SPECTREX CORPORATION

INSTRUCTION MANUAL

SPECTREX SUPERCOUNT™ SOFTWARE FOR WINDOWS®
FOR USE WITH PC-2200 AND PC-2300

March 2010

3580 Haven Avenue • Redwood City, CA 94063
PH: (650) 365-6567 • (800) 822-3940 • FX: (650) 365-5845
www.spectrex.com • email: info@spectrex.com

Table of Contents

SPECTREX CORPORATION

Seven Simple Steps (after the system is operational)

1

1. Turn on the instrument, computer and monitor.

2. With mouse, click on SPECTREX LPC icon.

3. Place sample onto **V Block** on the PC-2200.

4. Click on 123 to select **settings**.

5. Press spacebar or click on **GO** icon on to start counting.

6. Click on O/P to select output options.

7. Click on  to print results.

SPECTREX CORPORATION

For a computer running Windows 95, 98 or 2000, the system should have at least 32 MB Ram and 800 x 600 monitor resolution.

IMPORTANT

If dilution is necessary

Any sample with counts greater than 800–1000 per mL (cc) should be diluted to avoid coincident counts. It is important to always have as clean a diluent/suspension medium as possible. It should not have more than 30-40 particles greater than 1µm per mL.

For hydraulic oils, high quality, particle-free hexane is available from:
EM Science,
111 Woodcrest Road
Cherry Hill, New Jersey 08034.

Particle-free 5605 hydraulic oil is available from:
SCP SCIENCE
21800 Clark Graham
Baie D'Urfe, Quebec
H9X 4B6
CANADA
www.conostan.com

Particle-free limonene is available from:
Oil Analysis Labs, Spokane WA. (Phone 509-535-9791).

Catalog Number	Description
150-701-003	PartiStan Super Clean Fluid, 400ml
150-701-004	PartiStan Super Clean Fluid, 1 Gallon

DRIVER INSTALLATION FOR MX SOFTWARE
(See page 5 if you do not have MX software.)

Note: This is the current, recommended MX driver software installation and should be used if you have the latest Spectrex DVD, Rev 11.0 or flash drive. You will need Windows XP, Vista or Windows 7 to run this.

DRIVER INSTALLATION AND SET-UP

1) Turn on computer
2) Open files on Spectrex DVD disc or flash drive.
3) Run NIDAQ “890f1” EXE file
4) Restart computer when asked. This will install the “Measurement and Automation” program and its icon will appear on the desktop screen

SUPERCOUNT INSTALLATION AND SET-UP

1) Open Spectrex files on DVD disc or flash drive.
2) Run set-up for “Supercount MX.EXE”
    a.) If using PCI card, turn off computer and install A/D board. Restart computer.
    b.) If using USB, simply connect the cable to the USB port (no need to restart computer).
3) The desktop icon should read “SPECTREX Supercount MX”
4) Open SPECTREX Supercount software
5) Proceed to Section B of this manual “Instrument & Computer Interface Calibration”

DRIVER installation and set-up for NIDAQ 6.7- 6.9

Before unpacking and installing the National A-D data acquisition board (see Spectrex parts list) refer to the manuals supplied with your computer and install the main system components per their instructions. Then familiarize yourself with its operation before attempting to use the computer in conjunction with the LPC.

Note: Before removing or installing any A-D cards, make sure the computer is turned off - preferably unplugged from its wall socket.

1. Turn on computer

2. Load Spectrex CD and let boot up.

3. The NIDAQ installation will automatically start. If it does not automatically start, navigate to the CD drive and double click on setup.exe. Notice that if you are running Windows 2000, you may be asked to reboot your computer at this time. If so, re-insert the CD to initiate the install again after system comes back up.

4. Choose “Install NIDAQ/NI-SWITCH” from the menu. Only traditional NIDAQ is necessary to install. Deselect all other drives.

5. Proceed through the NIDAQ installation wizard. After installation is complete, you will be prompted to reboot your system.

6. Shut your system completely down.

7. Install the E-Series A-D Board in your computer.

8. Turn your computer back on.

9. Start the National Software by either:
   (For Windows XP users) choose Start/All Programs/National Instruments/Measurement & Automation.
   (For Windows ME, NT4 and 2000 users) choose Start/Programs/National Instruments/Measurement & Automation.
10. From the National Instruments Measurement and Automation Explorer, Click on the Plus (+) sign to the left of the label “**Devices and Interfaces**” to expand the tree.

11. From within “Devices and Interfaces”, click on the Plus sign to the left of the label “**Traditional NI-DAQ Devices**”.

12. Click on the Label under Traditional NI-DAQ Devices that corresponds to the specific board you have installed. For example, if you have a PCI-6024E board, you would click on the label PCI-6024E.

13. Choose the button labeled “Properties” near the top of the Application window. (Or, right click on the board label and choose properties from the context menu)

14. From the Configuration Device Dialog, choose the **AI** tab.

15. Verify that the **Polarity/Range** setting is set to “**-10.0V - +10.0V**”.

16. Verify that **Mode** is set to “**Referenced Single Ended**”.

17. Click “Apply” to save settings.

18. Close the Measurement and Automation Explorer Application.

SuperCount Software Installation and Set-up

1. Select windows “Start” button on toolbar.

2. Select “Run” then “Browse” and locate the CD and select “InstallSuperCount.exe”, open, and OK.

3. Follow the instructions and the Spectrex software will be installed.

4. Load Spectrex Software, select “Utilities” then “Counter Signal Calibration” and go to section B “Set up” - Instrument and Computer interface calibration.

Instrument & computer interface calibration B

1. Click on **Utilities** and then on **Counter Signal Calibration.**

2. Ignore the warning sign as you will now be setting up the calibration parameters for your particular computer. Click on **Yes.**

3. The **Card Calibration Parameter Values** window will appear at the bottom right side of screen.

4. Click on **Pre-gain Slide** which can be moved from left to right with the mouse. Set the number to the right of the slide to the pre-gain value on the front page of the Calibration Report for your instrument.

