact Sequoia for assistance if you have a large number of .DAT files you would like to have processed using the other inversion method than the one you originally selected.

Does the LISST-Portable require any calibration?

No. All that is required is that the user makes a background measurement before a measurement of a sample is taken. This is in order to evaluate the state and cleanliness of the optical system. If this is good (e.g. the current background measurement is close to the factory background, see FAQ above) the instrument will deliver good data.

What happens if there are particle present outside of the size range covered by my LISST-Portable?	This is a more complex question. Very briefly, the presence of sediment particles outside the size range covered by the instrument will cause some additional scattering on the inner- or outermost rings of the ring detector. In turn, this increased scattering will be detected as particle volume, so that the net effect is to increase the particle volume in the smallest and/or largest size classes. Typically, the effect can be seen if there is a significant amount of particles outside the size range, so that a rising tail will appear in the coarse and/or fine end of the size spectrum.
Does the instrument measure NTU, FTU or any other turbidity units?	No. All laser diffraction based instruments measure the volume distribution of the suspended particles. This may or may not be related to NTU.
Can I overcharge the rechargeable battery inside the instrument?	No. If you charge the battery with the power adaptor supplied by Sequoia as part of the instrument you cannot overcharge the battery.
What liquids can I use for suspending my particles?	Use ONLY water (fresh or salt water), ethanol or isopropanol (isopropyl alcohol) or non-corrosive oils for suspending particles! **Use of solvents such as acetone, toluene etc. for suspending particles will permanently damage the instrument and void the warranty!!**
Does the instrument detect different types of particles?	Regardless of the type of suspended particles, the LISST-Portable will measure the size and volume concentration of the particles. However, it cannot discriminate different types of particles (e.g. quartz and feldspar; organic and inorganic) from each other.
What is the volume of the mixing chamber?	When the mixing chamber is filled to the top with the lid in place it contains 175 ml.
What are the units for the concentration measurements?	The units for the concentration are in terms of particle volume per unit volume of liquid – micro-liters / l or µl/l.
Can I convert the volume concentration to mass concentration?	You will have to figure out the density of the suspended particles in your sample, or assume one. Then you can multiply the volume concentration from the instrument with the density to get the mass concentration. For example, if you have a volume concentration of 16.7 µl/l and you know that your particles have a density of 2.65 g/cm^3, then the mass concentration is 16.7µl/l * 2.65 g/cm^3 = 44.3 mg/l. For more detailed information, see these articles on Sequoia's website: http://sequoiasci.com/Articles/ArticlePage.aspx?pageId=204 and http://sequoiasci.com/Articles/ArticlePage.aspx?pageId=197
Can I convert volume concentration or mass concentration to ppm (parts-per-million)?	Yes. If you are looking for ppm by VOLUME, then the volume concentration in µl/l is equivalent to ppm by VOLUME. If your ppm is by MASS, then you must convert the volume concentration to mass concentration (see above) with units of mg/l. The units of mg/l are equivalent to ppm by MASS.
What is the operating range of the instrument in terms of optical transmission?	The operating range of the LISST-Portable in terms of optical transmission is 30-98%. Above 98% transmission the data will become increasingly noisy. Below 30% optical transmission the data will become increasingly influenced by multiple scattering and you may end up 'inventing' fine particles.

Do you have a question not answered here? Try the FAQ webpage on our website (http://www.SequoiaSci.com/faq/?SectionName=faq)! Otherwise contact us; see the front of this manual for detailed contact information.

