CyberOptics WaferSense® APS3 User's Guide

CYBEROPTICS®

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General Information

Note: This manual is for Airborne Particle Sensor technology products including WaferSense APS3 and PanelSense APS-FPD. The devices may also be referred to as WaferSense APS in the software section but is applicable to all form factors using APS3 technology.

WaferSense and PanelSense Device and Link

Changes or modifications not expressly approved by CyberOptics Corporation, may void your authority to operate the APS device.

The radio contained in the APS meets all the applicable FCC requirements for RF Safety. While in operation, the FCC requires users and nearby persons to maintain a minimum separation distance of 20 cm (8 inches) or farther from the APS3.

The APS3 Device and Link have been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

These devices comply with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

This ISM device complies with Canadian ICES-001.

Cet appareil ISM est conforme à la norme NMB-001 du Canada.

Software Note: ParticleSpectrum files are not backwards-compatible with previous versions of ParticleView and ParticleReview. Files that were recorded from ParticleView and ParticleReview will not be compatible with ParticleSpectrum.

The exclamation point within an equilateral triangle is intended to alert the user to the presence of important operating and maintenance instructions in the literature accompanying the device.

Laser:
The APS3 is a Class 1 laser product employing an embedded Class 3B laser whose radiation is fully enclosed and not exposed to the user.
Wavelength: 405nm
Beam Divergence: 36 milliradians x 178 milliradians
Pulse Duration: Continuous
Maximum Power: 200 milliwatts

Service:
Do not remove cover. No user serviceable parts inside. Return to Cyberoptics for service and calibration.

Power Supply and Charging:
Use only the power supply provided with this equipment for charging.
Input: 100-240 VAC, 50-60 Hz, 0.6A
Output: 5 VDC, 3.0A

Lithium Rechargeable Batteries:
Internal lithium batteries, if handled incorrectly, could cause injury or death. Refer to local regulations for handling and disposal of batteries. Battery should only be serviced by CyberOptics.

Static Sensitive Components:
Observe precautions for static sensitive components.

Disposal:
The product must not be disposed of with normal waste. Instead, it is your responsibility to dispose of your waste equipment by arranging to return it to CyberOptics for recycling. By separating and recycling your waste equipment at the time of disposal you will help to conserve natural resources and ensure that the equipment is recycled in a manner that protects human health and the environment. For more information about how to recycle your CyberOptics supplied waste equipment please contact our customer services department at 1-763-542-5000.

Large Particle Detection: APS3 units have large particle detection capability. This is in addition to the normal small particle detection. Large particle operation is very similar to small particle detection so that all of the sections in this manual describing settings and operation are still valid for large particle detection. How to operate large particle detection and the differences between the two modes are described in Appendix A – Large Particle Detection.

Labels on Devices

Laser and hazard labels as they appear on the APS3 devices.

WaferSense and ReticleSense Technical Support

Technical support is available from CyberOptics Corporation.

E-mail:	CSsupport@cyberoptics.com
Phone:	+1 763-542-5000 +1 800-366-9131 (US and Canada only)

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Part # 8025869 Rev A

Chapter 1

Introduction

The CyberOptics WaferSense® Airborne Particle Sensor 3 (APS3) measures airborne particles inside semiconductor process equipment, and PanelSense™ Airborne Particle Sensor - Flat Panel Display (APS-FPD) measures airborne particles for flat panel display manufacturing. Throughout this document, all devices in this family will be referred to as "APS."

The ParticleSpectrum™ software application makes it easy to view particle measurements in realtime. The large display and wireless link let you place the computer at a convenient distance from the APS3 device. The APS3 wafer is vacuum compatible, with an operating pressure of 0.4 (300 Torr) to 1.6 atmosphere, with the ability to go to 0 atmosphere.

APS3 consists of the following components:

- **APS3 device.** The APS3 is designed with a wafer-like and reticle-like form factor, so it can fit in most handling equipment or tools. The device is vacuum compatible, with an operating pressure of 0.4 (300 Torr) to 1.6 atmosphere, with the ability to go to 0 atmosphere.
- **ParticleSpectrum™ software.** The ParticleSpectrum software application monitors the particle measurements and other status information in real time. Review functionality lets you view and compare log files recorded. ParticleSpectrum runs on most personal computers that use the Microsoft Windows operating system. See Chapter 6, "Specifications," for platform requirements.
- **Wireless link.** The software communicates with the APS wafer by using a Bluetooth wireless link that attaches to a USB port on a personal computer.
- **Charging case.** The APS3 device is powered by an internal rechargeable battery, which you recharge by placing the APS3 device into the charging case.
- **Carrying case.** The carrying case makes it easy to take your complete APS3 system with you in the plant or on the road.

The following chapter provides you with instructions for installing your APS3 system.

See Appendix B – APS-FPD for additional information regarding PanelSense APS-FPD.

Carrying Case Contents:

Figure 1.3 APS3 Components

See Appendix B – APS-FPD for additional information regarding PanelSense APS-FPD and its components.

The APS3 Controls and indicators are visible on the outside of the device as shown below.

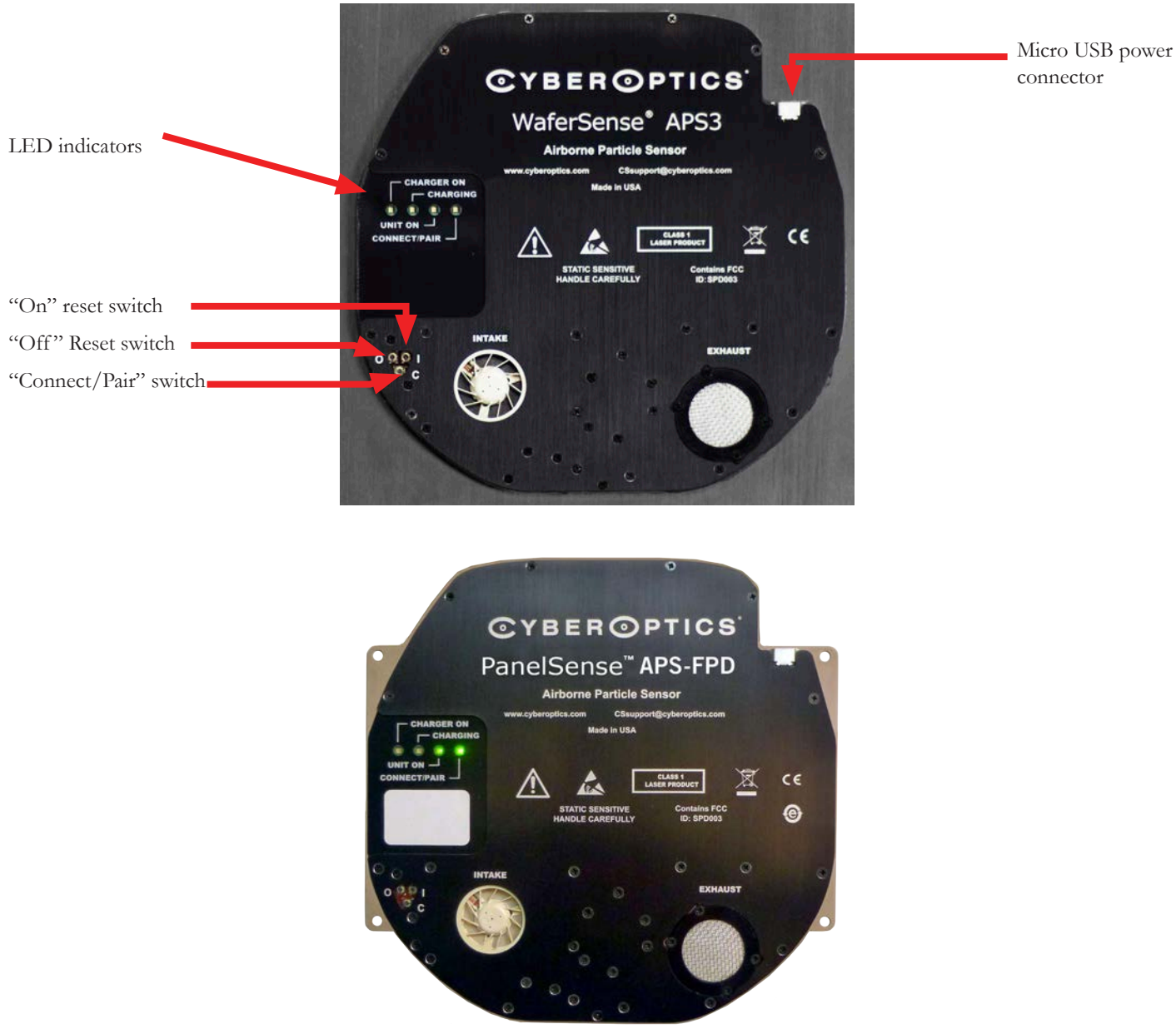


Figure 1.2 APS3 and APS-FPD unit.
Controls and indicators shown on APS3 300mm and APS-FPD.

Chapter 2

Installing Your APS3

This chapter describes the procedures you need to perform to install your APS system and get it ready for use. For best results, perform the procedures in the order they are presented in this chapter:

- Installing the ParticleSpectrum software
- Installing the wireless link on the USB port
- Checking communications between the link and the APS wafer
- Registering your APS device
- Running the ParticleSpectrum application

Caution

Dropping the APS3 or hitting it against a hard object can bend, break, or chip the housing; damage the internal components; or knock the APS3 out of calibration. While it is not as fragile as an actual silicon wafer, handle the APS3 with care, as you would any precision instrument. If the APS3 is damaged or in need of calibration, see Chapter 5, "Maintaining Your APS3" Chapter 5, "Maintaining Your APS3."

Caution

The APS3 is thicker than a standard silicon wafer so use **extreme care** to assure that the wafer has proper clearances when being transported through the tool. For example, when you use the device in a tool for the first time, move the APS3 through the tool in manual mode, visually verifying all clearances. Even when clearances are sufficient for safe APS3 pass-through, if the robot end-effector is taught too high, you risk crashing and damaging the APS device.

The Intake blower and exhaust filter are fragile. Do not direct compressed air or gas into either the intake or the exhaust of the APS3. Damage to the unit may result.

Installing the ParticleSpectrum APS3 Software

To install and run the APS software ParticleSpectrum, your computer must have the following:

- Windows 7 (32-bit or 64-bit), Windows 8, Windows 10 operating systems
- One free high-power USB 1.1 or USB 2.0 port

To install the APS software, do not plug in the link before you start. The software must be installed first using the following steps:

1. Log on using an account with Administrator privileges.
2. Insert the WaferSense APS Installation Disk into the CD drive.

   The InstallShield Wizard starts automatically, as shown in Figure 2.1. If the wizard doesn't start automatically, use Windows Explorer to view the contents of the CD and doubleclick the **WaferSenseInstaller.exe** program.

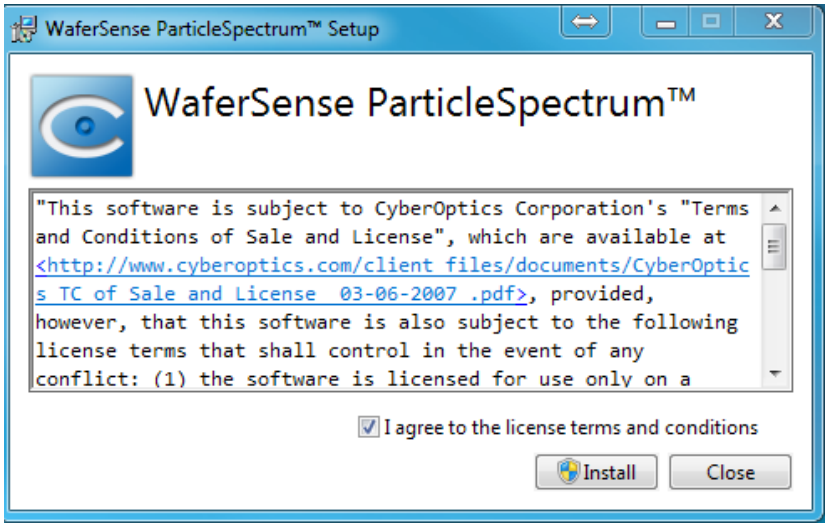


Figure 2.1: The InstallShield Wizard

3. Follow the instructions provided by the wizard to install the software.

4. After you complete the instructions for all of the wizard screens, click **Close**.

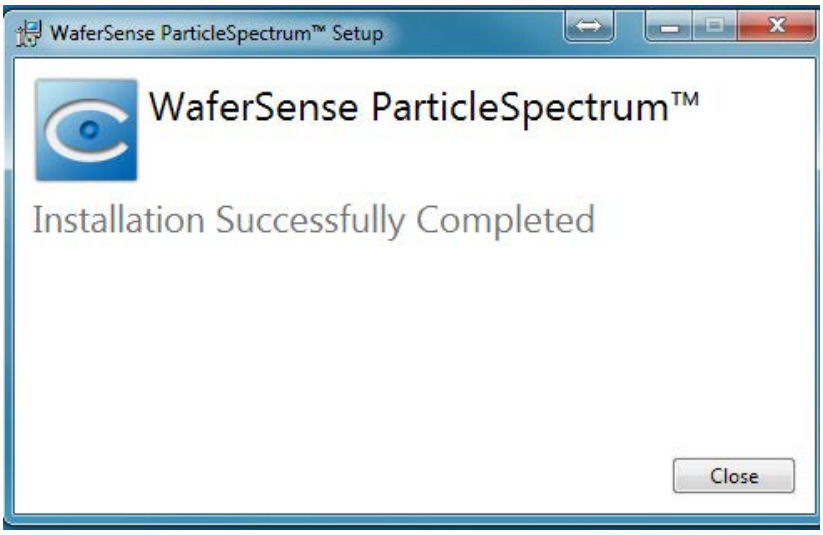


Figure 2.2: Final Software InstallShield Screen

By default, the Setup program installs the ParticleSpectrum applications in a new program group called CyberOptics. Setup also installs an online copy of this user's guide, which is available from the ParticleSpectrum **Info** menu and in the CyberOptics program group in the Windows **Start** menu.

Note:

The **WaferSenseInstaller.exe** will install device drivers for the Link Device.

Link Device Drivers

If the Link Device drivers do not install correctly, you can manually install them by navigating to the Drivers folder when the **WaferSenseInstaller.exe** completes installation. Navigate to your local disk and follow (C:\Program Files (x86)\CyberOptics\WaferSense\Drivers\FTDI) and click **DPInst_x64.exe** to run the Link Device Installer.

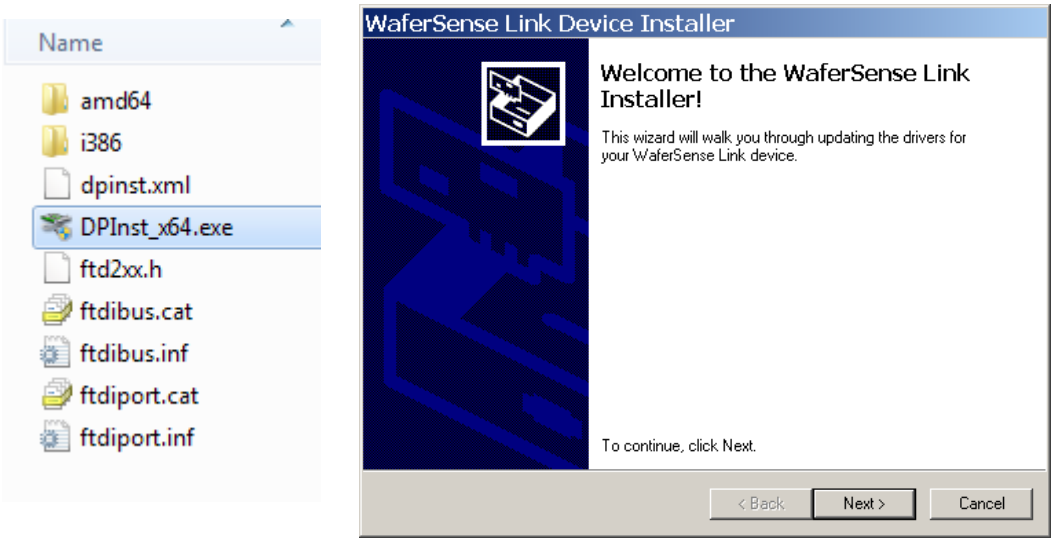


Figure 2.3: Link Device Install Wizard

1. Click **Next >** and the wizard automatically completes the link installation.

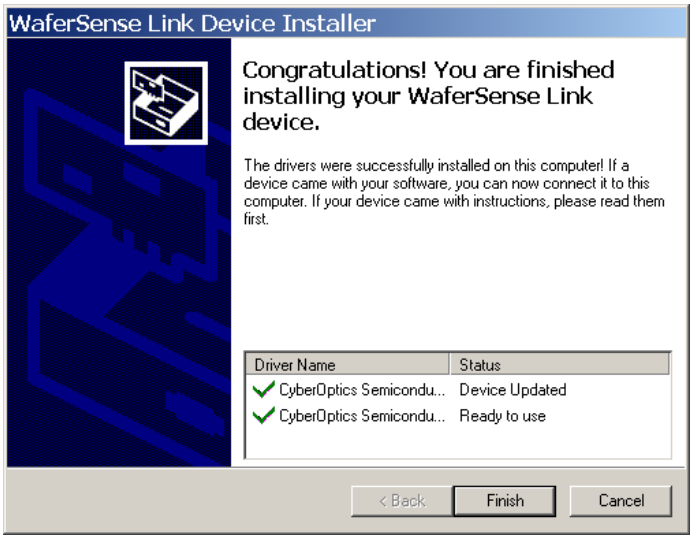


Figure 2.4: Final Link InstallShield Screen

2. Click **Finish** to close the Link Device Install Wizard

Installing the Wireless Link

Before starting the wireless link installation, complete "Installing the WaferSense APS Software," on page 2.2.