5. Repeat this for the Voltage Reference **Vref** and **Offset.**

6. Click on **Exit/Save** and you are now in calibration.

General Principles of Particle Counting 4

The Spectrex Laser Particle Counter (referred to throughout this manual as LPC) determines the number and size distribution of particles in a liquid suspension. The system currently handles particle sizes ranging from 1 µm to 100 µm in diameter. It accomplishes this by analyzing the forward scattering interference patterns created by illuminating the particles with a beam of monochromatic light. This is called Fraunhoffer diffraction. The characteristics and amplitudes of these patterns are analyzed in real time to determine both the number and size of the particles creating these patterns.

Two groups of 16 size ranges are available: the **F0 filter** sizes particles from 1 µm to 16 µm in size, and **F80 filter** sizes from 17 µm to100 µm. The F0 and F80 refer to the amount of effective illuminating beam attenuation used to size particles in the two size ranges. Since larger particles reflect more light, either the illumination source or the detector signal must be attenuated when measuring them to ensure that the resulting amplitude signal remains within the operational range of the detector amplifiers.

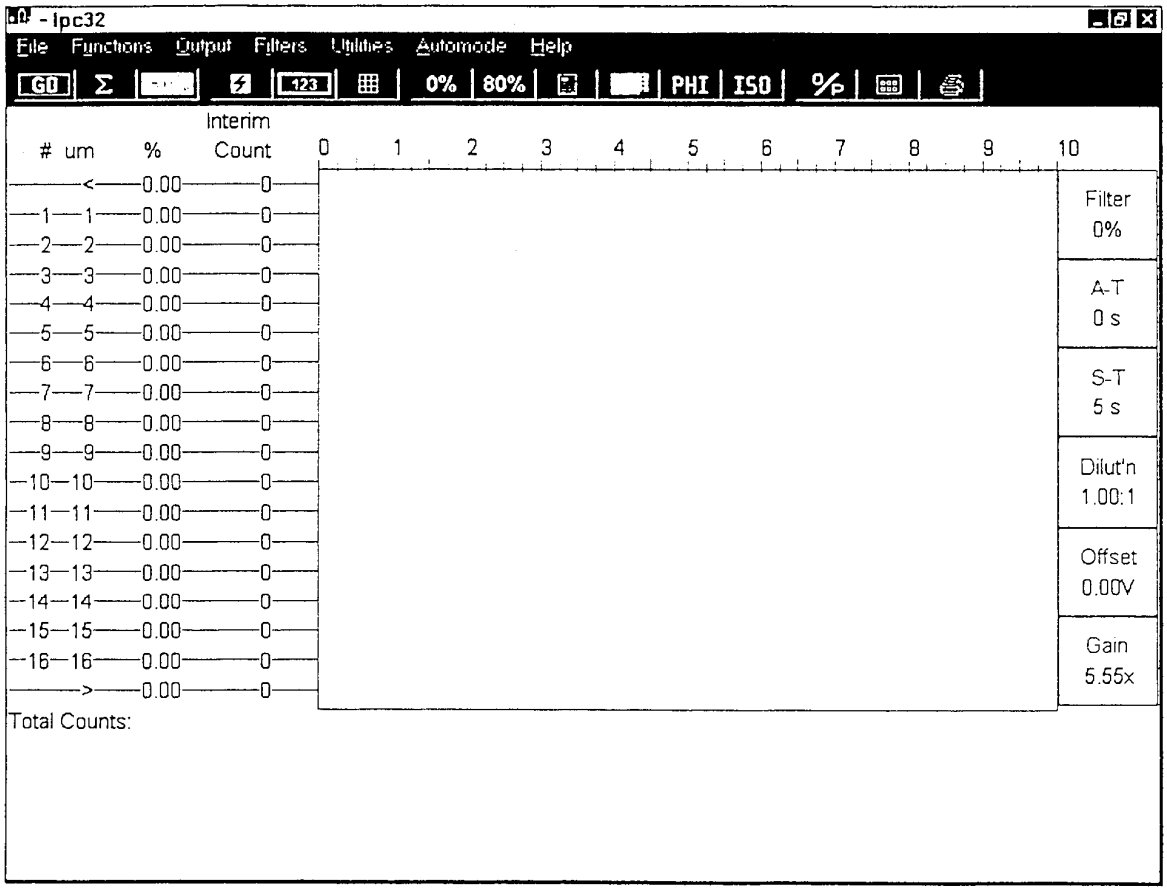
While the LPC is analyzing a sample, it updates an onscreen histogram in real time as the system detects each new particle. By the end of the sampling interval, this histogram provides a graphic representation of the relative number of particles detected in each size range.

The LPC can also present the data comprising the histogram in tabular form, providing precise numerical quantities and other information not present on the histogram. The tabular data may (at option of the user) include any or all of the following:

1. The percentage of the total sample population which falls into each size range.
2. The percentage of the sample's total surface area represented by particles in each of the size ranges.
3. The percentage of the sample's total mass represented by particles in each of the size ranges.
4. The concentration (in parts per million) of particles in each size range.

The summary data, which appears after the histogram, includes additional information such as the mean particle size, the standard deviation of same, the total number of particles detected per unit volume, the dilution factor used, etc.

Features of the Main Menu/Histogram Screen A



SPECTREX CORPORATION

The icons through which full operation is conducted are arrayed in a horizontal line above the histogram of the introductory screen. They are each described, if you direct the pointer onto it, by a balloon.

Icons (reading from left to right)

Start sample counting (1-16 µm range).
Starts a count in the lower (1-16 µm) range.

Start count, integrate mode (1-100 µm range).
Starts a count of both the lower range (1-16 µm) and the higher range (17-100 µm).