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12 Troubleshooting

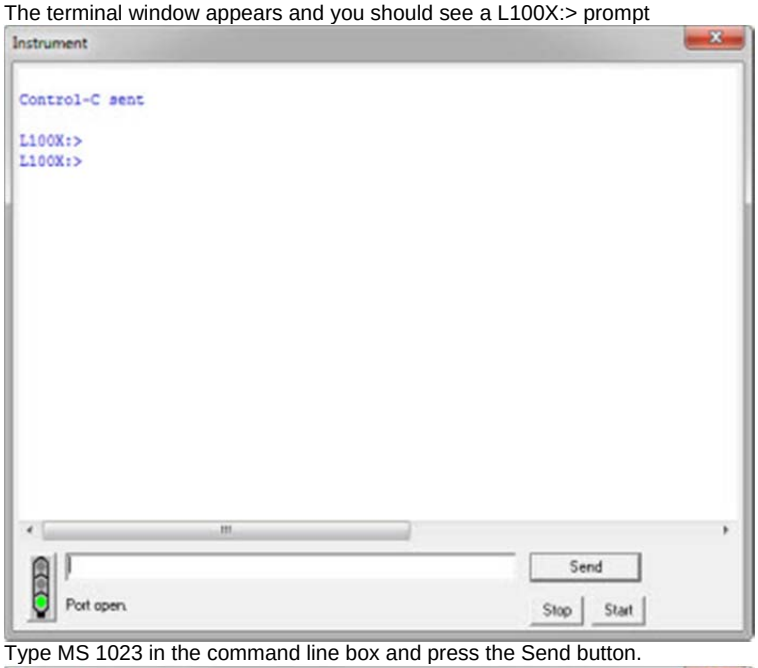
When computing the size distribution (step 5) the instrument freezes and does not display the computed data

Your base name may have become corrupted. Try to restart the LISST-Portable and enter a new base name, e.g. Test. Then try again.

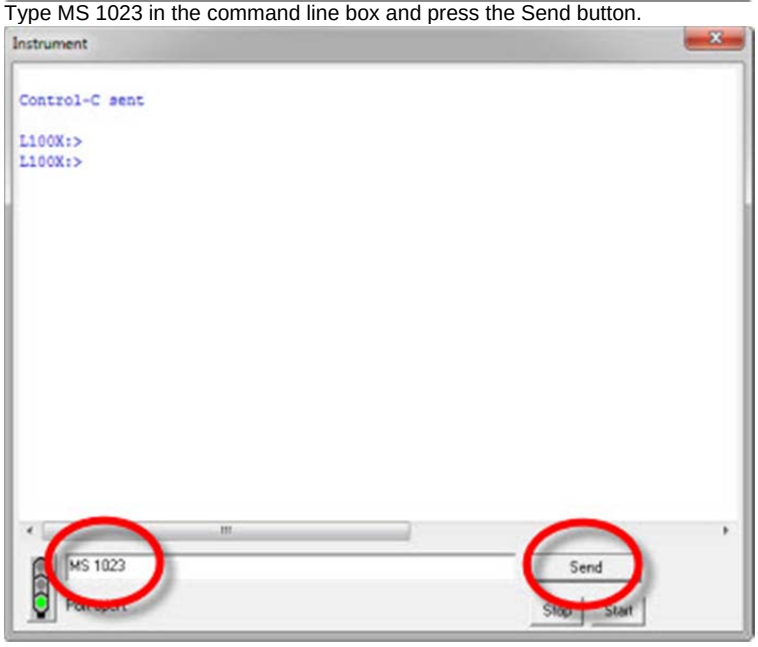
The pump doesn't start when sampling or when pushing the mixer button. The light comes on.

If the blue light comes on, the pump is getting power. Temporarily increasing the voltage to the motor can help clear excess sediment or free a stuck mixer impeller.

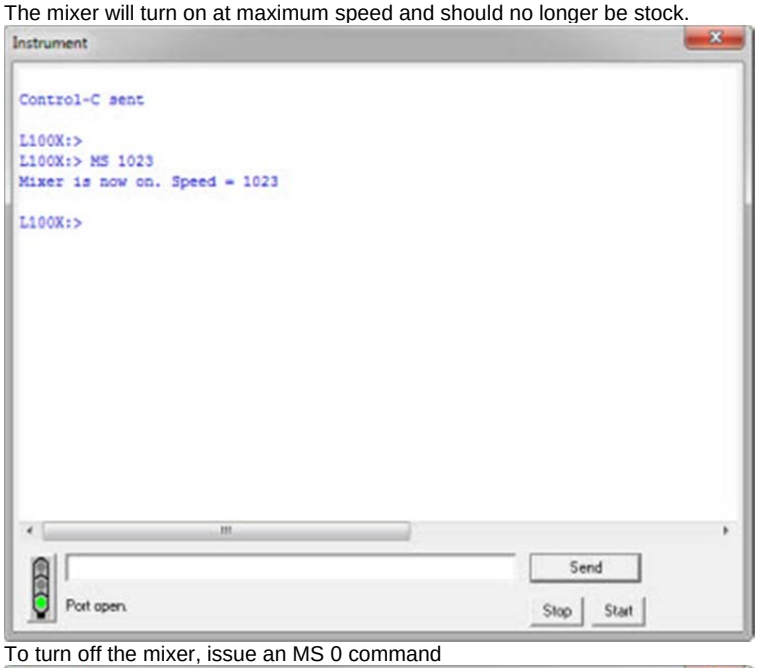
1) Connect the LISST-Portable to the PC where the LISST-Portable software is installed.
2) Open up the software and establish communication by selecting Operations | Connect – Use External Interface or click the traffic light icon . Notice that the LISST-Portable screen changes to 'External Interface Activated'
3) Open the terminal window by selecting Communication | Terminal Window or click the terminal window icon .
4) The terminal window appears and you should see a L100X:> prompt