To install the wireless link:

1. Turn on your computer.
2. Locate an unused, high-power USB port on your computer. The APS3 wireless link module requires a high-power USB port, such as the built-in ports on your computer and ports on USB hubs that have power cords. Unpowered USB hubs won't work.
3. The USB cable provided with your APS system has a different plug on each end. Locate the end with the plug that matches the USB port on your computer and plug the cable into the port.
4. Plug the other end of the cable into the link module.

   Windows automatically finds the drivers installed during the Link Device Installer in Figure 2.3 and Figure 2.4 on page 2.4.

   The **Power** light on the module turns on indicating that the module is getting power from the USB port. Ignore the **Pair Status** and **Connection Status** lights for now.

Checking Communications Between the Link and the APS3 Device

To complete the installation, verify that the APS device and link can communicate:

1. The APS operates from an internal rechargeable battery. Before using the APS for the first time, charge it for two hours. For information on checking the charge on the battery and the procedure for recharging, see "Using the Rechargeable Battery," on page 3.24.
2. On the APS, there are reset buttons as described in Chapter 1. These buttons are rarely used, and require the use of a paper clip, or other small device to activate. These buttons are usually for "pairing." Placing the unit in the charging case and connecting the charger power supply will start the APS device. See page 3.3.
3. Verify that the **Pair Status** lights on both the APS3 and link module are on. The APS and link module in your kit were paired at the factory and will operate with only that particular link module. If either light is not on, your APS device and link might not be paired with each other. To reset the pairing, see "Changing the Pairing Between the APS Device and Link," on page 3.30.
4. Immediately after turning on the APS, the **Connection Status** lights on the APS and link will blink slowly. After a few seconds the APS and link will connect and both lights will be on and no longer blinking. If the lights continue to blink, see "Monitoring the Wireless Connection to the APS device" on page 3.26.
5. After starting the ParticleSpectrum application (see "Running the ParticleSpectrum Application," on page 2.8), you can verify the connection to the APS by comparing the serial number printed on the APS device to the serial number shown in the About your APS dialog, which is available in the ParticleSpectrum application by choosing the **Info** menu item.

That completes the installation of your APS system.

Note: Pairing instructions for APS-FPD can be located in Appendix B

Registering Your APS for Calibration Service

To maintain optimum performance, every twelve months you should have your APS calibrated and the battery replaced. These services can be performed only at the factory.

To help you keep track of the next service date so you can schedule this service when it is convenient, register your APS device with the factory. When you start the ParticleSpectrum application (see "Running the ParticleSpectrum Application," on page 2.8), it prompts you to register your APS3 device for calibration. You can also register your APS device in any of the following ways:

- On the Internet: http://cyberoptics.com/semiconductor/wafersense-reticlesense-registration/
- By sending an e-mail message containing the model, serial number, and contact information to wsregister@cyberoptics.com

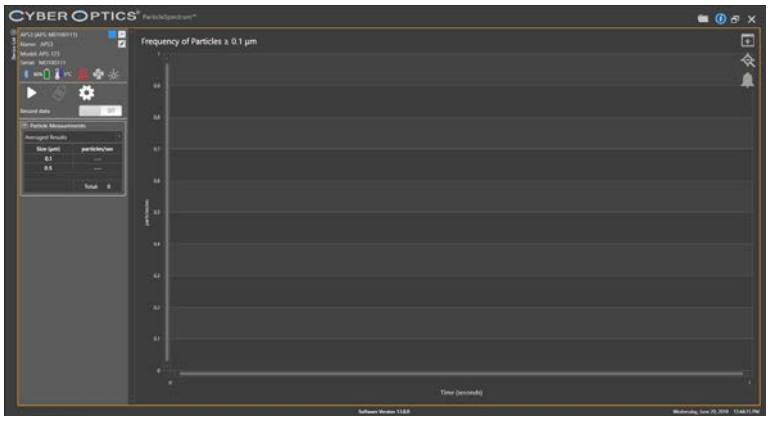
Large Particle Detection: APS3 units are capable of measuring large particles. This is in addition to the normal small particle detection. Large particle operation is very similar to small particle detection so that all of the sections in this manual describing settings and operation are still valid for large particle detection. How to operate large particle detection and the differences between the two modes are described in Appendix A – Large Particle Detection.

Running the ParticleSpectrum Application

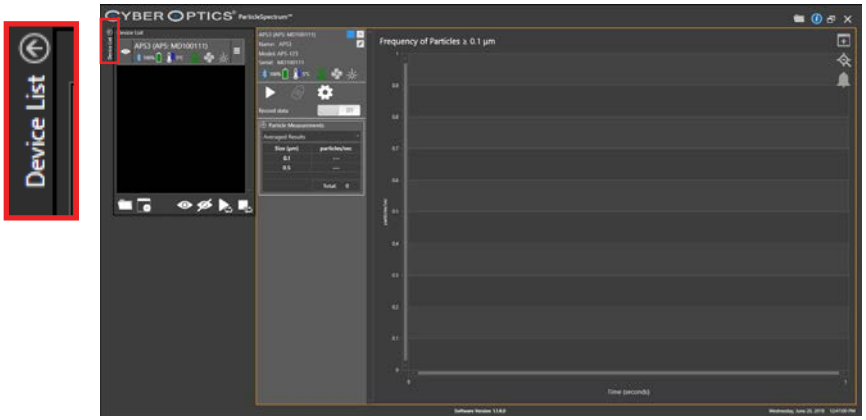
To start the ParticleSpectrum application:

1. From the Windows **Start > Programs** menu, choose **CyberOptics > ParticleSpectrum**. The ParticleSpectrum application starts, as shown in Figure 2.5.

   Initializing communications usually takes less than a second. For information on using ParticleSpectrum, see Chapter 3 "Using Your APS3." If the APS3 device has not been registered, ParticleSpectrum will display the Calibration Registration dialog. To complete the registration, proceed to the next step.



Default View



Default View with Device List on the Left side. The device list can be enable and minimized by selecting the arrow icon above **Device List**

Figure 2.5: Starting the ParticleSpectrum Application

2. If ParticleSpectrum displays the APS Calibration Registration dialog, as shown in Figure 2.6, you haven't registered your APS device. Follow the instructions in the dialog to complete the registration.

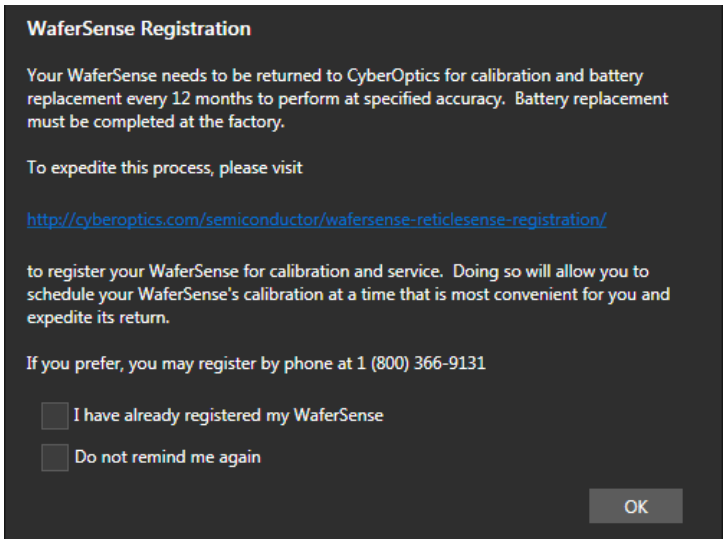


Figure 2.6: Calibration Registration Dialog

Technical Support

CyberOptics offers free technical support to customers. If the APS hardware or software appear to be malfunctioning, please contact us, and we'll be happy to assist you.

When you contact us, please make sure that you have the following information available:

- A detailed description of the problem you are having, including the exact text of any error messages and a list of steps to reproduce the problem.
- Information about your computer, including manufacturer, CPU type, version of Windows, and memory size.
- The version of the ParticleSpectrum application. The software version is available in the ParticleSpectrum application by choosing the **Info** icon in the upper right side of the screen.

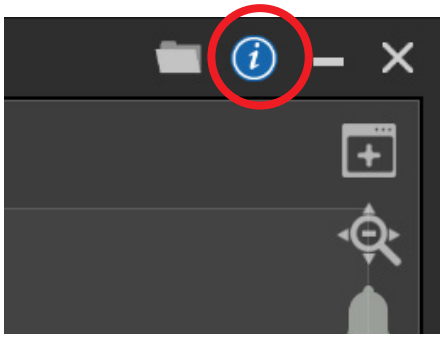
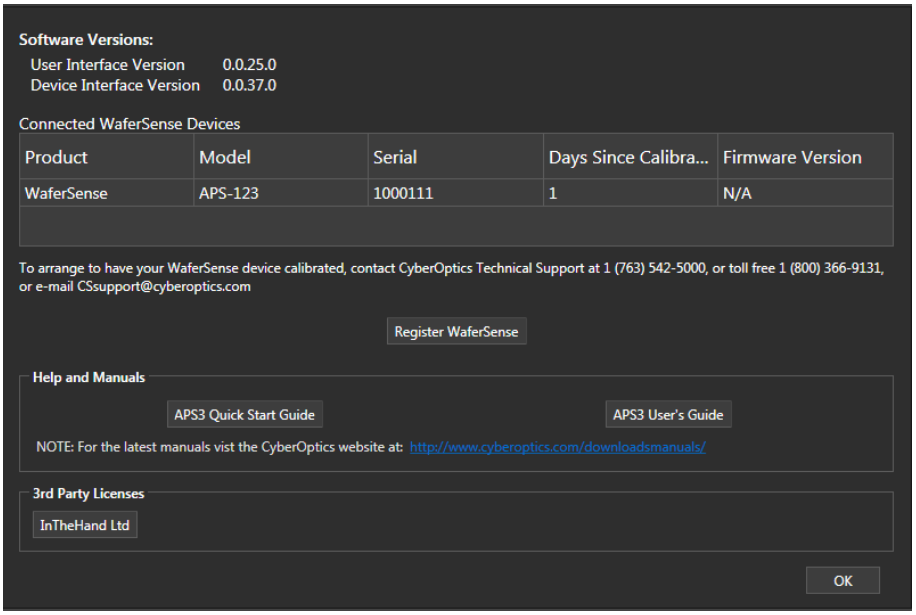


Figure 2.7: The About ParticleSpectrum Dialog

- The serial number of your APS device. The serial number of the APS device is printed on a label on the top of the APS device. The serial number is also available in the ParticleSpectrum application by choosing the **Info** icon menu item.



Technical support:

- Toll free: +1 800-366-9131 (US and Canada only)
- E-mail: CSsupport@cyberoptics.com
- Internet: www.Cyberoptics.com

Chapter 3

Using Your APS3

This chapter gives you instructions for performing the following tasks with the Airborne Particle Sensor 3 (APS3) device:

- Opening and closing the charging case
- Using the APS3 device buttons and status lights
- Making a simple particle measurement run
- Setting the purge and measurement times
- Monitoring for excessive particle levels
- Recording the particle measurements
- Configuring the display
- Monitoring the operating temperature
- Using the rechargeable battery
- Monitoring the wireless connection to the APS3 device
- Monitoring the pressure, laser, and fan
- Reporting asynchronous events
- Changing the pairing between the APS3 device and link
- Saving your settings
- Additional Display Features

Opening and Closing the Charging Case

The APS3 device comes in a plastic charging case that is used for storing it when not in use and for charging the rechargeable battery in the APS3 device (see "Using the Rechargeable Battery" on page 3.25). The APS3 device should be stored in the sealed charging case when not in use.

The charging case is air-tight. After air transport it may be necessary to relieve the pressure differential in order to open the case. To do so, loosen the pressure relief vent screen until air enters the case. Then re-tighten the screw.

To open the charging case:

1. Loosen the captive screws on the top of the case (see Figure 3.1).

Figure 3.1: Opening the Charging Case

2. Lift the lid of the charging case using the captive screws.

To close the charging case:

1. Lower the lid.
2. Tighten the captive screws until the top of the case is secured. (see Figure 3.1)

Using the APS3 Controls

APS3 devices are designed to operate "hands free" in normal use.

- The unit is turned on by inserting the unit in the charging case and applying power to the charging case.
- The unit is completely turned off by activating the "shutdown" button in the ParticleSpectrum software..
- A "shutdown" turns off all internal electronics in the APS3. After a shutdown the unit must be restarted in the charging case. Therefore, if the intent is to put the unit into standby mode, where the fan and laser are turned off but the electronics are still active, the "stop" button in the ParticleSpectrum should be used instead of the "shutdown" button.
- In abnormal situations, the reset switches on the front panel can be used to activate a shutdown or to turn the unit on from a shutdown. See page 1.2 for a view of the reset switches. The button indicated by "1" turns the unit on. The button indicated by "0" turns the unit off.

Using the APS3 Indicators

APS3 devices have the following status LED (see illustration on page 1.2)

- **Charger On.** Glows green when power is applied to the charging case.
- **Charging.** Glows red when the unit is being charged. Goes dark when the battery has reached 100% charge. Glows red if the charger is connected and the battery discharges below 95%. Goes dark when the inductive charger is no longer powered.
- **Unit On.** Indicates when the device is on.
- **Connect/Pair. Note**: Glows green when the unit is successfully paired with a link box. Blinks red/green slowly when it is searching for a link. This usually occurs just after turn on or before the link box is powered by the host computer. Blinks red/green rapidly when the pairing function is activated by the "C" reset switch. This rapid blinking indicates it is receptive to a new pairing.
- When the APS3 device is on and has been removed from its charger and is ready for in-tool use, the "Unit on" and the "Connect/Pair" LEDs should both be glowing steady green. The APS3 device can be operated inside the charging case. However, do not connect the charger while operating the APS3 inside the case.

Making a Simple Particle Measurement Run

The APS3 device detects particles by size, sending the data to the ParticleSpectrum application in nearly real time. ParticleSpectrum displays the readings graphically and numerically, showing particle measurements by particle size. You can place the APS3 device in a piece of equipment, run the equipment through its paces, and watch the ParticleSpectrum display for particle measurements that might indicate a problem with the equipment.

To use the APS3 device with ParticleSpectrum:

1. Make sure the computer running the ParticleSpectrum application is within the range of the link module, up to 30 ft (10 m).
2. Normally, you would place the APS3 device on the equipment you want to check and then start the equipment in motion, monitoring the ParticleSpectrum display. To get an idea of how the APS3 system works, for now just set the device on a desk or table and turn it on.
3. Start the ParticleSpectrum application. The ParticleSpectrum window appears, as shown in Figure 3.3 on page 3.5.
4. Click **START** to start the measurement run in the **Device Controls** (see Figure 3.2).