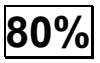
Stop current run now.
This will permit stopping a sample run at any time.

Clear. Delete previous run.
This clears the screen and all data for the next run.

Counter Settings.
These settings establish count time, dilution factor, etc. and will be described later (Page 11).

Load filter.
This selects the **filter file** required for any specific sample.
F0/F80 for normal use, F11/F81 for small vial use and F30/F83 for hydraulic oils.

Load F0 file (1/16 µm range).
This provides quick access to this file.



Load F80 file (1-16 µm range).
This provides quick access to this file.

Report. View listing of numbered counts.
After a sample run has been completed this displays a listing of the percentages, etc. in each size bin.

Return to histogram display, if you are in listing mode.
Self-evident.

PHI **PHI standard classification** (cumulative plot used by sedimentologists).

ISO **ISO standard classification** (graph) used mainly for hydraulic oils. This displays the standard ISO graph and computes ISO code for the sample.

O/P **Comment/Print out options**.
See later description (page 18).

Dilution calculator. This provides a quick and easy way to calculate and enter **dilution factor** when a sample has to be diluted.

Print

Use of Keystrike Commands (as the alternative to the mouse)

The following key commands are provided:

Key Location	Action
Space Bar	Start count as **Go**.
I	Start integrate count.
C	Clear screen.
Exit	Return to histogram from any of the put-down windows.

IMPORTANT

The *Settings* window provides the following functions: (Use the Tab Key to step down)

1. Dilution Factor
Any number up to 999,999 can be entered. This number will be automatically entered by using Dilution Calculation Icon.

2. Pause in Integrate
This on/off option provides a pause between F0 and F80 counting in **integrate mode** to count rapidly settling larger particles. It provides time for stirring or bottle inversion.

3. Time To Sample
Any number up to 9,999 can be entered.
Note: this is the time in seconds for the computer to sample. The LPC takes approximately 16 seconds to take a scan and will recycle as long as the computer is collecting data.

4. Volume Exponent
This selects the power to which the particle size radius is raised when calculating % volume. The user can enter a value between 2 and 3. (Spectrex recommends 1.75).

5. Standards
See pages 14 and 27.

6. Autoscaling
This will automatically set the scale of the histogram for the time set (3 above).

7. Include Underflow
This is for counting particles in the 0.5 – 1.0µm range. It should only be used for clean samples, with total counts less than 300>1µm. The threshold knob should then be set to 6

8. Specific Gravity (of the particles)
This permits accurate, automatic calculation of the Mass/Bin and Total Suspended Solids.

9. Max Scale Value
This sets the Histogram Scale.

10. Minimum Size allowed
This is left at 0 unless, for hydraulic oils, if 5 µm is the smallest size required and then it is set at 5.

11. Maximum Size allowed
This is normally left at 99.

12. Data File Subdirectory
Leave this with the word DATA entered.

13. OK
When the correct numbers have been entered, click on this button.

Dilution Calculator (more detailed description)

Tab down:

1. Enter dilution volume (usually 100 mL).
2. Enter sample volume (default value: 1 mL).
3. Click on **Calculate**. Dilution Factor will appear.
4. Click on **Use Value**. Correct Dilution Factor will appear in window and Dilution Window will disappear.
5. **Exit** permits exiting window without calculation being made.

Menus A

The main menus are accessible through the icons displayed above the histogram on the screen after booting up the software. Both a mouse and keyboard can be used to operate menus.

The LPC supports two principal groupings of size ranges which are referred to as **filter files.** A grouping of size ranges is simply a group of 16 contiguous size ranges (size ranges are also called “bins”). For example, the “F0 filter” includes the following 16 bins: 1/2 µm, 2/3 µm, 3-4µm, 4-5µm, 5-6µm, 6-7µm, 7-8µm, 8-9µm, 9-10µm, 10-11µm, 11-12µm, 12-13µm, 13-14µm, 14-15µm, 15-16µm and 16-17µm. As you can see, the ranges are contiguous (each picks up where the preceding one left off). This group of bins is collectively referred to as the “F0 filter.”

The second size grouping is the “F80 filter” which contains the following bins: 17-22µm, 22-27µm, 27-32µm, 32-37µm, 37-42µm, 42-47µm, 47-52µm, 52-57µm, 57-62µm, 62-67µm, 67-72µm, 72-77µm, 77-82µm, 82-87µm, 87-92µm and 92µm-100µm.

Each filter file also has a bin for particles which are either too large or too small to be classified. These are called the **underflow** and **overflow** bins.

Analyzing a sample using a single filter file

In many cases it is sufficient to analyze a sample using only one of the two “filter files” (F0: 1-16µm, F80: 17-97µm). To do this, select the desired filter file by clicking on the “load filter” icon. (More on menus in the program later.) Whenever you run a sample, the LPC assumes that you wish to use whichever filter file is currently loaded. The current filter file selection is displayed in the “Filter” box on the right edge of the Particle Counter screen.

“Integrated” mode

This uses BOTH size ranges for the same sample. The LPC will analyze particles using either one or both of the filter files. In situations requiring size data extending beyond the range of a single filter file, both filter files must be applied to the same sample. For example, if the sizes of interest ranged from 10µm - 50µm, then neither the F0 nor the F80 filter file could handle the entire size range alone. Since the F0 only covers sizes from 1-16µm and F80 only covers 17-92µm, it is clear that both filter files must be used. When a suspension is analyzed using both filter files, the sample is said to be **“integrated.”** In “integrated” mode, the results of a F0 particle count and of an F80 particle count are integrated into a single histogram and report. Such an analysis will display the results in 32 bins instead of the usual 16 (along with the omnipresent overflow and underflow bins). This mode is useful to produce a complete “workup” on a given suspension.