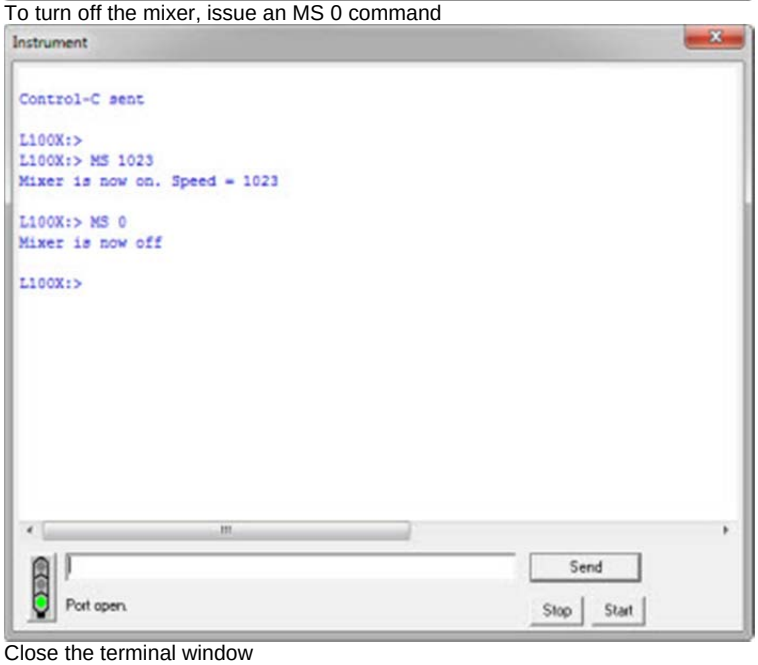
5) Type MS 1023 in the command line box and press the Send button.



6) The mixer will turn on at maximum speed and should no longer be stock.



7) To turn off the mixer, issue an MS 0 command



8) Close the terminal window
9) Click the traffic light icon to close communication with the LISST-Portable. The LISST-Portable touch panel will become active and the instrument is ready for normal use.

13 Warranty

STATEMENT OF LIMITED WARRANTY AND LIABILITY

This Statement of Limited Warranty applies to all Sequoia Scientific, Inc. (“SEQUOIA”) products ("Products"). Any additional or different terms, including any terms in any purchase order, will be of no effect unless agreed to in writing by an authorized representative of SEQUOIA as reflected in a written SEQUOIA quotation.

1. Limited Warranty
SEQUOIA warrants that upon delivery by SEQUOIA (a) the Products will be free from defects in materials and workmanship, (b) the Products will perform substantially in accordance with SEQUOIA's applicable specifications, and (c) any Products (or components or parts thereof) that are manufactured by SEQUOIA do not infringe any U.S. patent or copyright.

2. Correction of Non-Compliance
If, during the twelve months after delivery (the “Warranty Period”), any Product does not comply with the warranties set forth in 1(a) and 1(b) above, SEQUOIA will, at its option, either (a) repair the Product, (b) replace the Product, or (c) refund the purchase price paid by Customer to SEQUOIA for the Product; provided that Customer gives SEQUOIA written notice of the noncompliance within the Warranty Period and ships the Product to SEQUOIA within one month after the end of the Warranty Period. As to any Product repaired or replaced by SEQUOIA, the Warranty Period will end upon the later of the end of the original Warranty Period or 90 days after SEQUOIA's delivery of the repaired or replacement Product to Customer. Any Product, component, part or other item replaced by SEQUOIA becomes the property of SEQUOIA. SEQUOIA may use refurbished components in the repair of Products supplied hereunder.