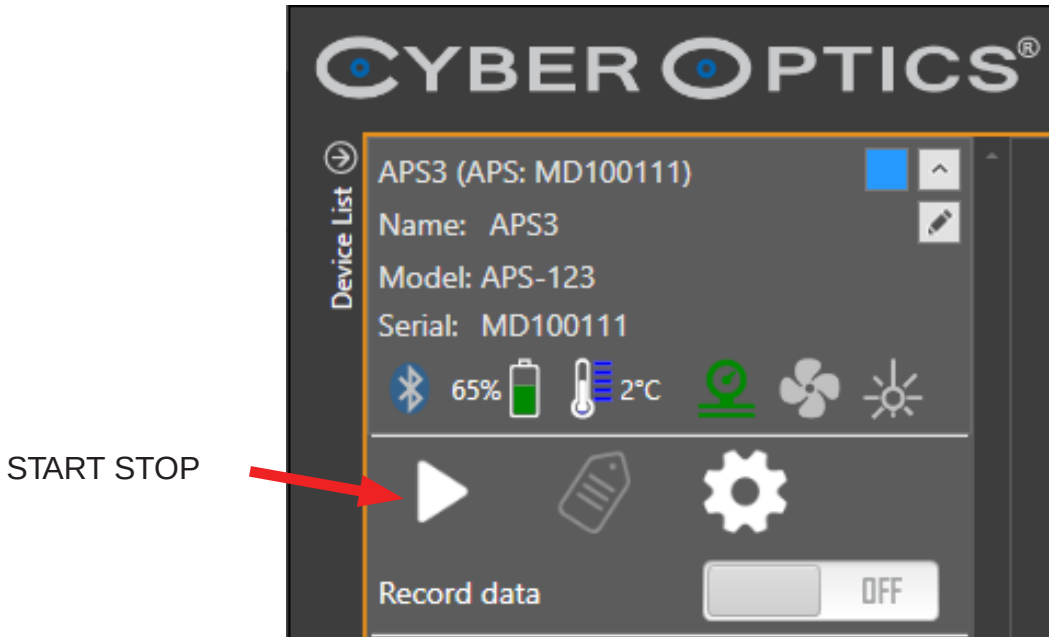


Figure 3.2: Making a Simple Measurement Run

The particle run begins by purging the APS3 device's particle sensor before starting to detect particles (for more information, see "Setting the Purge and Measurement Times" on page 3.7.).

Figure 3.3: Reading the ParticleSpectrum Display

- **Numerical and graphical displays.** The top-left quadrant of the ParticleSpectrum display shows the particle measurements in numerical form. As the APS3 device detects particles, it assigns them to "bins" based on particle size. The displayed numbers are particle measurements averaged over a time interval (see "Changing the Averaging Interval," on page 3.19). The grid area of the display on the right shows a graph of the particle measurements. You can select one bin at a time to display on the graph (see "Selecting the Particle Size to Graph," on page 3.17). The graph shows a dotted line for the average particle measurement over time, as shown in the numerical displays, and a solid line that is the real-time particle measurement received from the wafer. You can adjust the horizontal and vertical scales of the graph (see "Changing the Vertical Scale," on page 3.18 and "Changing the Horizontal Scale," on page 3.19). The most recent measurement always appears at the right edge of the graph. When the APS3 device is purging, the measurement display boxes and the graph are blank. A Purging Countdown Timer will appear in the lower left portion of the graph window.

- **Particle frequency and particle density.** ParticleSpectrum displays particle measurements as either particle frequency (number of particles per unit time) or as particle density (number of particles per volume). For more information, see "Displaying Particle Density or Frequency," on page 3.17.

The other features of the ParticleSpectrum display are described later in this chapter.

Setting the Purge and Measurement Times

When you click **START**, the APS device measures particles for the specified measurement time, or until you click **STOP**. Prior to beginning the measurement, to purge the particle sensor, the APS wafer runs its fan for a period of time without measuring particles. You can specify the times for both purging and measurement. Typically a purge time of 60 seconds clears the APS device of residual particles prior to starting a new measurement.

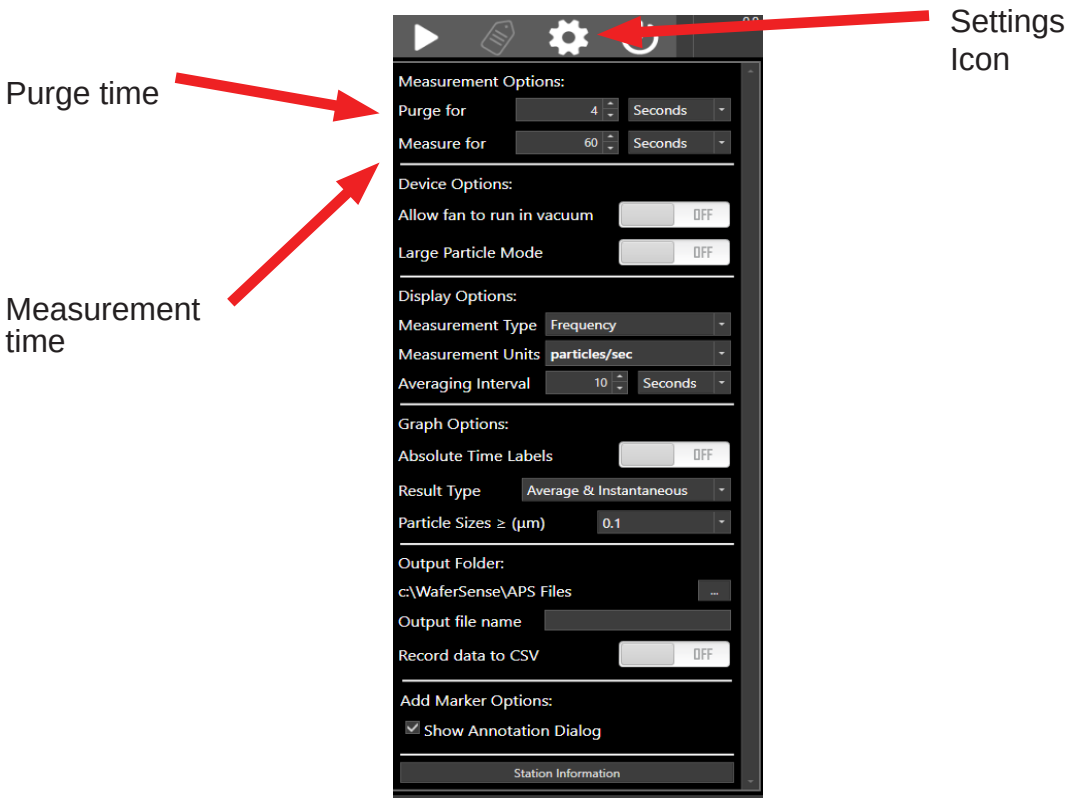


Figure 3.4: Setting the Purge and Measurement Times

To set the purge time:

- Under **Settings** > **Measurement Options**, use the **Purge for** controls to choose the time and the units (seconds or minutes).

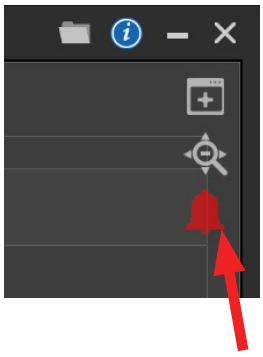
To set the measurement time:

- Under **Settings** > **Measurement Options**, use the **Measure for** controls to choose the time and the units (seconds, minutes, or hours).

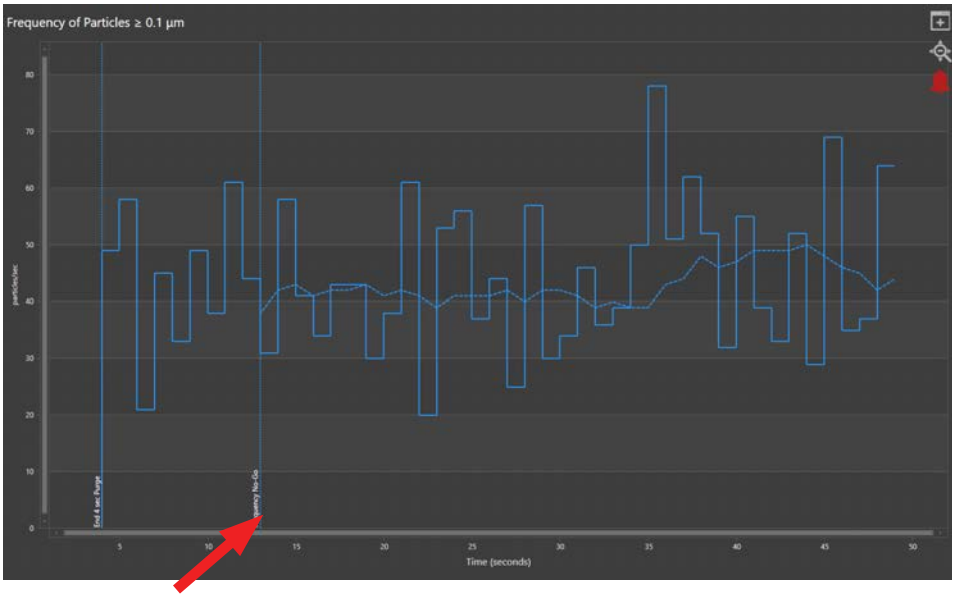
Monitoring for Excessive Particle Levels

You can use the Go/No-Go feature in ParticleSpectrum to monitor particle measurements for sustained excessive levels, to indicate when average measurements exceed your specified thresholds. When a Go/NoGo alarm is active, and a measurement is in progress, the Go/No-Go Alarm area of the display, located in the upper right corner of the screen, indicates the current Go/No-Go condition as shown in Figure 3.5.

Green: Measurement below threshold.



Red: Measurement exceeds threshold.



A No-Go marker is added to the graphical display

Figure 3.5: Go/No-Go Indicators

To set the Go/No-Go threshold:

1. Click **Configure Go/No-Go** (see Figure 3.6).

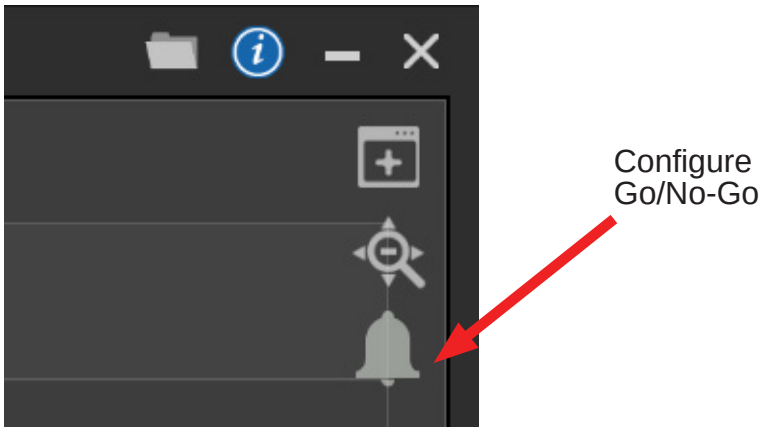


Figure 3.6: Setting the Go/No-Go Thresholds

The Set Go/No-Go Threshold dialog is displayed, as shown in Figure 3.7.

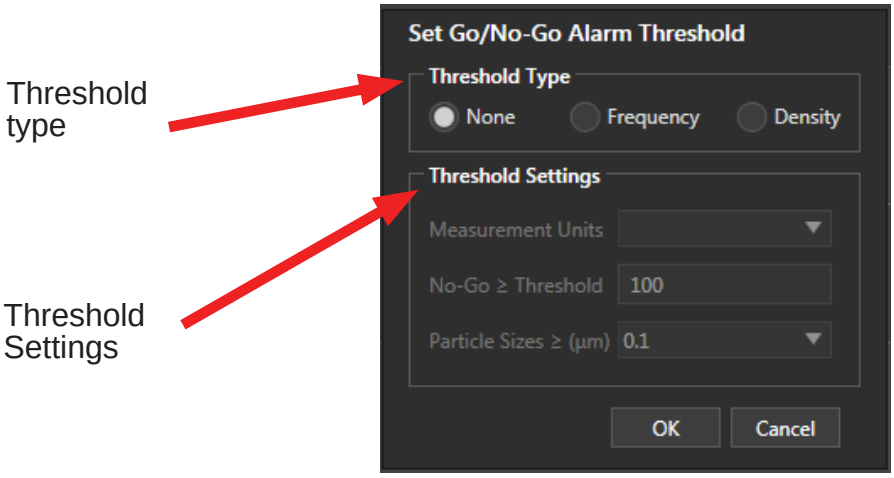


Figure 3.7: Set Go/No-Go Threshold Dialog

2. Under **Threshold Type**, select either a **Frequency Threshold** alarm or a **Density Threshold** alarm. To disable the alarm, select **None**. Note that choosing a threshold type in the Set Go/No-Go Threshold dialog doesn't affect whether the measurements

displayed in the main ParticleSpectrum window are frequency or density measurements. You need to set that display choice in the main window (see "Displaying Particle Density or Frequency," on page 3.17).

3. Under **Threshold Settings**, specify the frequency or density units from the **Measurement Units** menu, the numerical value of the alarm **No-Go Threshold**, and the bin to apply the threshold to by selecting an option from the **Particle Sizes** drop-down menu. Lengthening the averaging interval smooths out the raw data, so the measurement must exceed the threshold for a longer time to trigger the alarm. The averaging interval you specify for the Go/No-Go threshold is independent of the averaging interval for graphing the particle measurements (see "Changing the Averaging Interval," on page 3.19).
4. Click **OK**. The Go/No-Go settings take effect immediately. When the next active No-Go event occurs, ParticleSpectrum changes the green Go/No-Go indicator to red (see Figure 3.5 on page 3.8).

Recording the Particle Measurements

You can record the particle measurement data to a log file and view the file in the Review feature. For information on log files, see "Viewing Log Files," on page 4.1.

Log files include the particle measurement data and user-specified data (see "Including User-Specified Information in the Log File," on page 3.13). Particle measurements are recorded at intervals of one second, regardless of the horizontal scale display.

To record particle measurement data during measurement runs:

1. In the **Device Controls** for the device.
2. To start recording, click **START**. The **START** button changes to **STOP**. ParticleSpectrum starts recording after the purge cycle is complete, or until you click **STOP**. See Figure 3.8.

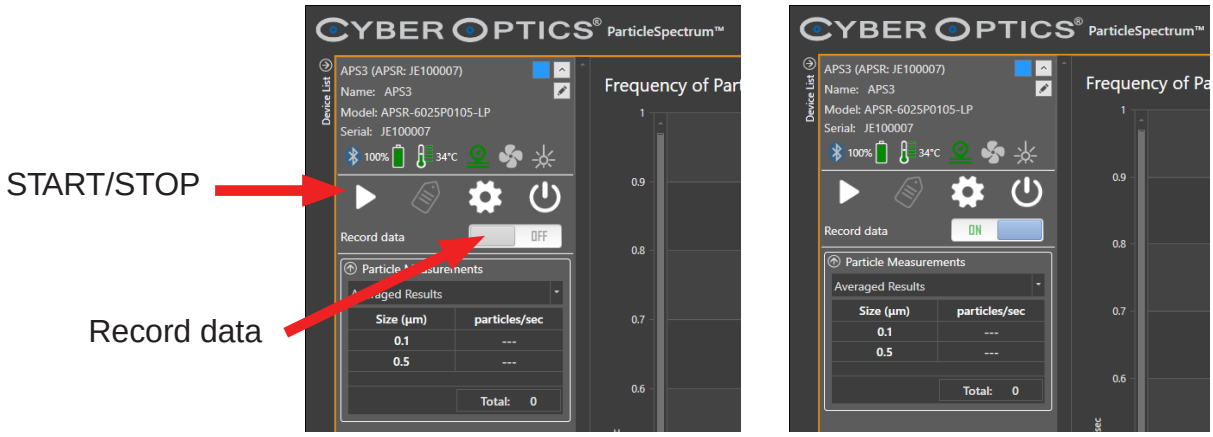


Figure 3.8: Recording Particle Measurement Data

3. To stop the recording before the specified recording time has expired, click **STOP**. When the measurement time expires, or when you click **STOP**, ParticleSpectrum ends the current log file. To review the log file see "Viewing Log Files," on page 4.1

Placing Marks in a Log File

At the start of recording and at No-Go and other events, ParticleSpectrum automatically places marks in the log file. In addition to marks created automatically by ParticleSpectrum, you can manually create your own marks in a file while you are recording, and you can add annotations to the marks.

Adding Marks Manually

To manually add a mark to a log file:

1. Choose the menu **Settings > Add Marker Options > Show Annotation Dialog**. This menu item toggles the display of the Annotate Mark dialog on and off. The setting is off by default. If you don't display the Annotate Mark dialog, you can still add marks to the file, but you won't be able to add your own comments to be saved with the marks.

2. While you are recording data, click **Add a Mark** (see Figure 3.9).

Figure 3.9: Adding a Mark

The Annotate Mark dialog is displayed (see Figure 3.10).