Standards (See page 27 for complete listing of standards and their sizing ranges)

Universally accepted size range groupings: A sizing standard is simply a universally recognized set of specified size ranges. The LPC sizes particles into very narrow size groupings (e.g. the F0 filter has 16 separate size groups:
1-1.99µm, 2-2.99µm, 3-3.99µm, etc.) Standards, on the other hand, have fewer groupings each of which covers a wider range of sizes. For example, in the “Phi” standard, particle sizes are grouped as follows:

Phi #	Size range (µm)
10	1-2
9	2-4
8	4-8
7	8-16
6	16-32
5	32-64
4	64-128

As you can see, there are fewer groups (a mere 7 instead of the 32). However, some of the groups cover much wider ranges than any range found in an individual filter file (group #6 alone covers a size span of 16µm). The size ranges of this standard (2-128µm) require the sample to be analyzed using both the F0 filter file (1-16µm) and the F80 filter (17-100µm).

As you may have guessed, standards can only be applied to integrated samples since they require the size ranges appearing in both the F0 and F80 filter files. There are several such universal particle sizing standards. The standards supported by the LPC are: Phi, ISO, NAS 1638, SAE and NSF (the exact specifications of each standard appear in Appendix A).

Reports available from “normal” and “integrated” samples

When analyzing a sample using only one filter file, the only report available is the 16-channel report. The results of an integrated sample, however, can be reported in BOTH the 32–channel formal (specific counts/percentages of every size bin in F0 and F80) AND by the size groupings of the current standard (6-7 channels worth of results, depending on which standard you are using). When the results are reported “by standard,” all of the particle counts and densities observed in a sample are reported with respect to the standard’s size ranges.

ISO standard plot option

A special sizing standard is the ISO standard. It is special because when it is applied to an integrated sample, you have the option of producing an ISO plot.

This plot depicts the concentration of particles in each of the size ranges in the ISO standard on a log scale. In addition to the size densities, the graph computes the ISO cleanliness class of the sample based on the observed number of particles greater than 5µm and 15µm particles per ml. This is particularly handy in situations where hydraulic oils are being analyzed since many installations require that such oil be replaced when the number of particles in suspension exceeds a set amount.

Functions above icons (from left to right)

a. File

New (Clear) Histogram. This clears the previous run in preparation for next run. It is quicker to use.
Open Histogram File. This gives access to any previously stored histogram file. (Click on **Open**.)
Save Histogram File. Enter file name and click on **Save.**
Save Histogram as. Same as **Save File** above.
Print Histogram print-out. However, it is quicker to click on icon.
Print Preview. Previews what will be printed. The Page 1 of 2 will be displayed. Click on **Next page** to view page 2.
Previous Page brings you back to page 1.
Two Page displays both pages.
Zoom In and **Zoom Out** are self explanatory.

b. Functions

These functions are all available elsewhere.
Clear Counter. Clears histogram.
Filter Select. Gives access to all the filter files.
Update filter file. Permits changing filter parameters.
Normal Sample. Same as Icon **GO**.
Integrated Sample. Same as **Σ**
Settings. Same as 123
Setting Scan.
Stop. (Sampling or graph)

c. Output

Log Plot. Output scale will be logarithmic.
Review Report. Displays the numbers listings of previous run.
Save Report to File. Same as **Save Histogram,** but it is a **prn** file. It can be read by Excel and put into graphical format. However, the data will be lost to the Spectrex software so you should save it as a **hst** file first.
Output Options. Same as icon O/P
ISO Standard Graph. Displays the standard ISO graph and computes the ISO code for a sample. Same as icon ISO.
Cumulative Graph. Same as Phi.
Parameter Listing. Displays the filter parameters for the filter files in use and can be printed out at this stage.

d. Filters

This accesses the filter files. See **Navigating menus** section of manual.
Load Filter File. Loads a filter file of your choice. Enter file number in **file name** space and click on **Open.**
Save Filter File. Provides availability of saving and loading a new filter file generated by the LPC user.
Load 0% Filter. Loads of 0% Filter-the most commonly used one.
Show filter File Parameters. Shows linearization values etc. You can print these from here.
Load 80% Filter. Loads 80% Filter-sizing 16-100µm.
Edit Filter Parameters. Provides ability to create and change linearization values, offset and ADC gain. They define how a histogram matches the actual size of particles in a standard. These numbers should not be changed unless instructed by Spectrex.

e. Utilities

Stopwatch. A window will be displayed. **Start, Stop, Reset** and **Done** are self evident. This is useful to check the time the LPC takes to count a sample. Push the count button on the LPC while clicking on **Start.**

Cycle Timer. Gives the elapsed cycle time for the computer to complete one complete count cycle. This is set at Spectrex and should not be changed.

Background Calibration. This function is useful to check the consistency of a standard or sample. It is also titled **Background/Threshold Utility.** For more details see **Background Threshold Utility** section of manual (Page 16).

Dilution Factor Calculator. See pages 6 and 30.

Counter Signal Calibration. See Appendix F.

Note: Do not change these values unless specifically directed to do so.

Detailed Descriptions of Filter Parameters 7

Filter File Maintenance

Each filter file is actually a collection of parameters. These parameters include:

1. The “Linearization” parameters for each channel.
2. The lowest size of particle in each channel.
3. The analog to digital converter gain parameter and offset settings to be used.
4. The integration link file for this filter.

What is a Linearization Parameter?

To understand what the linearization parameters and channel labels are, a couple of concepts need to be understood. The size of a given particle is determined by measuring the maximum amplitude of its interference pattern. In general, bigger particles produce higher Maximum Signal Amplitudes (MSAs) than smaller particles do. The MSA is just the highest voltage level seen in a given particle’s interference pattern (light intensities of the interference patterns are converted to voltage levels). The “voltage levels” are digitized into integers from 0 to 225.