SEQUOIA's warranties shall be void and not apply if the Product has been subjected to misuse or alteration or repaired by a party not approved by SEQUOIA or the serial number on a product (if applicable) has been altered or defaced. SEQUOIA shall not be liable for normal wear and tear (such as replacement of consumables), nor for defects or failure caused by maintenance, misuse, negligence or failure resulting from non-compliance with SEQUOIA’s specifications, operating or maintenance manuals.

3. Infringement Indemnification
If any Product does not comply with the warranty set forth in 1(c) above, SEQUOIA will defend and indemnify Customer against any third-party claim asserted in any proceeding against Customer based on this noncompliance; provided that Customer gives SEQUOIA prompt written notice of the claim, SEQUOIA has exclusive control over the defense and settlement of the claim, Customer provides such assistance as SEQUOIA may request in connection with the defense and settlement of the claim (in which event SEQUOIA will reimburse the reasonable out-of-pocket costs incurred by Customer to provide such assistance), Customer does not settle the claim without the prior written consent of SEQUOIA and, upon SEQUOIA's request, Customer returns the Non-Complying Product to SEQUOIA for modification, replacement or a refund of the purchase price paid by Customer to SEQUOIA for the Non-Complying Product, less a reasonable allowance for Customer's use prior to return.

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THE WARRANTIES SET FORTH IN PARAGRAPH 1 ABOVE ARE EXCLUSIVE AND IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED. SEQUOIA DISCLAIMS ANY AND ALL WARRANTIES, EXPRESS OR IMPLIED (INCLUDING, BUT NOT LIMITED TO, ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, AND ANY IMPLIED WARRANTY ARISING FROM COURSE OF PERFORMANCE, COURSE OF DEALING, OR USAGE OF TRADE) OTHER THAN THOSE SPECIFICALLY SET FORTH IN PARAGRAPH 1.

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SEQUOIA will not be liable for any indirect, incidental, special or consequential damages, any cover, or any loss of revenue, profit, data or use.

7. Limitations of Liability
SEQUOIA's liability (whether in contract, tort, or otherwise; and notwithstanding any fault, negligence, strict liability or product liability) with regard to any Product (including, but not limited to, any breach of or default by SEQUOIA) will in no event exceed the purchase price paid by Customer to SEQUOIA for such Product. Further, SEQUOIA will not be liable for, or be in breach of or default on account of, any delay or failure to perform as a result of any cause, condition or circumstance beyond SEQUOIA's reasonable control.

8. Indemnification by Customer
Customer acknowledges that the Products are designed and manufactured for use in non-critical, monitoring situations. If Customer chooses to purchase a Product or Products for use in applications that could result in damages in excess of the price of the Product if the Product does not operate properly or otherwise fails, Customer acknowledges and agrees that it is Customer’s responsibility to provide for redundancy and/or other safety or back-up measures sufficient to assure that failure of a Product(s) will not cause such damages. Customer agrees that it will defend and hold SEQUOIA harmless from any and all claims and costs (including but not limited to attorney’s fees and other costs of defense against such claims) in excess of the price of the Products arising directly or indirectly from such Customer’s use of the Products. Such indemnification is a critical part of the consideration being provided by

Customer (over and above the price paid for the Product(s)) for the right to use the Products for such purposes and Customer shall not use a Product or Products for such purposes if it is unwilling or unable to provide such indemnification.

9. Statute of Limitations
Customer will not commence any action based on breach of warranty with respect to any Product more than 18 months after SEQUOIA's delivery of such Product.

10. Software
The Products may include or be delivered with certain computer programs, databases or other software that is proprietary to SEQUOIA. SEQUOIA hereby grants Customer a nonexclusive license to use such software solely for the purpose of operating Products. Customer will not: use any such software for any other purpose; modify, adapt, translate, or create derivative works based on any such software; or disassemble, decompile or reverse engineer any such software. No title to or ownership of any software or intellectual property rights are transferred to Customer.

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12. Controlling Document
In the event of any conflict or inconsistency between any provision of this Statement of Limited Warranty and any other provision of the Order, the provision of this Statement of Limited Warranty will control.

13. Controlling Law
This Statement of Limited Warranty will be governed by the laws of the State of Washington without reference to its rules relating to choice of law for the purpose of applying another jurisdiction’s law. The U.N. Convention on Contracts for the International Sale of Goods will not apply.

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