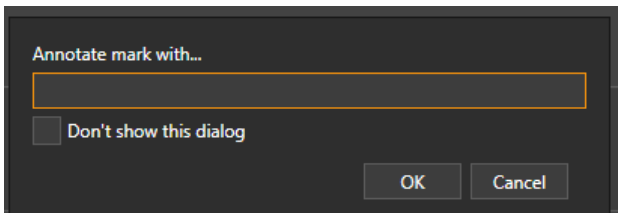


Figure 3.10: Annotating a Mark

3. In the Annotate Mark dialog, type the text you want to record with the mark location in the file and click **OK**. You can't add another mark until you click **OK**.

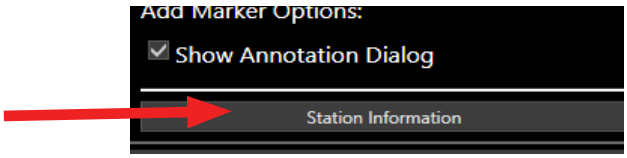
   If you don't want to be prompted with the Annotate Mark dialog when you click **Add a Mark**, the next time the dialog appears, check **Don't show this dialog** and click **OK**. If you have previously checked this box, and you now want to have the dialog displayed again, choose the device menu **Settings > Add Marker Options > Show Annotation Dialog** to toggle on the display of the Annotate Mark dialog.

Including User-Specified Information in the Log File

Operator, **Tool**, **Station**, and **Comment** are text fields you can use to record your own information in each log file. You can fill in any text information you want in these fields.

To include user-specified information for logging:

1. Choose the **Settings > Station Information** menu item.



   The Set Station Information dialog is displayed, as shown in Figure 3.11.

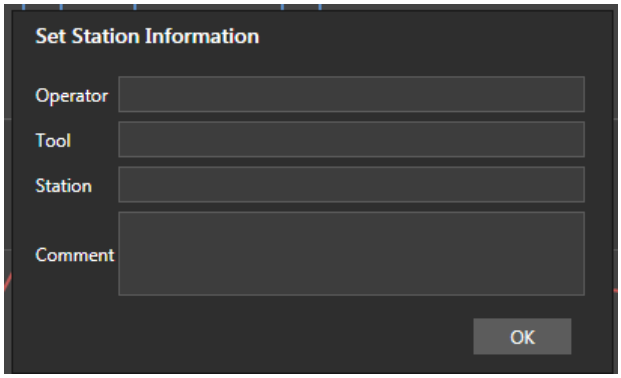


Figure 3.11: Set Station Information Dialog

2. Type your text into the **Operator**, **Tool**, **Station**, and **Comment** text fields.
3. To accept the changes and close the dialog, click **OK**.

Log File Directory Location

By default, ParticleSpectrum writes log entries to the directory C:\WaferSense\APS Files\. If you prefer, you can specify a different directory (see "Changing the Log File Directory," on page 3.16).

Log File Names

By default, log file names are automatically assigned by ParticleSpectrum and consist of the serial number for the APS device followed by the date and time (see Figure 3.12).

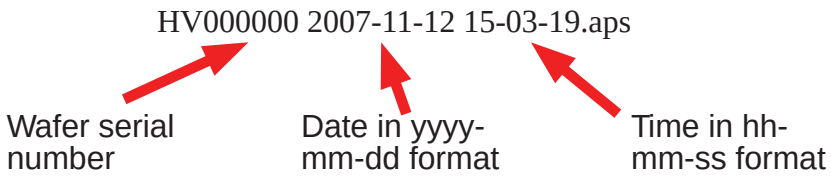


Figure 3.12: Default Log File Names

You can specify a different log file name prefix to replace the APS device serial number, in which case, ParticleSpectrum still adds the date, time, and the appropriate extension.

To specify a different log file prefix:

1. Choose **Settings > Output Folder > Output file name**

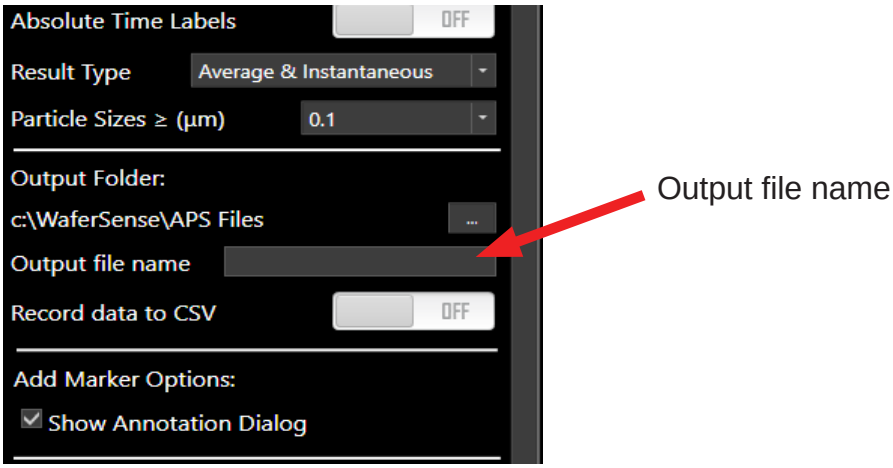


Figure 3.13: Specifying a Log File Name Prefix

2. In the **Output file name** prefix box, enter the text you want to replace the APS wafer serial number in log file names.
3. Click anywhere off the screen to close the Settings Menu.

Importing Log Files Into Other Applications

If you want to be able to import log files into other programs, such as MATLAB or Microsoft Excel, you need to have ParticleSpectrum write log files in comma-delimited format (also called comma-separated-values or CSV files) as well as the *.aps* file format.

The comma-delimited files are named as described in "Log File Names," on page 3.14, above, but with the *.csv* extension, rather than *.aps*.

To have ParticleSpectrum record comma-delimited files:

1. Choose the menu item **Settings > Output Folder**. The Log File Options dialog is displayed (see Figure 3.14).

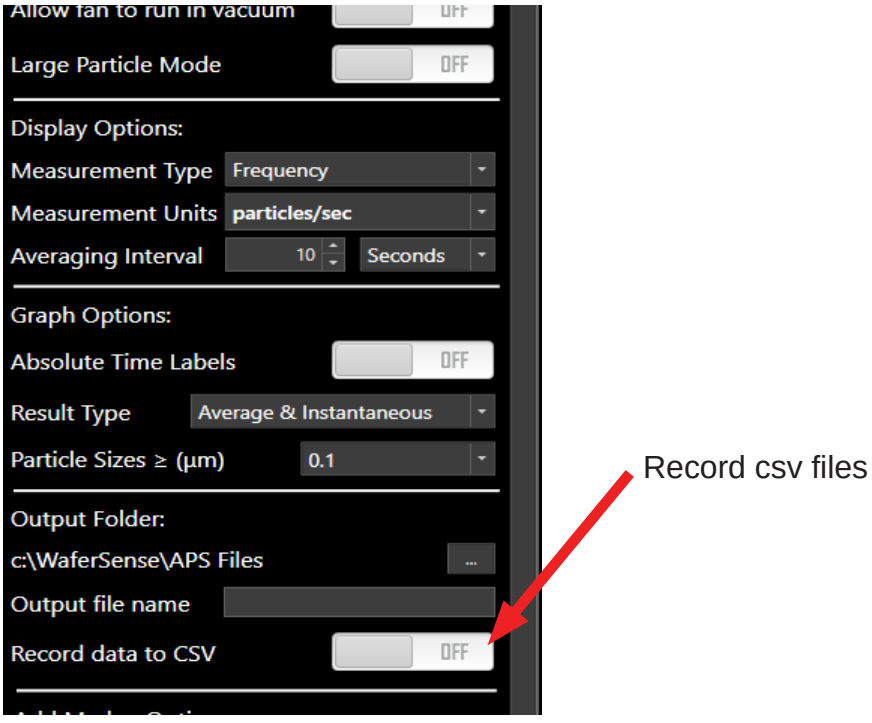


Figure 3.14: Recording Comma-Delimited Files

2. Select the **Record data to CSV** button so it reads **ON**.
3. Click anywhere off the screen to close the Settings Menu.

The layout of the data in the comma-delimited file is in columns as displayed in Figure 3.15. Marks are also saved.

	A	B	C	D	E	F	G	H
1	Time (sec)	APS3 (APSR: JE100007) 0.1um/ft^	APS3 (APSR: JE100007) 0.5um/ft^3	APS3 (APSR: JE100007) 0.1um/sec	APS3 (APSR: JE100007	Date	Time of Day	Marker
2	1	0	0	0	0	7/13/2018	2:21:40 PM	End 4 sec Purge
3	2	2929917.96	433654.14	293	43	7/13/2018	2:21:41 PM	
4	3	2819921.04	383229.24	282	38	7/13/2018	2:21:42 PM	
5	4	2679924.96	363059.28	268	36	7/13/2018	2:21:43 PM	
6	5	2789921.88	413484.18	279	41	7/13/2018	2:21:44 PM	
7	6	2819921.04	383229.24	282	38	7/13/2018	2:21:45 PM	
8	7	2339934.48	383229.24	234	38	7/13/2018	2:21:46 PM	
9	8	2899918.8	463909.08	290	46	7/13/2018	2:21:47 PM	
10	9	2379933.36	342889.32	238	34	7/13/2018	2:21:48 PM	
11	10	2609926.92	272294.46	261	27	7/13/2018	2:21:49 PM	
12	11	2809921.32	383229.24	281	38	7/13/2018	2:21:50 PM	
13	12	2959917.12	403399.2	296	40	7/13/2018	2:21:51 PM	
14	13	2599927.2	443739.12	260	44	7/13/2018	2:21:52 PM	
15	14	2589927.48	453824.1	259	45	7/13/2018	2:21:53 PM	
16	15	2739923.28	453824.1	274	45	7/13/2018	2:21:54 PM	
17								

ParticleSpectrum writes data to the file once per second

Figure 3.15: Layout of Comma-Delimited File

Changing the Log File Directory

By default, ParticleSpectrum writes log entries to the directory C:\WaferSense\APS Files\. If you prefer, you can specify a different directory.

To change the log file directory:

1. Choose the menu item **Settings > Output Folder > Browse Icon**

2. In the Browse for Folder dialog, specify the folder name for the log files, and click **OK**.

Configuring the Display

You can change the way particle measurements are displayed by selecting which particle size bin to graph, by choosing to display either particle density or particle frequency, by changing the vertical and horizontal scales, by changing the averaging interval, and other elements in the display.

Selecting the Particle Size to Graph

You can choose which of the cumulative particle measurement bins to graph.

To choose which particle bin to graph:

- In the **Graph Options**, choose the particle size from the **Particle Sizes** list drop down menu (see Figure 3.16).

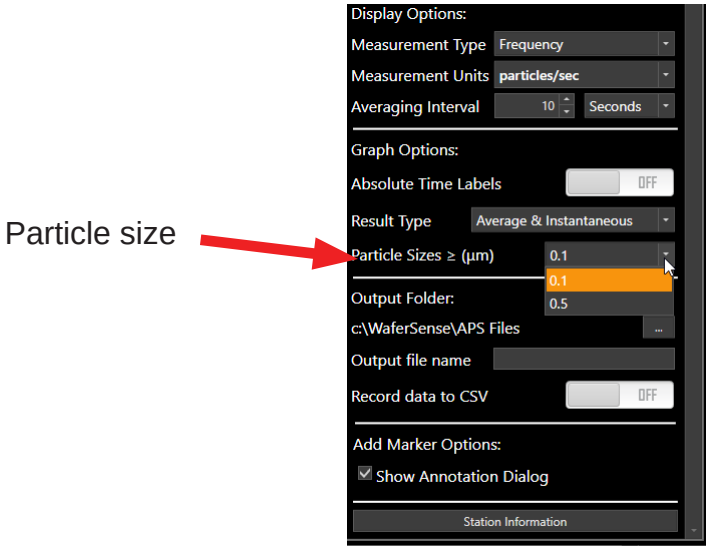


Figure 3.16: Selecting the Particle Size for the Graph

Displaying Particle Density or Frequency

ParticleSpectrum displays particle measurements as either particle frequency (number of particles per unit time) or as particle density (number of particles per volume).

To choose particle density or particle frequency:

- In the **Display Options**, under **Measurement Type**, select **Density** or **Frequency** (see Figure 3.17).

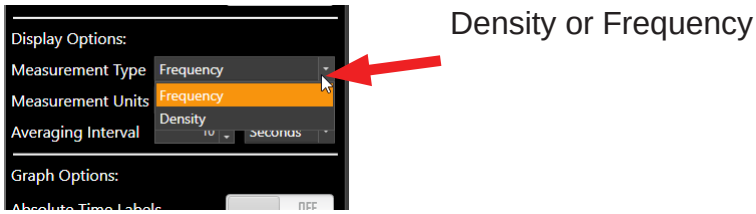


Figure 3.17: Displaying Particle Density or Frequency

Changing the Vertical Scale

You can set the vertical scale for the particle measurement graph. The scale is in particles per unit time when displaying particle *frequency*, or in particles per unit volume when displaying particle *density*. Particle measurement values that are too large to display with the current scale setting may appear to be off screen. The Zoom out to extents button will adjust to fit on the screen.

To change the vertical scale:

- In the **Display Options**, under **Measurement Units** choose the type of measurement for your application. If you have chosen to display particle density, the units will be those of volume. If you have chosen to display particle frequency, the units will be those of time.
- The graph window will adjust to the units that have been selected. The **vertical scale bar** can be adjusted to accommodate the larger values, and the **Zoom out to extents** button in the upper right of the graph window will also adjust to the new values if you've already recorded data.

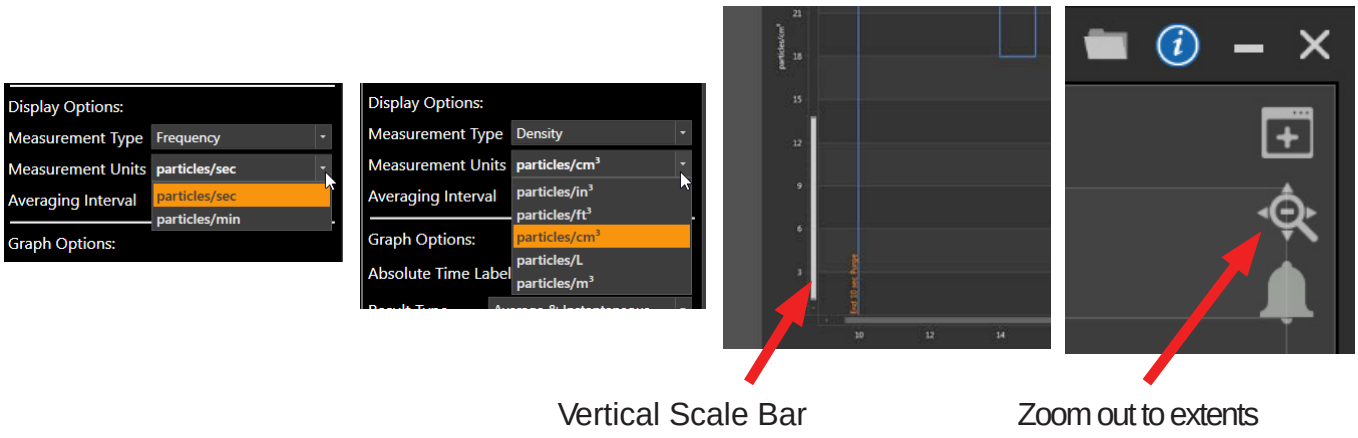


Figure 3.18: Vertical Scale

Changing the Horizontal Scale

You can set the horizontal scale for the particle measurement graph. The scale will list time in seconds, or can list **Absolute Time Labels**.

The horizontal scale setting affects only the display of the particle measurements. The APS device always sends measurements once per second to ParticleSpectrum, and log files always record measurements at increments of one second.

To change the horizontal scale to list **Absolute Time Labels**:

- In the **Graph Options**, under **Absolute Time Labels**, select the button to read **ON.** The new setting takes effect immediately.
- The graph window will adjust to the units that have been selected. The **horizontal scale bar** can be adjusted to accommodate the larger values, and the **Zoom out to extents** button in the upper right of the graph window will also adjust to the new values if you've already recorded data.