Unfortunately, the exact relationship between a particle's MSA and its size is anything but linear. That is the problem the linerarization parameter table is designed to remedy. The linearization parameters are simply the MSAs of particles of 18 different sizes. For instance, in the F0 filter file, the particles sizes are 1µm, 2µm, 3µm… In the F0 filter file Spectrex would need to know the MSA of 1µm particles, 2µm particles, 3µm particles, etc. all the way up to that of 16µm particles. With this information we can take any observed MSA and look it up on our list to determine what the particles' size must be.

To go from the abstract to the concrete, some the actual MSA's for the F0 filter are listed below:

Size (µm)	**MSA (0.255)**
< 1 µm	14
1	18
2	24
3	32
4	42
5	54

If our system detected a particle whose MSA was 26, we could determine its size just by looking on the table above. (26 falls between the 24 MSA of a 2 µm particle and the 32 MSA of a 3µm particle). Since this value exceeds the MSA of a 2µm but not that of a 3µm particle, this particle must belong in the 3 µm bin. Note that the values on the table define the maximum value permissible to be included in a certain bin, so values from 14 are in the "< 1µm" bin, values from 15-18 are in the "1µm bin" and so on.

There are two special entries on this table that need further explanation: the first and the last. The first entry is the maximum underflow value. Any signal with an MSA up to and including 14 in this case, is deemed to be "underflow" which means that its size is some unknown value less than 1µm. The other special case is the last entry, which is ignored! Any particle with an MSA greater than the value for channel 16 is deemed to be "overflow".

Now that you are an expert in MSAs, the following explanation will make a lot more sense. A filter file is primarily a collection of the MSAs of 17 particle sizes (underflow up to the 16th size designation). These MSAs are collectively referred to as "linearization parameters". They make the non-linear relationship between MSA and the particle size "linear" by specifying MSA ranges for each particle size range. Fortunately, Spectrex Corporation has already figured out the MSAs for you.

Background Threshold Utility 8

The threshold knob on the front of your LPC sets the counter's trigger threshold. This "trigger" threshold is simply the DC voltage level just high enough to include the signal of the smallest particle of interest. For example, if your counter's circuitry were such that the signal from a 1µm particle went from 0 up to 0.63v, then you would want the counter to increment each time the signal moved above that level since that would indicate that another particle had drifted through the beam. The proper "trigger" threshold would be a hair below 0.63v.

Finding the Background

The first step in setting the background level is to determine the setting, which will exclude the counter's noise such as dust floating through the beam, amplifier noise, etc. The Find Background function does this. The procedure to find the background is as follows:

1. Clear the stage (remove any bottles from the counter) and close the light tight cover.
2. With **Main Menu** on screen, click on **Utilities** and select **Background Calibration.**
3. Select **Find Background,** then **Review Parameters.**
4. Indicate the number of sample counts you intend to take. We recommend 10. Enter background setting of 4 and hit **OK.** The Window will close and you will be returned to the **Find Background** Window.
5. Set the threshold knob to 4.
6. Select **Take counts.** The computer will open a new window with a prompt **OK** to begin sampling. While the LPC is counting, the computer will indicate the number of counts taken, the current average, and the total number of events for any completed counts.
7. If the average counts are greater than 10, increase the threshold knob setting to 5 and repeat steps 3-6 above. Continue until the average is less than 10 counts. Normally, the background threshold setting should not be greater than 8. Call Spectrex if it is. **The Threshold should never be set to below 4 on the dial. Normally it is set at 4.**

Checking a Standard Bottle

Whenever the counter hardware is moved, the optical alignment needs to be checked. To do this, you first determine the background threshold level as described above. You then use the **Standard Bottle** function within **the Background threshold utility.** To check a standard bottle, enter the number of counts you wish to take. Indicate the background, which standard you wish to check and the count to expect (the count is written on the label on each standard). The procedure to check a standard bottle is as follows:

1. Place the desired standard bottle on the stage.

2. Select **Standard bottle,** then **Review Parameters.**

3. Indicate the number of counts (Samples) you intend to take. Then enter the background setting (normally on 4) for the standard bottle and the expected count from the front of the bottle. Click on **OK** after the expected count from the front of the bottle. Clicking on **OK** after last entry will close the **window** and you will be returned to the previous window.

4. Select **Take Counts.** The computer will open a new window with a prompt to set the threshold knob on the front of the LPC to a new setting (usually 10). Clicking on **OK** will start the LPC counting (only do this after resetting the knob). While the LPC is counting, the computer will indicate the number of counts taking the current average, and the expected value, as well as the totals for any completed counts.

5. If after the computer has finished taking the specified number of counts, the average sample deviates from the expected count by more than plusminus 15%, the LPC may need an optical re-alignment or electronic **gain** correction. Check all three bottles before jumping to any rash decisions however.

Checking a Custom Bottle

This function is essentially the same as the Standard Bottle function. The difference is that it is intended to operate on any bottle with particles of any size within the basic capability of the instrument. The procedure to check a custom bottle is as follows:

1. Place the desired custom bottle on the stage.

2. Select **Custom Bottle**, then **Review Parameters.**

3. Indicate the number of counts (samples) you intend to take. Then enter the background setting of the particle size of interest and the expected count from the front of the bottle. Clicking **OK** after the last entry will close the **Window** and you will be returned to the previous window.

4. Select “Take counts”. The computer will open a new window with a prompt to set the threshold knob on the front of the LPC to a new setting. Clicking “OK” will start the LPC counting (only do this after resetting the knob). While the LPC is counting, the computer will indicate the number of counts taking the current average, and expected value, as well as the totals for any completed counts.

5. After the computer has finished taking the specified number of counts, the average sizes will be computed and displayed.

Counter Signal Calibration

See Appendix F, page 38

This sets the Card Calibration Parameter Values.

Important: Do NOT change these values. They have been preset by Spectrex for your particular particle LPC.

Output Menu in Detail

9

The LPC can present the results of a sampling in several ways. In addition to the basic screen display, the LPC also produces reports containing the precise numerical counts observed in a sample. These reports can be sent to the printer, disk, or may be previewed on the screen in test format. When the output is sent to the printer, you may choose to include a comment which appears at the top of each printout. This comment, which typically is used to commit the particulars of a sample to hardcopy, consists of 8 lines of test, each line containing 60 characters. The output Function Menu itself lets you do the following: specify where the output should be sent and select which columns should be included in the report.

Detailed Explanation of Output Printout

A. Title

(Report Comment)

Identification and description of sample.

B. Histogram Showing Size Distribution

Bin Number Left hand vertical column indicates bin or channel number, normally 32 bins are used.

Particle size range Moving from left to right: the next vertical column shows the particle sizes from 1 to 100 micrometers (symbol µm). Note: 1µm is equivalent to one thousandth of a millimeter or one millionth of a meter. The human eye is able to see down to about 50µm, while the Spectrex Instrument can count and size down to 1µm.

Particle size in % Next column is the percentage distribution over the complete size range.

Count Column (Interim, for 16 bin) (total, for 32 bin).
For 16 bin mode, these numbers are only indirectly related to the absolute number of particles in each bin and depend on time of count. For 32 bin mode, they are the absolute counts, the same as C3.

Bar Graph	This gives a quick visual indication of the size distribution.
"Histogram"	The scale at the top can be changed as necessary.
Filter Box	(The topmost of six rectangles to the right of Bar Graph). F0 is used for clear water samples. F30 is used for opaque hydraulic oil samples. F11 is used for the small vial attachment.
A-T	This is the actual number of seconds it took to collect the sample.
S-T	This is the number of seconds SET on the computer to take the sample.
Dilution	If the sample has to be diluted, this is the amount of dilution needed.
Offset and Gain	These are constant presets in the computer to ensure that the sized particles are entered in the right bins.

C. Listings

These are the vertical columns of numbers immediately under the Histogram (for 16 bin o/p) or on page 2 (for 32 bin o/p)

Bin Number	As explained above in B.
Size	As explained above in B.
Total Counts	This column lists the absolute number of particles per mL in each bin and indicates the dilution factor. If there is a "0" in the sub 1 µm category this does not mean that there are not any submicron particles present. Unless specifically requested we usually size from 1µm upward as there is a slightly indeterminate factor below that size, while we are sure that all 1 µm particles are counted.
Counts Percent	As explained in B.
Surface Area %	The computer rearranges the distribution by Surface Area. The Surface Area is derived by multiplying counts percent by the "square" of the diameter.

Volume Percent This is calculated using the “cube” of the diameter. You will notice that the percentage distribution is heavily weighted toward the larger particle range. A “volume calculation” in Settings mode permits calculating the power from 2 (square) to 3 (cube).

Mass Per Bin (in parts per million)
The Volume Percent is multiplied by the specific gravity to derive the weight of the particles in each size range. The total of this column gives the total suspended solids in parts per million or milligrams per liter. (see E-2 below).

D. Standard Classification

This is usually in “Phi” categories, used by sedimentologists, geologists and water engineers. It is a relisting of C above in reduced number of channels. Other “Standard” listings, for hydraulic oils, are ISO, NAS and SAE and NSF for filtration testing. If you would prefer one of these three rather than “Phi,” specify in “Settings” mode.

E. Totals

Total number of particles in the sample. This is the total of C3 above.

Total number suspended solids. This is a sum of the listing C7 and is both in parts per million and in milligrams per liter.

Dilution Factor. This is an indication of how much dilution was necessary to get the required results.

Specific Gravity. This important aspect of the sample is entered into the computer before the sample is run and is used to calculate the mass per bin (C7) and total suspended Solids (E2).

Mean Size and Standard Deviation are computed from total counts per mL (C3).

Date and Time at which the sample was running is a valuable reference for the future.

Water Standards

NSF

Group #	Size Range (µm)
1	>1
2	1-5
3	5-15
4	15-30
5	30-50
6	50-100

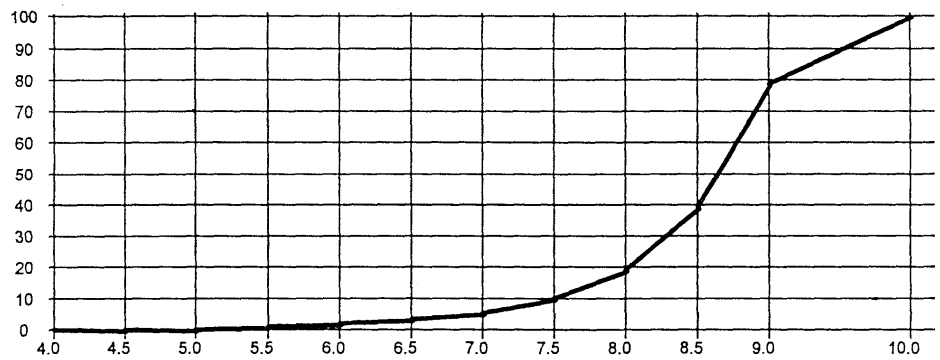
Phi Sizing – for SEDIMENTOLOGY

Phi

Phi #	Size Range (µm)
10	1-2
9	2-4
8	4-8
7	8-16
6	16-32
5	32-64
4	64-128

Cumulative % of sample

Phi size vs. Cumulative percentage of sample counts



SPECTREX CORPORATION

Phi	Cumul%	Phi	Cumul%
4.0	0.43	7.0	5.34
4.5	0.43	7.5	10.26
5.0	0.43	8.0	19.02
5.5	1.28	8.5	39.32
6.0	2.35	9.0	78.42
6.5	3.63	10.0	100.00