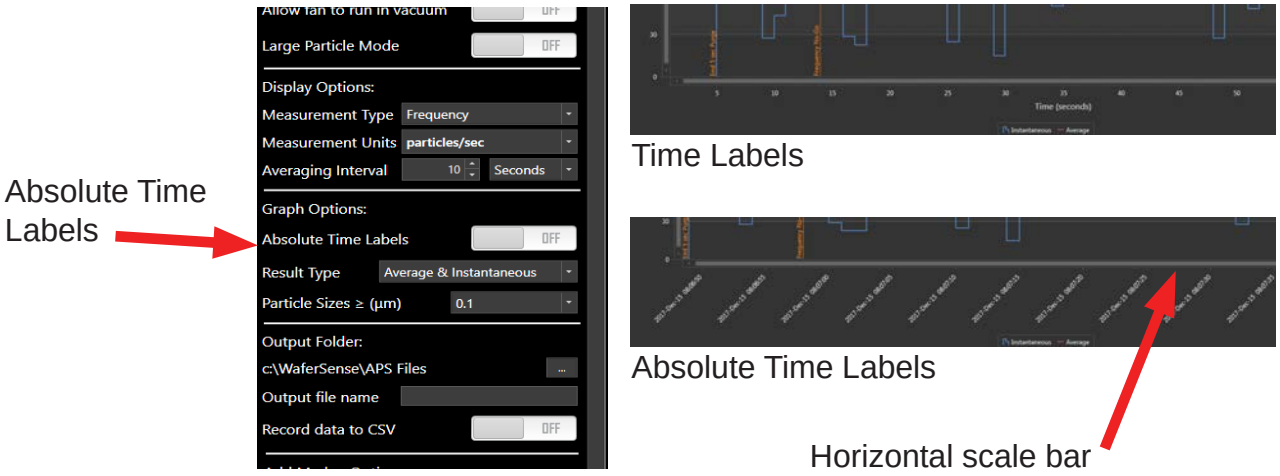


Figure 3.19: Horizontal Scale

Changing the Averaging Interval

The values displayed in the numerical readouts are moving averages of the particle measurements. ParticleSpectrum averages the raw data over an interval that you specify. ParticleSpectrum displays both the raw data and the averaged data in the graph.

The averaging interval you specify affects only the display of the particle measurements. The APS wafer provides the following:

- Measurements are always sent once per second to ParticleSpectrum and log files always record the raw measurements at increments of one second.
- The APS airflow is always 0.1 cubic feet per minute.

To change the averaging interval:

- In the **Display Controls**, under **Averaging Interval**, choose the interval in seconds, minutes, or hours for averaging the particle measurements. The new setting takes effect immediately.

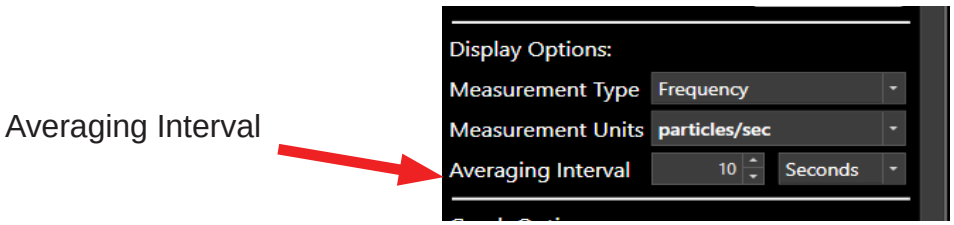


Figure 3.20: Horizontal Scale

For example, you know the airflow through the APS device is 0.1 cubic feet per minute but you want to average the particle count over one cubic foot of air. You can determine the length of time the APS device needs to run using the following formula:

$$\frac{1 \text{ cu ft.}}{0.1 \text{ cu ft. per minute}} = 10 \text{ minutes}$$

Using the formula you know the APS device needs to run for 10 minutes to process one cubic foot of air.

Measurement Accuracy

The APS device's accuracy is based on particle density measurements using an averaging interval of ten minutes. The shorter the averaging interval, the accuracy of numeric measurements is degraded while longer averaging intervals will have increased accuracy of the numeric measurements.

Device Status Icons ParticleSpectrum

ParticleSpectrum lists a Device Status Bar for connected devices in two different locations; the Device List, and the Graph Window for the device. The Device Status Bar has icons showing Battery Level, Operating Temperature, Pressure, Fan, and Laser

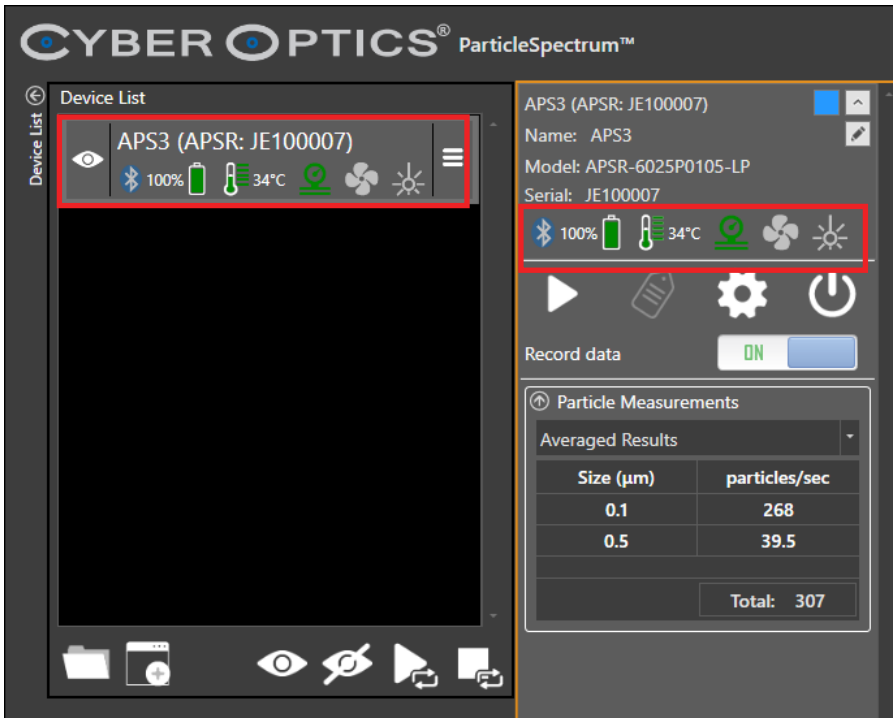


Figure 3.21: Device Status Bar

Additional Icons in Device List

There are additional icons for the connected device in the Device List.

- **Visibility**, hide and unhide the device. When the device is hidden, the graph window for the device is also hidden.
- **Menu,** remove the device from the device list. If the device is removed, you will need to restart the ParticleSpectrum software.
- **Select Review File**, accesses log files to be import into ParticleSpectrum for review.
- **Manage Device List,** manages and links list of connect devices.
- **Display All and Hide All Devices**, displays and hides all devices in the device list
- **Start All and Stop All Devices,** starts and stops all devices in the device list.

Additional information can be found in Appendix B

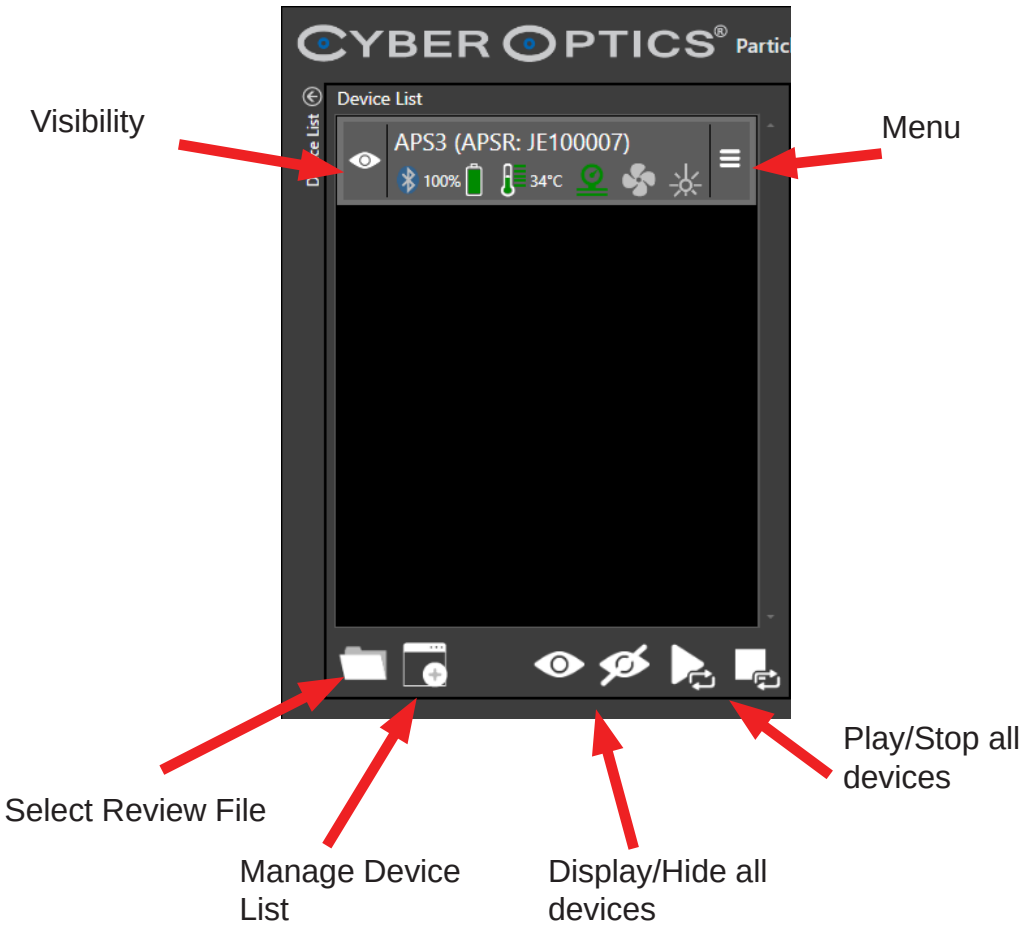


Figure 3.22: Device Status Bar in Device List

Monitoring the Operating Temperature

The operating range for the APS devices to achieve the specified accuracy for readings is 15°C to 45°C. The APS can withstand exposure to 60 °C for brief periods. The **Temperature** monitor in the **APS device status bar** of the ParticleSpectrum window (see Figure 3.23) shows the current operating temperature of the APS device with a numeric readout and a color graphic.

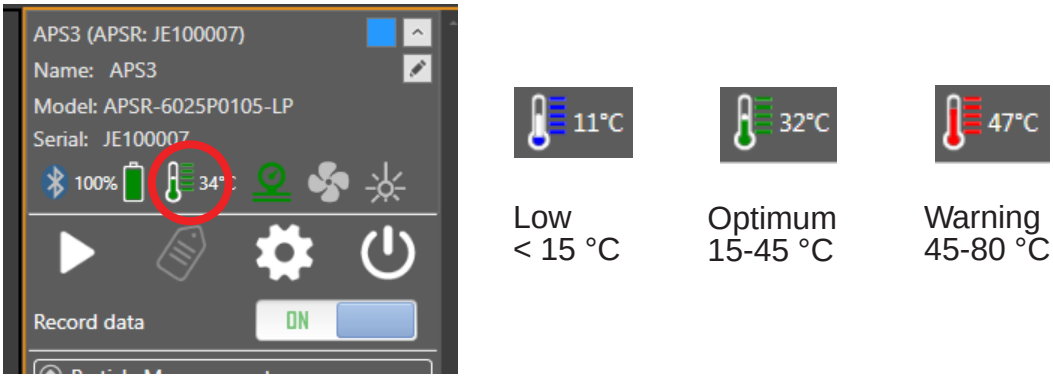


Figure 3.23: Temperature Monitoring Gauge

The temperature bar changes color to indicate where the current temperature is relative to the accurate operating range:

- **Blue.** Less than 15 °C; the APS device is operating below the range where it produces accurate readings.
- **Green.** 15 °C to 45 °C; the APS device is operating in its optimum temperature range, where it produces readings meeting the specified accuracy.
- **Red.** 45 °C to 80 °C and Greater than 80 °C; the APS device is operating at a temperature so high that it might be damaged.

Using the Rechargeable Battery

The APS device operates from an internal rechargeable battery. From a full charge, the battery provides about four hours of continuous use. Before using your APS device for the first time, charge it for two hours.

The battery can be recharged about 400 times before the charge life starts to degrade significantly. The battery is not user replaceable. For information on replacing the battery, see "Annual Factory Calibration and Battery Replacement," on page 5.3.

Battery performance degrades at temperatures outside the temperature range: 15 °C - 45 °C.

Monitoring the Battery Level

ParticleSpectrum receives frequent updates from the APS device on the status of the APS device's battery. The **Battery** indicator in the **APS device status** bar of the ParticleSpectrum window shows the approximate percentage of operating time remaining before you must charge the battery.

Battery status

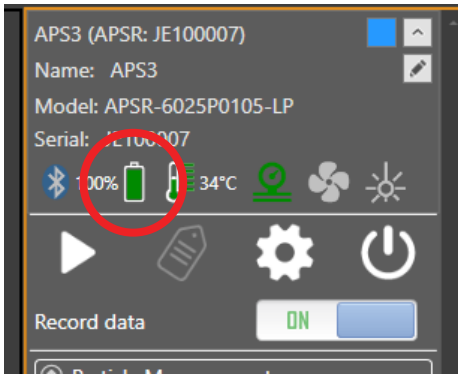


Figure 3.24: Battery Monitor

Charging the Battery

To charge the APS device's battery:

1. Use only the battery charger supplied with your APS device. Using a different battery charger might damage your APS device or create a safety hazard.
2. Do not charge the APS device if the temperature is higher than 45°C. Charging the APS device at a temperature higher than 45 °C might damage the APS2 device housing or create a safety hazard.
3. Place the APS device in the charging case (see "Opening and Closing the Charging Case," on page 3.2). Close the lid.

Figure 3.25: Contact Case Connection and Pressure Relief Vent

4. Plug the charger line adapter into a 100 VAC to 240 VAC mains and plug the other end into the charging case connection on the right side of the charging case. (See figure 3.25)

   The charging case is air-tight. After air transport it may be necessary to relieve the pressure differential in order to open the case. To do so, loosen the Pressure Relief Vent screw until air enters the case. Then re-tighten the screw.

5. When power is applied to the charging case, the "Charger on" LED will light and the "Charging" LED will also light unless the unit is already fully charged. In addition the "Unit on" LED will light. If the unit is still paired to a powered link box the "Connect/Pair" LED will light.

6. Charge the unit until the "Charging" LED goes dark. The unit is now fully charged and ready for data collection. However, the unit can be used if not fully charged.

7. The APS can remain in the charging case with power applied to the case even when fully charged. The battery will not be damaged. The APS should be stored in the sealed charging case when not in use.

Micro USB Charging

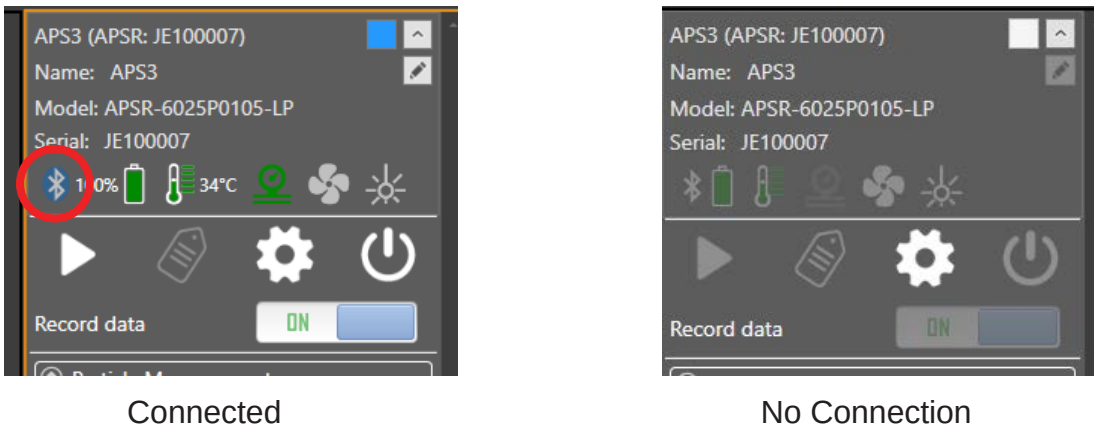
The APS3 contains a micro USB connector to allow charging and operation from a standard USB power source. (see page 3.25). CyberOptics offers an optional Power Bank and cable that can connect and extend the normal APS3 battery life. Alternatively, the customer can connect any standard USB power source to this connector. However, this connector is only a power connector and does not transmit any data to or from the unit. Also, because of the extreme thinness of the APS3, only a very thin micro USB connector can attach without interfering with the carbon fiber substrate. Contact CyberOptics for more information.

Monitoring the Wireless Connection to the APS3 Device

The ParticleSpectrum application communicates with the APS device by using a Bluetooth wireless link. The wireless link has a range of up to 30 ft (10 m).

The **Connection** indicator in the **APS device status bar** area of the ParticleSpectrum window shows the wireless connection between the APS device and the link module. The connection quality is indicated by the color of the bar and the wording below the bar (see Figure 3.26):

- **Blue - Connected.** The connection between the link and APS device is good. With a good connection, the APS device is sending the maximum number of readings per second to the link module (at least 200 readings per second).
- **Grey - No connection.** Indicates that there is no connection between the APS device and link module. The entire device status bar will be greyed out.



Connected

No Connection

Figure 3.26: Wireless Connection Monitor

The Bluetooth wireless link technology used in the APS device is a low-power technology that operates in the 2.4 GHz radio frequency band. This unlicensed band is also used by many other types of devices, such as cordless phones and microwave ovens. Another 2.4 GHz device operating in close proximity could interfere with the APS system. When this happens, separating the devices by at least 6 ft (2 m) usually solves the problem.

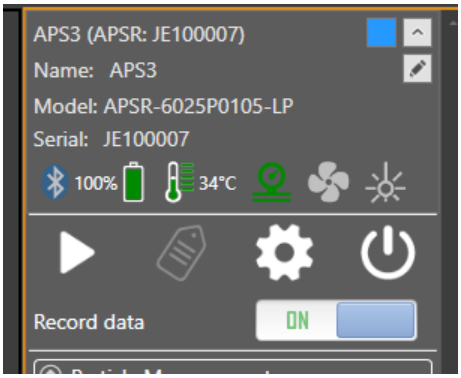
Other factors can also affect the wireless link, such as the distance between the APS device and link, and obstacles between the device and link that block the signal. If ParticleSpectrum indicates that the connection isn't good, try moving the wireless link module a few feet closer to the APS device.

After turning off the APS device, the Connection indicator might not change to grey for a few seconds.

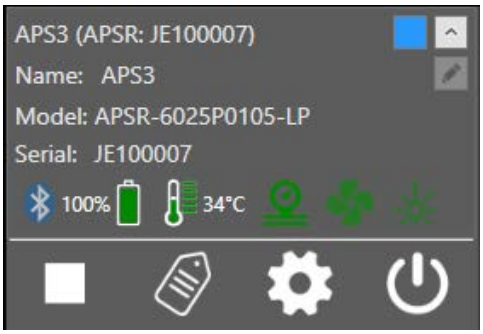
Monitoring the Pressure, Laser, Fan

In addition to connection, battery, and temperature, ParticleSpectrum includes indicators for the status of the atmospheric pressure, the laser, and the fan:

- **Fan.** The APS device uses a fan to flow gases in the local atmosphere through the particle detector. When the fan is operating, this indicator is green; otherwise the indicator is grey. If the fan
- **Pressure.** For the fan to work, local atmosphere must be at a minimum pressure of 0.4 atmosphere. When the pressure is high enough for good readings, the Pressure indicator is green; otherwise the indicator is red. If the APS device detects pressure dropping below 0.4 atmosphere, the fan and laser will automatically turn off to prevent damage.
- **Laser.** The APS particle detector works by scattering laser light off of the particles. The Laser indicator is green when the laser is operating; otherwise the indicator is grey.



Device Status bar when not measuring



Device Status bar when measuring

Figure 3.27: Pressure, Laser, and Fan Status

Reporting APS System Events

Specific APS system events are reported to ParticleSpectrum when they are encountered by the APS device. For example, an event can include a low battery or a laser failure and can stop particle measurement. The events described in this section include the following:

- Low battery
- Laser failure
- Low pressure environment

The following information lists these events and the resulting ParticleSpectrum behavior when the event is reported by the APS device.

Low Battery

When the battery charge decreases to the point that there is not enough power to drive the laser and fan, ParticleSpectrum is unable to perform meaningful measurements, resulting in one of the following events depending on the current state of the APS device.

- **Purging**. If a low battery condition arises while the sensor is purging, ParticleSpectrum displays a warning dialog and aborts the measurement.
- **Measuring**. If a low battery condition arises when the sensor is actively measuring, ParticleSpectrum shuts off the fan and laser, inserts a data mark in the log file, saves the log file contents, and stops the measurement.

To correct this problem recharge the sensor battery as described in Charging the Battery.

Laser Failure

In the unlikely occurrence of a laser failure, ParticleSpectrum is unable to perform meaningful measurements, resulting in one of the following events depending on the current state of the APS device.

- **Purging.** If a laser failure occurs when the sensor is purging, ParticleSpectrum displays a warning dialog and aborts the measurement.
- **Measuring.** If a laser failure occurs while the sensor is actively measuring, ParticleSpectrum turns off the fan and laser, inserts a data mark in the log file, saves the log file contents, and stops the measurement.

If a laser failure occurs, the APS device needs to be serviced. Do not attempt to operate it again until it is serviced. For information on sending the APS wafer to CyberOptics for servicing, refer to page 5.3 in Chapter 5.

Low Pressure Environment

In low pressure environments below 300 Torr (0.4 atmosphere), the APS device responds in order to prevent damage, resulting in the following event:

- **Pressure below 300 Torr.** The APS device's fan turns off. The laser remains on and ParticleSpectrum continues to record and display data. ParticleSpectrum inserts a data mark into the log file noting that the fan was turned off due to low pressure.

Figure 3.28: Below Pressure Warning and Fan Off

When the pressure returns above 300 Torr, the fan turns on and ParticleSpectrum inserts a data mark into the log file noting that the fan is functioning.

For operation of the fan to continue running below 300 Torr, select the **Device Settings** icon. Under **Device Options** click **Allow fan to run in vacuum** button to read **ON**. This will allow continued operation of the fan in a vacuum. The **Device Status Bar** icon for the fan will turn green.

Note: The **Allow fan to run in vacuum** is specific to your device hardware. If you power down the device with the setting still **ON**, the fan will turn on the next time you power up the device. If you connect a new APS device that did not have the feature turned on previously, you will need to go into the **Device Options** to turn the **Allow fan to run in vacuum** feature back **ON**.

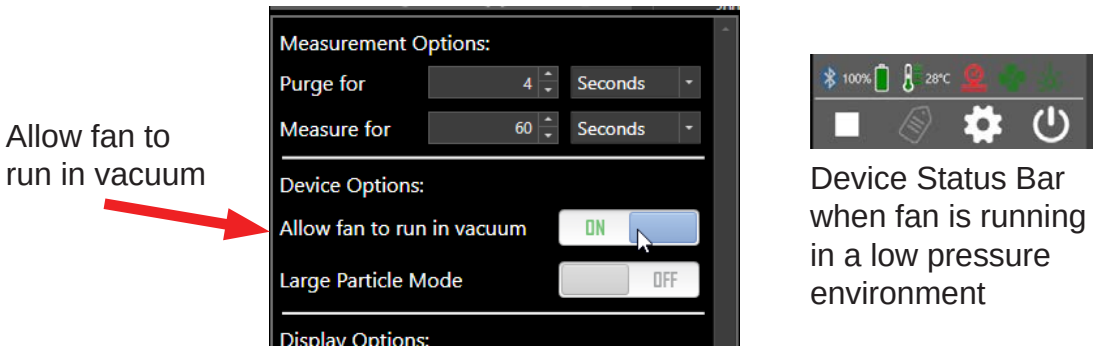


Figure 3.29: Fan Operation in Vacuum

Changing the Pairing Between the APS3 Device and Link

The APS device and link module in your kit were paired at the factory and will operate with only that particular link module. You can change this pairing, so that you can use your APS device with a different APS link module, or vice versa. Link modules for different CyberOptics WaferSense or ReticleSense products, such as Auto Gapping Sensors (AGS), are not interchangeable.

To pair an APS device and link module:

1. If you are changing the pairing of an APS device that is already paired with a link module, first unplug the currently paired link module. You can't pair an APS device with a new link module while the currently paired link module is powered on.
2. Make sure the "**Power** " LED is illuminated on the link module you want to pair, and make sure the "Unit On" LED is illuminated on the APS device.
3. On the APS device, press and hold the **"C" reset switch** button until the **"Connect Pair" LED** starts to blink rapidly (about four times per second).
4. On the link module, press and hold the "**New Pair"** button until the "**Pair Status"** and "**Connection Status" LED** lights start to blink rapidly (about four times per second).

   The **LEDs** on the link module and the APS device will continue to blink for a few seconds until the link and the APS device have established a new pairing, after which the LEDs will be on and no longer blinking.

Saving Your Settings

Each time you exit the ParticleSpectrum application, it saves your current settings for Go/No-Go threshold, horizontal scale, vertical scale, and other display settings, and log file directory. The next time you start ParticleSpectrum, it restores those saved settings.

Additional Display Features

ParticleSpectrum has additional display features for APS devices that can be found in the graph window for the device. This includes hiding the graph line, minimizing device information, and adding a name for the device.

To hide the graph line:

1. A color box is assigned to the device, which is located in the upper right corner of the device information.

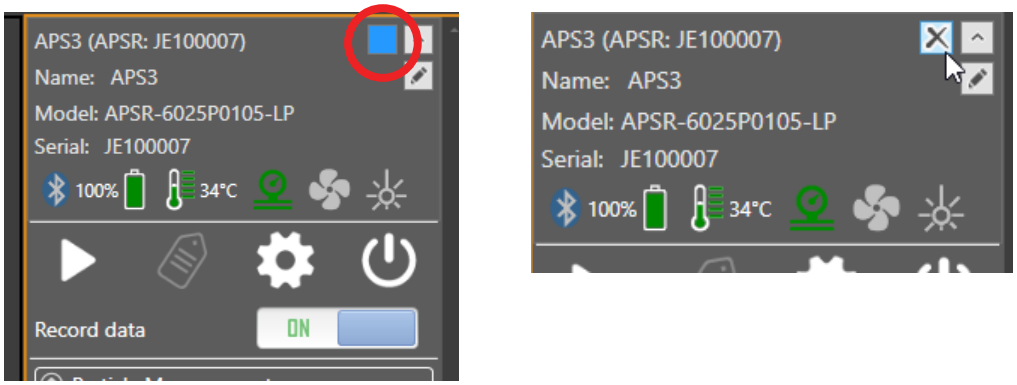


Figure 3.30: Hide Graph Line

2. Select the color box to hide and unhide the charted graph for the device. The 'X' will indicate that the charted graph is hidden.

To minimize device information :

1. A grey box with an arrow head is assigned to the device, which is located in the upper right corner of the device information.
2. Select the grey arrow box to minimize and maximize the device information.

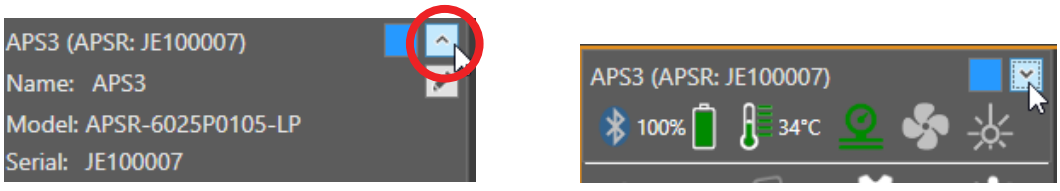


Figure 3.31: Minimize/ Maximize device information

To add a device name:

1. A grey box with a pencil icon is assigned to the device, which is located in the upper right corner of the device information.
2. Select the grey pencil icon to enter a name for the device. You can also edit or delete an existing name. The name will be saved to the device, and will also be outputted to the .aps log file, and comma delimited (.csv) file.

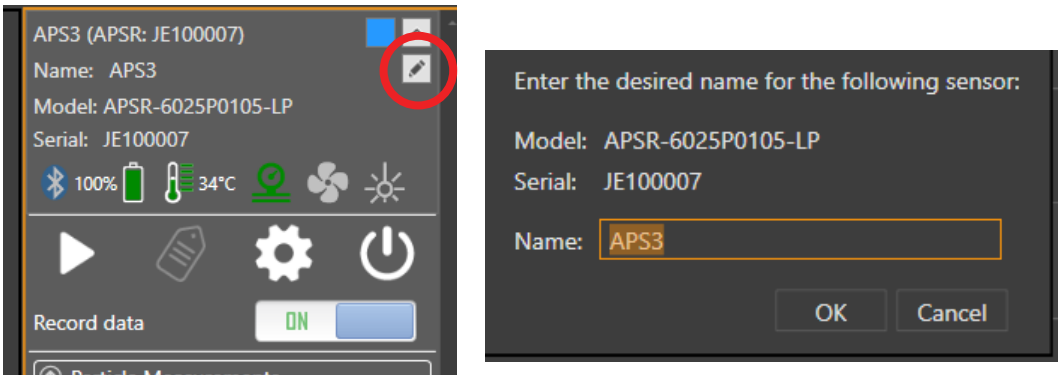


Figure 3.32: Add device name

Chapter 4

Viewing Log Files

The ParticleSpectrum contains Review functionality, letting you replay log files that you previously recorded. This chapter provides instructions for performing the following tasks using Review Features:

- Review Log Files
- Working with marks
- Changing log files
- Configuring the display
- Displaying user-specified information from the log file

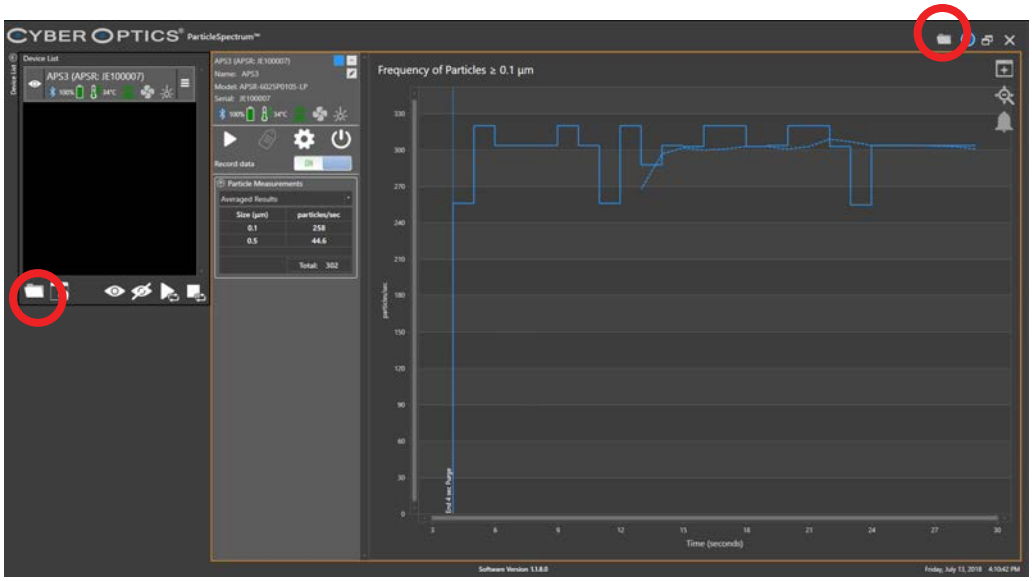
This chapter assumes that you are familiar with the information in Chapter 3, "Using Your APS3."

Note: ParticleSpectrum files are not backwards-compatible with previous versions of ParticleView and ParticleReview. Files that were recorded from ParticleView and ParticleReview will not be compatible with ParticleSpectrum.

Review Log Files

To review a log file:

1. Locate **Device List** or **Device Graph Window**, select the **Select Review File** folder icon.



2. Navigate to the log file you want selected and select 'OK' as shown in Figure 4.1 to load the log file into ParticleSpectrum.

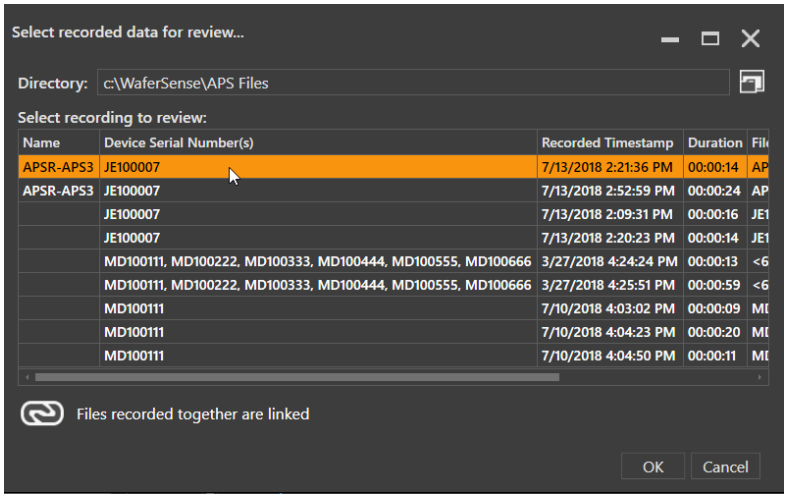


Figure 4.1: Running the Review Feature

3. The **Review** window will appear below the active device as shown in Figure 4.2, displaying the controls and the graphical window used to review log files. The log file will also appear in the **Device List**.