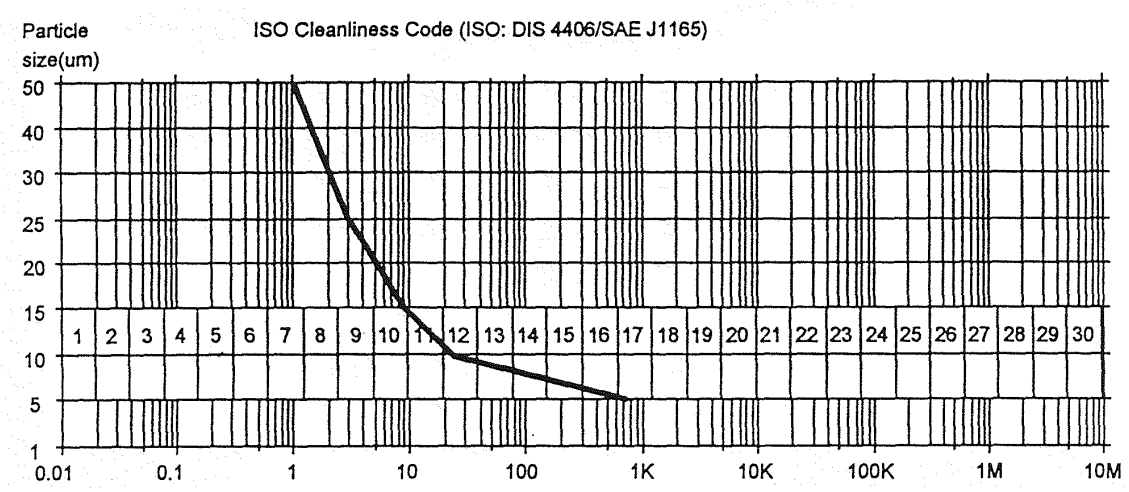
Phi size			
Phi (5%)	6.90	Median	8.63661
Phi (16%)	7.83	Mean	8.57434
Phi (25%)	8.15	Dispersion	0.792296
Phi (50%)	8.64	Skewness	2.84736
Phi (75%)	8.96	Kurtosis	1.45323
Phi (84%)	9.26		
Phi (95%)	9.77		

(Typical Print-out for sediments.)

Oil Standards

ISO 4406

Group #	Size Range (µm)
1	>5
2	>10
3	>15
4	>25
5	>50



SPECTREX CORPORATION

Number of particles/mL greater than indicated size

>Size	count/mL
5 µm	723
10 µm	23
15 µm	9
25 µm	3
50 µm	1
ISO Code	17/10

(Typical demo printout for ISO 4406 for hydraulic oils.)

NAS 1638

Group #	Size Range (µm)
1	<5
2	5-15
3	15-25
4	25-50
5	50-100
6	>=100

SAE 749D

Group #	Size Range (µm)
1	<5
2	5-10
3	10-25
4	25-50
5	>50

GB

Group #	Size Range (µm)
1	<5
2	5-15
3	16-25
4	26-50
5	50-100
6	>100

USING THE YELLOW-CAPPED CONOSTAN STANDARD FOR HYDRAULIC OIL MEASUREMENT FOR ISO 11171 and NAS-1639c (3 POINT) OUTPUT.

***Note**: This standard is set for counting particles 4 um and greater for ISO 11171. and NAS-1638c. The Conostan standard used has 6000 particles 4 um and greater but has been diluted 10:1 in the yellow-capped bottle to keep the total below 1000. Thus the counts on the front of the particle counter should read 600 + or – 10%. Be sure to set the dilution factor in the software at 10:1. Opacity for your samples should not be greater than 30%. Thus it is important to have a Spectrex Opacity Meter.*

1) Grasp the standard bottle with yellow cap by the narrow neck and turn upside down.

2) Swirl slowly, in a six inch circle, ten times. Make sure that the white, magnetic stir bar stays in the neck and does not hit the glass walls.

3) Click on “filters” icon and change the computer software Filter File from F-0 to F-30

4) Click on “Filter Parameters” and ensure that the linearization values are 0,0,0,0,11,13,18,22,25,27,29,31,35,40,45,50,55,65,
The ADC Offset is 129, the ADC Gain is 2000 and the Intergration Link File is 83.

5) Return to “filters” icon and click on “Save filter file”, enter F-30 and then save.

6) Set “minimum size allowed” to 4 um

7) Set the threshold knob on the front of the particle counter to 35.

8) Place standard bottle on the particle counter, waiting 25 seconds after swirling, and take a series of counts. Ensure that the stir bar is rotating in the bottle.

9) If the counts are off by more than 10% of the number 600 written on the standard, find the best setting to get within the 10%. You are now in calibration.

10) For printing the results, select ISO 11171 or NAS 1638c in “settings” window.
Note: *Spectrex recommends particle free Limonene, Johnson’s Baby Oil (available from any drugstore) or Hexane. This standard is a Conostan oil standard. Reference: Partistan 2806 Secondary reference Standard. Conostan Division, SPC Science, 800-361-6820,mboivin@scpscience.com.*

Important (for SAE and NAS standards)

If total counts per 100 mL are greater than 100,000 then there are coincident counts. The number of particles per mL are so high that the laser has begun to strike two (or more) particles at the same time, making them look like one larger one. It is important in this case to dilute your sample so that the number on the front of the LPC is less than 1000. (The number of total counts greater than 5 mm dia on the computer print-out would be less than 100,000 per 100 mL). Use the dilution techniques outlined in the introduction to this appendix.

Calibration

Besides the standard Red, White and Green capped calibration bottles, Spectrex can provide, upon request, a bottle of red 5606 oil containing AC Fine Test Dust obtained from Fluid Technologies, Stillwater, Oklahoma, and thus a primary standard. It has a Yellow Cap. This bottle contains a known number of particles per mL greater than 5 µm. This number is recorded on the label on the bottle. To provide long term stability, the airspace in the bottle contains inert argon gas. Fluid Technologies guarantees its standard for one year. Do not use standards past their expiration date. Reorder directly from Spectrex Corporation.

Step 1
Gently swirl and invert the bottle for 15 seconds to resuspend the particles.