   The log file does not contain a status bar, and does not playback functionality.

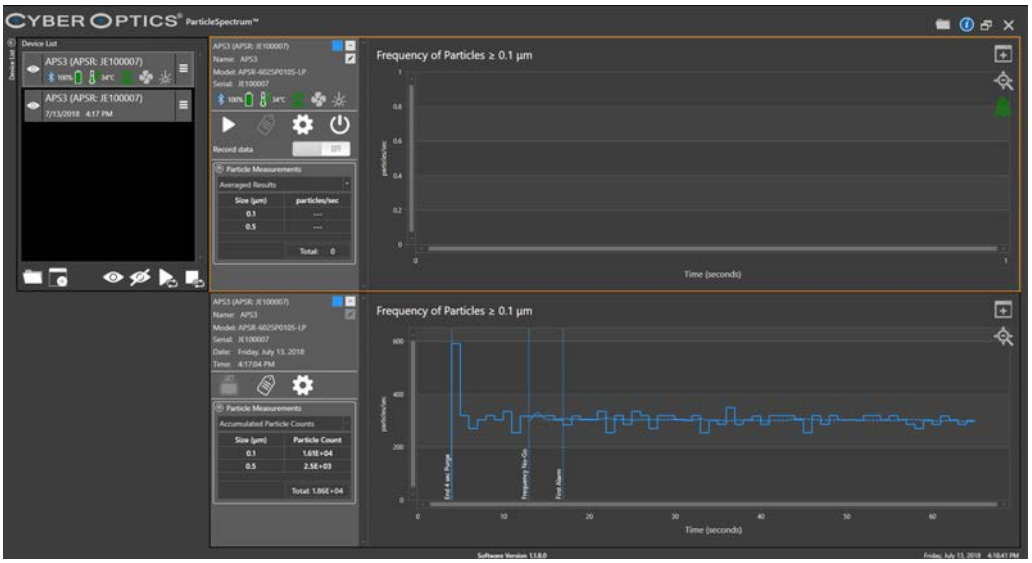


Figure 4.2: Opening a Log File

You are able to reorder the **Log File** and **Device** using the **Device List Menu Settings,** by selecting **Move Up** or **Move Down**. The appearance in the graph window will also adjust the order of appearance. You are also able to **Remove** the Log File. The **device list** and **graph window** will adjust accordingly.

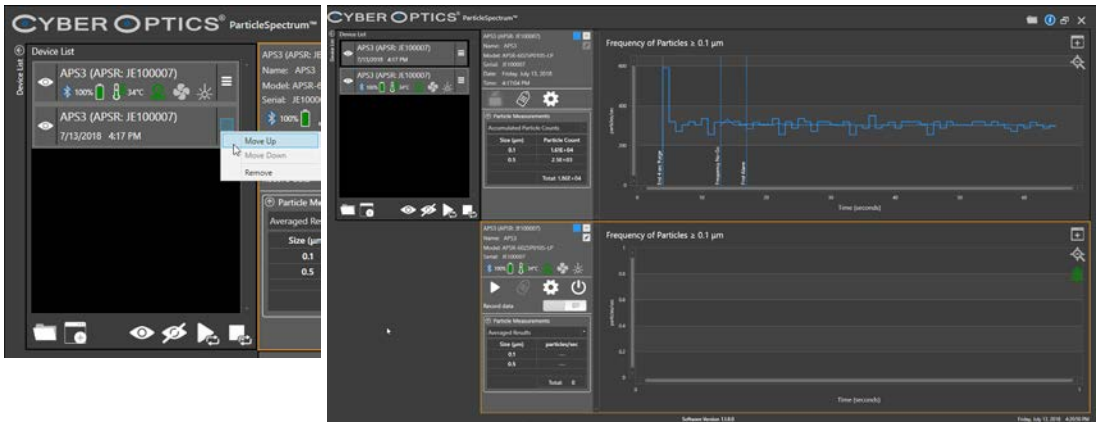


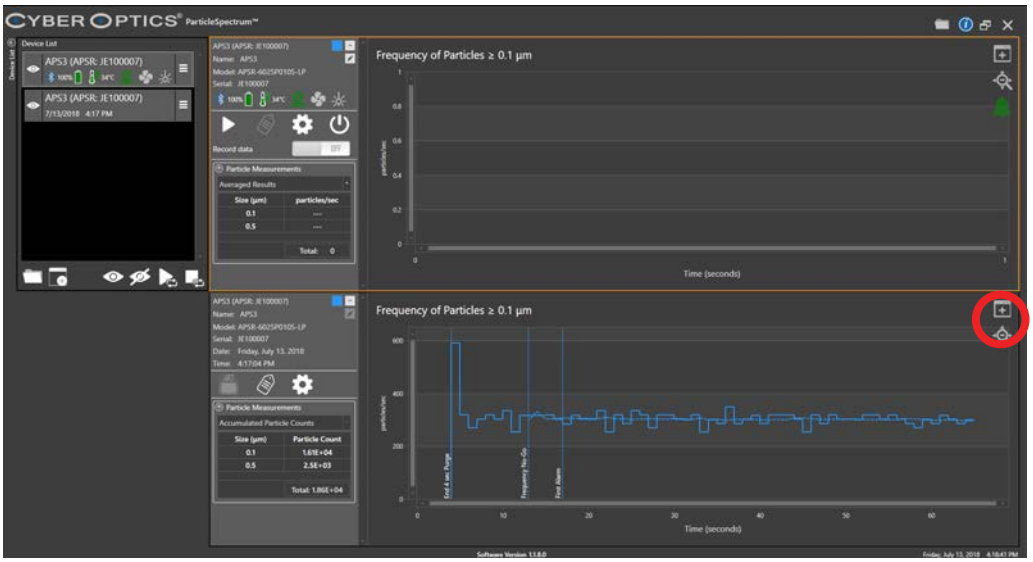
Figure 4.3: Reordering Appearance

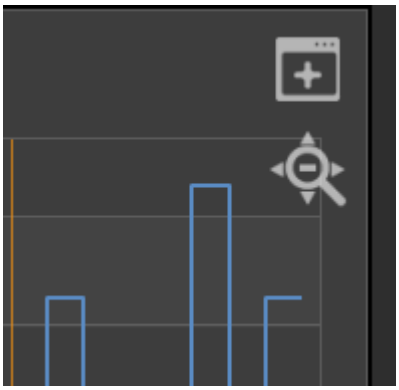
Expanding Review Space

This **Review Graph Window** can be expanded to the primary work space. These same steps can also be used to expand the **Device Graph Window**.

To expand the **Review Graph Window**:

1. Locate and select the **Maximize** icon in the upper right of the graph window.





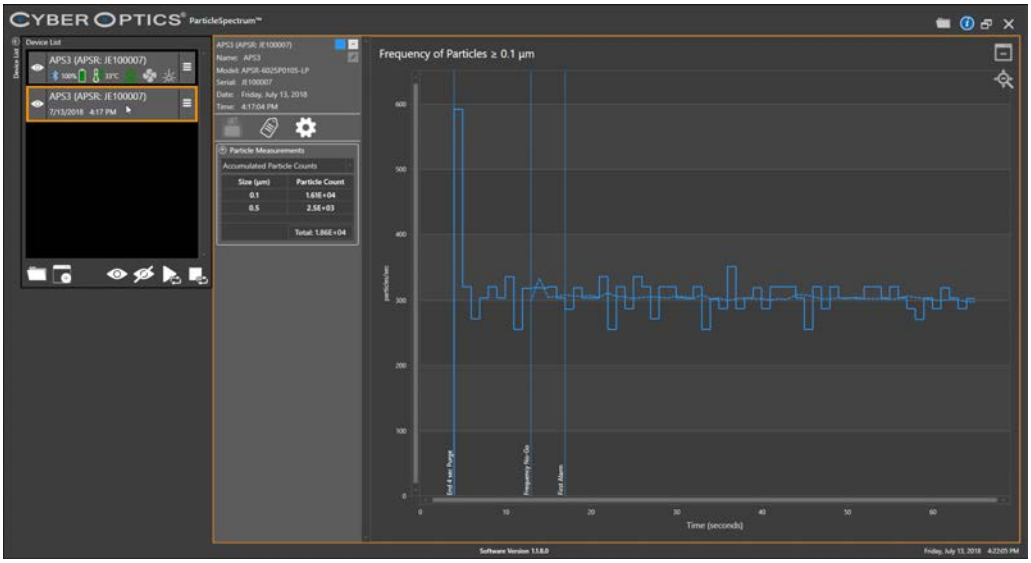
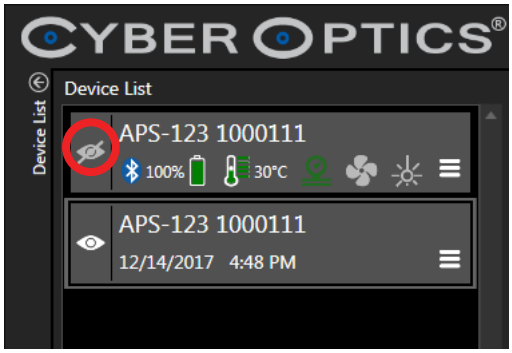


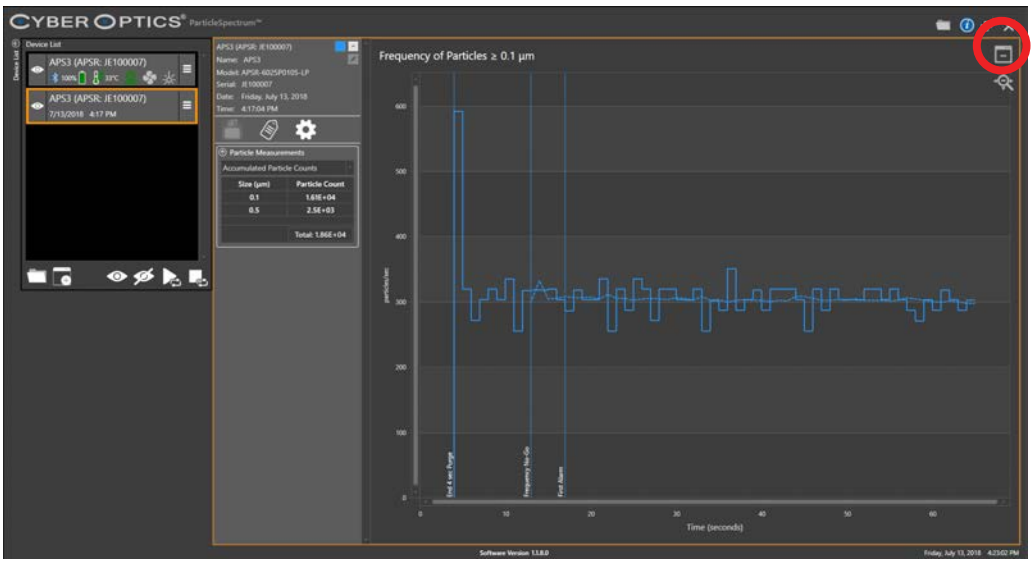
Figure 4.4: Expanding Review Space

2. You can also select the **Visibility** icon in the **Device List** to hide any item, and the **Graph Window** will adjust to the maximum size. When you select the **Visibility** icon to **Show Device**, the graph window will appear for that device, and adjust to show the Graph Windows of both visible items.



To minimize the **Review Graph Window** and revert to the previous view of showing both Graph windows:

1. Locate and select the **Minimize** icon in the upper right of the graph window.



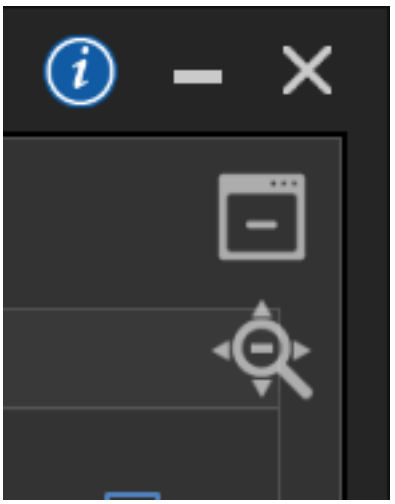


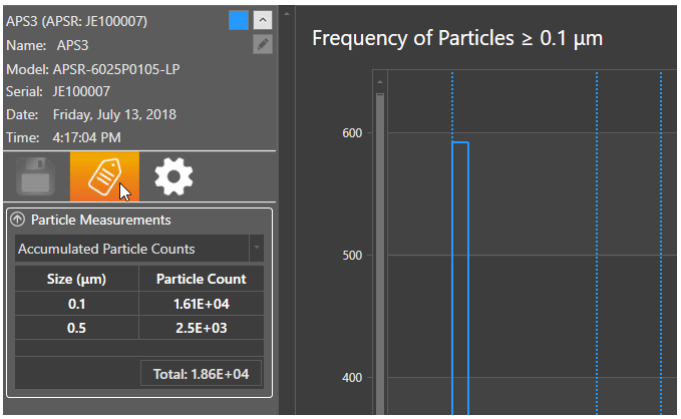
Figure 4.5: Minimize Review Space

Working with Marks

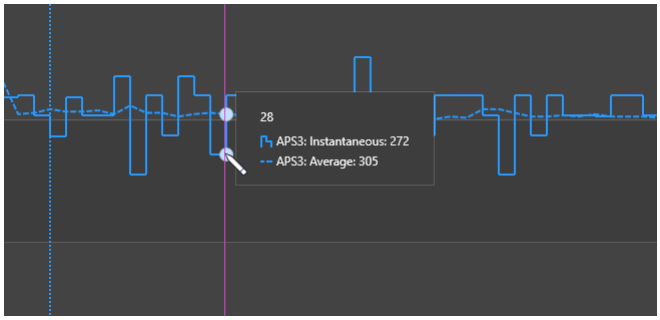
You can add a marker annotation, and edit an existing marker annotation in the log file.

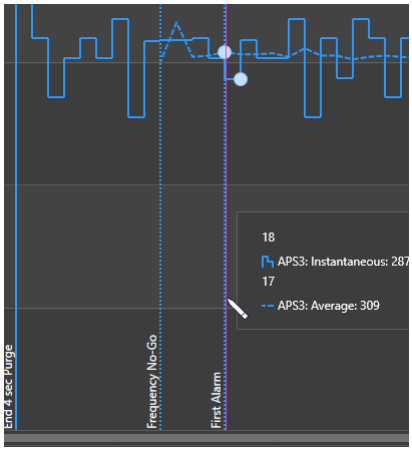
To add/edit a marker:

1. Select the Marker Icon in the Review Graph Window.
2. The Marker Icon will turn orange, indicating you are in the add/edit mode.

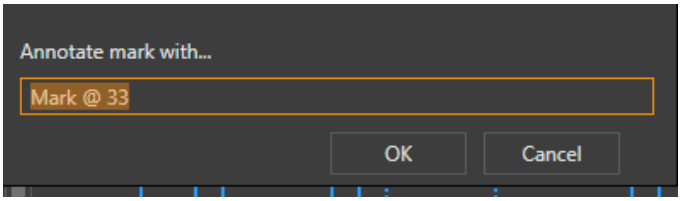


3. A pencil cursor will appear when hovering over the graph. Select where you want to place the marker on the graph. To edit an existing marker, select the vertical dotted line.





4. The annotation dialog will pop up. Add/ edit the annotation and select OK.



5. To exit the add/edit marker mode, select the Marker Icon. The icon will return to a grey color.

Changing Log Files

You can open a log file using the **Select Review File** folder icon, as described in "Running Review," on page 4.2. (see Figure 4.1). If you don't see the file you want in the list, navigate to the location you've chosen for log files to be saved to. See ""Changing the Log File Directory," on page 3.16.

You can open and view multiple log files at the same time, and the main window will adjust to show multiple **Graph Windows** from what's in the **Device List**.