Step 2
Carefully wipe the bottle with a clean, lint free, oil free cloth and place it in the V-Slot on the stage of the LPC. Visually check that there are no dust particles or other blemishes on the area where the laser beam enters the bottle. The red circle drawn by the laser should be faint.

Step 3
Set the “Threshold” knob on the LPC to approximately 25-30 (to get the correct count on the standard bottle).

Step 4
Run a count. The histogram on the computer screen will “grow” and the LPC display will show rapidly changing (increasing) counts.

Step 5
When counting has stopped, the final number should match the number on the bottle plus or minus 15%. If it is beyond this range, adjust the threshold knob on the LPC to zero it in.

Check that the resulting print-out looks like this:

Bin	Size	Total Counts/cc	Counts percent	Surface area %	Volume percent	Mass/bin ppm
1	>5	258	99.61%	100.00%	100.00%	2.20
2	>10	41	15.83%	61.85%	94.49%	2.08
3	>15	24	9.27%	46.41%	84.18%	1.85
4	>15	3	1.16%	10.15%	37.67%	0.83
	>50	1	0.39%	0.00%	0.00%	0.00

ISO Class:	15/12
Total Counts:	258/cc
Total suspended solids:	2.20ppm (mg/liter)
Spec. gravity:	1.00
Mean size:	7.05 um
Standard deviation:	4.19 um

Instructions for use of the Magnetic Stirrer Attachment for the Laser Particle Counter

This attachment is a standard attachment and is helpful in keeping larger particles in suspension. It should always be used for hydraulic oils.

The Magnetic Stirrer is fitted underneath the glass plate in the Stage area, and so positioned that it is centered under a sample bottle or beaker when it is positioned in the “V”slot.

The Stirrer Motor automatically starts rotating when the LPC is turned one, so there is no need for a separate On/Off switch. All that is needed is a stir-bar to be dropped into the sample.

Step 1
We recommend a stir-bar approximately 1” long and 3/8” in diameter. It should be carefully cleaned before using to avoid contaminating the sample. (One is included with your equipment).

Step 2
With the stir-bar in the sample, place the sample in position on the LPC. The bar will rotate at approximately 2 cycles a second, giving a gentle, even, agitating movement.

Note: If magnetically attracted particles are to be counted, a special u-metal plate is available from Spectrex to deactivate the magnetic stirrer.

Instructions for "Auto-Averaging" Software

Introduction

This software revision greatly improves the accuracy and reproducibility of the data collected with the Spectrex LPC System.

The system both counts and sizes the particles in the sample liquid. The counts are automatically taken from the LPC display while the size distribution is the accumulation of counts displayed on the histogram over a set-time. The new software permits maximum data collection of both functions by "auto-averaging" and increasing sampling time.

A. The Procedure is very simple:

1. With the histogram displayed on the computer screen click the **Setting' icon.**
2. Move cursor down to **Time to Sample.**
3. Enter number of seconds required to get good, statistically representative results. This becomes the **Set Time.** (60 seconds would be typical).
4. Click on **OK**.
5. Start particle count by either hitting the space bar or clicking on/or **GO.**

B. What will happen:

The histogram will grow until the A-T box (Actual Time) number coincides with that in the S-T box (Set Time). Meanwhile the LPC will take a series of counts, as many as will fit into the time envelope defined by S-T and will display an average on output.

Example: If S-T is 60 seconds and the LPC takes 17 seconds to perform one count cycle, then it will make a series of 3 count cycles while the computer is accumulating 60 seconds worth of sizing data.

17 x 3 = 51 (well below the S-T of 60)

The more time the LPC can cycle its counts and the longer the "Set Time" is, the more accurate the results will be.

Taking an extreme

You can make “Set Time” be up to 9,999 seconds. Thus the particle cycles 9,999 = 588 times in this period and average the results.

Working backward

If you wanted to average 5 counts on the LPC, multiply the number of seconds taken for one count by 5 and add an extra 5 seconds for safety (thus (5 x 17) + 5 = 90 seconds.) If you use the “Integrate” mode the total time will be double as the higher size range (F80 or F83) will repeat the 5 cycles. Thus the final decision as to how long to count is a compromise between “limited time” and “required accuracy.”

It is important that the diluent used should have as low a particle count as possible. The “Dilution Calculation” program provided in the Windows® Software is a great help in entering the correct dilution factor in the settings window. However, this does not correct for pre-existing counts in the diluent. If these are ignored they can cause considerable error.

Example

If the diluent has 40 particles greater than 1 mm and the dilution factor is 1,000 then the final count is 40 x 1,000 = 40,000 (too high). If the final count on the particle counter is 800 so that the final absolute count is 800 x 1,000 = 800,000, then this 40,000 is relatively insignificant (5%). However if the final count on the particle counter is only 400, then the final absolute count is 400,000 and 40,000 is a very significant factor (10%).

On the other hand, if the diluent has only 10 particles per cc, then for a final count of 400,000 the extra 10,000 particles added by the diluent is only 2.5%.

Summary

1. Keep diluent count as low as possible, (30/mL or less).

2. Add sample so that the final count on the particle counter is **at least** 20 times the diluent count.

3. Always ensure that the final count does not exceed 800-1,000 to avoid coincident counts.

This is accessed through the Utilities Window.

Warning

If Spectrex supplies a computer with your particle counter, **do not change** these values unless specifically directed to do so by Spectrex. If you proceed from here the **Card Calibration Parameter Values** window appears.

This contains three **slide** controls:

a) Pre-Gain
b) Voltage Reference
c) Offset

Each can be adjusted by clicking on the slider and moving it to left or right. The values to the right of each **slide** define the sizing capability of the sofware.

Important: Make a note of these values before changing them.

Note

For customers who buy the particle counter and software, installing it on their own computer, then these values must be set by the end user as they are individually customized to her/her particle counter.