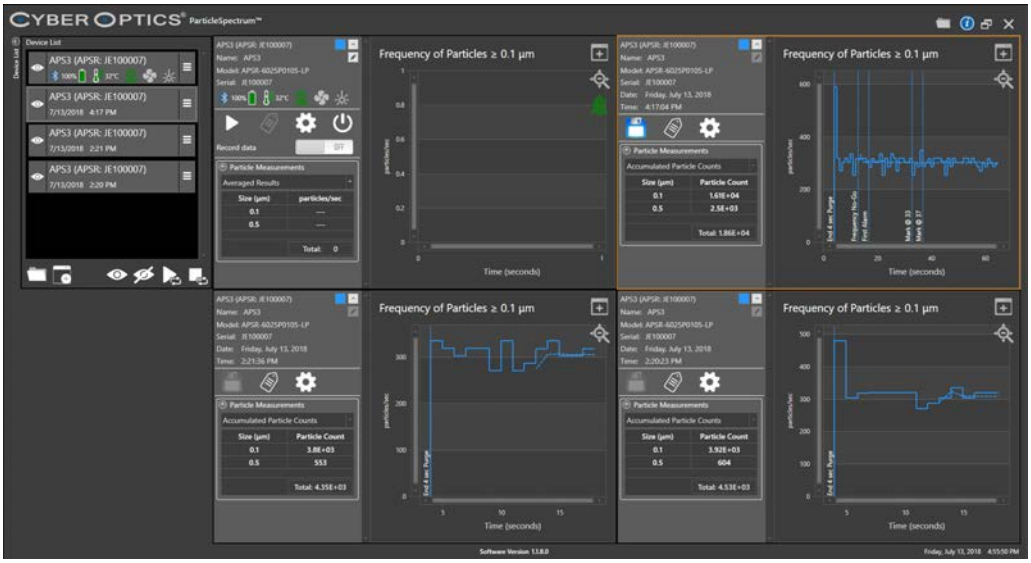


Figure 4.6: Multiple Review Windows

Configuring the Display

You can change the way particle measurements are displayed in the graph display by selecting which particle size bin to graph, by choosing to display either particle density or particle frequency, by changing the vertical and horizontal scales, and by changing the averaging interval.

Reviewing Measurements

The left side of the **Review Window** for the log file display allows you to review log files in numeric form for either Density or Frequency mode. Each particle bin displays a differential measurement and a cumulative measurement.

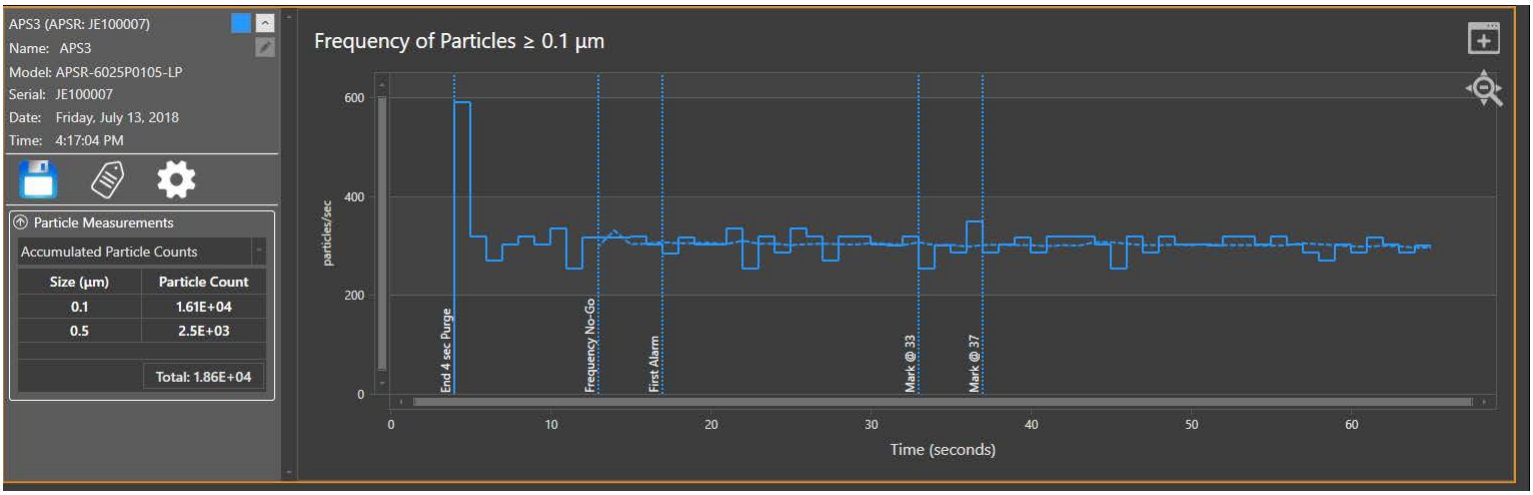


Figure 4.7: Frequency or Density Display

To choose which information to display:

1. In the **Settings** icon**, Display Options,** select **Density** or **Frequency** from the **Measurement Type** drop down menu**.**

   Review displays particle measurements as either particle frequency (number of particles per unit time) or as particle density (number of particles per volume).

2. To change the averaging interval, under **Averaging Interval** select seconds or minutes for averaging the particle measurements. The new setting takes effect immediately.

The measurement values displayed in the measurement boxes are an average of the 1Hz density or frequency sample stream taken over the selected averaging interval.

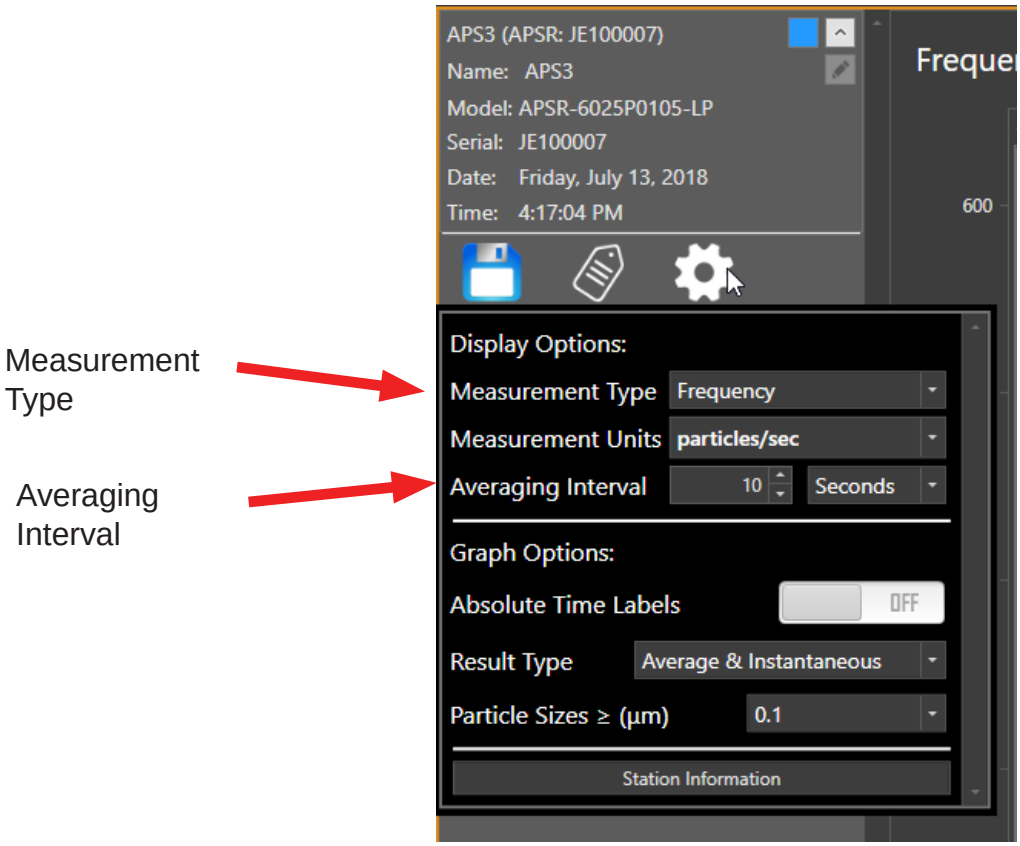


Figure 4.8: Review Display Options

Reviewing Graphs and Resetting Parameters

The graph shows one line for the particle measurement data. The running average trace is blank until the first averaging interval, selected by the **Averaging Interval** controls, then displaying a second line on the graph.

To choose which particle bin to graph:

1. In the **Display Options**, choose the particle size from the **Graph Particle Sizes** (see Figure 4.9).

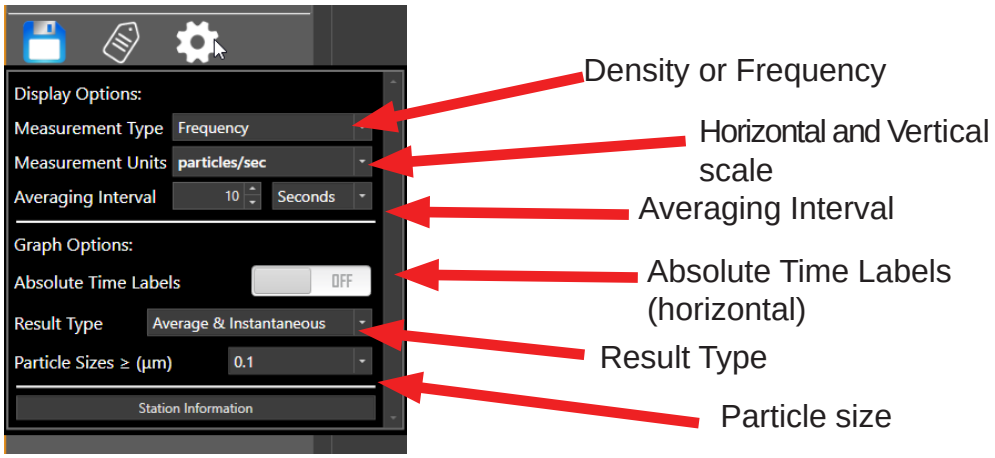


Figure 4.9: Selecting Graph Parameters

2. To choose particle density or particle frequency, in the **Display Options** select **Density** or **Frequency**.

   Review displays particle measurements as either particle frequency (number of particles per unit time) or as particle density (number of particles per volume).

3. Adjust the horizontal and vertical scales of the graph:

   Vertical Scale. The scale is in particles per unit time when displaying particle *frequency*, or in particles per unit volume when displaying particle *density*. Particle measurement values that are too large to display with the current scale setting are truncated at the top of the graph.

   Horizontal Scale. You can set the horizontal scale for the particle measurement graph. Default is set to scale by time (seconds) between the divisions on the horizontal axis, or showing **Absolute Time Labels.** The horizontal scale setting affects only the display of the particle measurements. The log files always record measurements at increments of one second.

4. To change the **Averaging Interval** choose an interval in seconds or minutes for averaging the particle measurements. The new setting takes effect immediately.
4. To change the **Result Type** choose 'Average & Instantaneous', 'Average Only', or 'Instantaneous Only'. The new setting takes effect immediately.

Displaying User-Specified Information from the Log File

Operator, **Tool**, **Station**, and **Comment** are user-specified text in ParticleSpectrum from a 'Record Data' session that can be recorded in a log file along with the particle data.

To display the user-specified information for a log file in Review:

1. Choose the **Settings > Show Station Information** menu item.

   The Station Information dialog is displayed and is read-only, as shown in Figure 4.10.

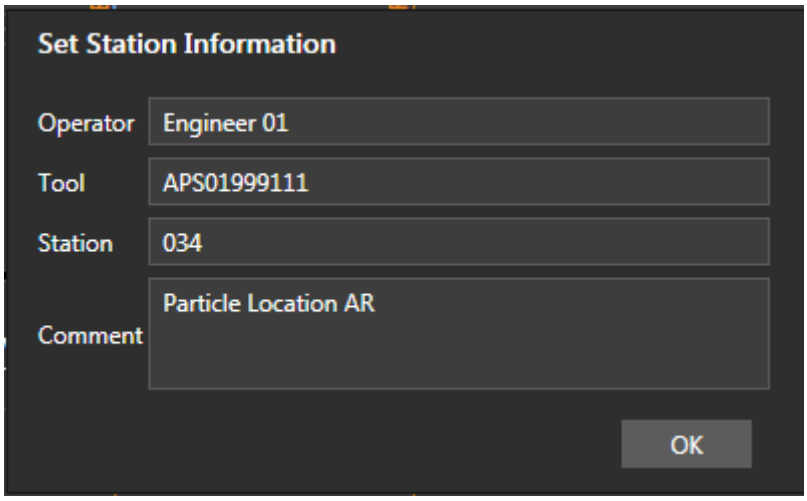


Figure 4.10: Station Information Dialog

Select **OK** to close the dialog.

Saving a modified Review file

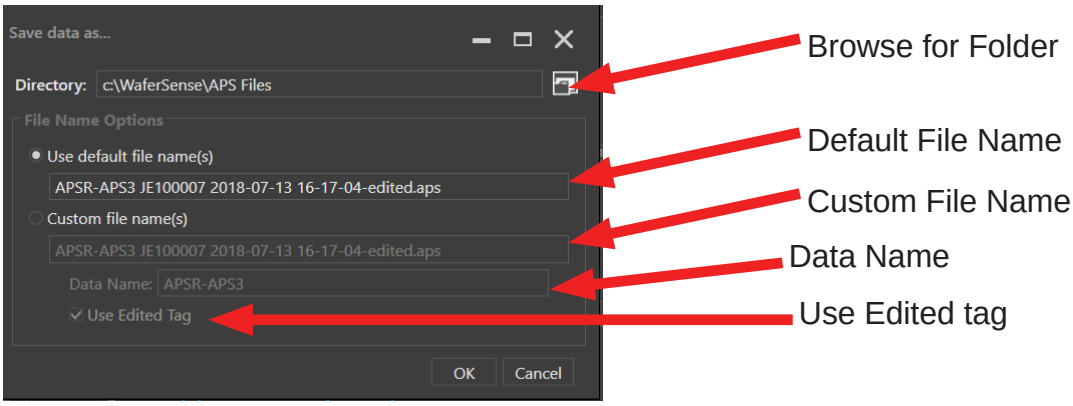
Upon opening a log file for review, the **Save Modified Review File** icon will be inactive. When any markers are added or edited in a review file, the **Save Modified Review File** icon will become active.

Inactive icon

Active icon

To save a modified log file in Review:

1. Choose the **Save Modified Review File** icon.
2. The 'Save data as' window dialog will appear.



3. The **Directory** is set to the default folder location where the log file was recorded to. To change the directory, choose the **Browse for Folder** icon.
4. For **File Name Options**, you can choose to use the **Use default file name**, or **Custom file name**. Note: **Use default file name** will have the tag 'Edited' at the end of the file.
5. To save as a **Custom file name**, select **Custom file name.**
   a. **Data Name,** can be customized. The Data Name will replace the content before the serial number.
   b. **Use Edited tag,** by default this is checked on. Unchecking this box will remove the 'edited' tag at the end of the file name.
6. Click the OK button to save the log file, and the dialog window will close.

Figure 4.11: Saving a modified Review file

Chapter 5

Maintaining Your APS3

This chapter discusses the following:

- Annual factory calibration and battery replacement
- Battery use and disposal

Warning

The edges of the APS3 devices are thin. It may be possible to sustain injury from these edges if the APS3 device is not handled with proper care.

Protection afforded by compliance EN61010-1 (2010) may be impaired if the equipment is not used as specified.

Caution

Use extreme care to assure that the device has proper clearances when being transported through the tool. For example, when you use the device in the tool for the first time, move the device through the tool in manual mode, visually verifying all clearances. Even when clearances are sufficient for safe APS3 pass-through, if the robot end-effector is taught too high, you risk crashing and damaging the APS3 device.

Periodic calibration and battery replacement is the only regular maintenance your APS3 device requires:

Annual Calibration and Battery Replacement.

Once a year, you should have your APS3 device calibrated and the internal rechargeable battery replaced by returning the APS3 to the CyberOptics factory.

Cleaning the APS3 Device.

If cleaning is required, wipe the outside of the APS3 device with IPA (isopropyl alcohol). If the APS3 device is used in a clean environment, follow proper procedures for this environment.

Warning

Do not immerse the APS3 device of the link module in liquid. Do not spill liquid on the APS3 device or on the link module.

Warning

The use of controls, adjustments, or procedures other than those specified in this manual may result in exposure to hazardous optical radiation.

Annual Factory Recalibration and Battery Replacement

Every 12 months, you should return your APS3 device to the CyberOptics factory, where we will calibrate the APS3 wafer and replace the internal rechargeable battery. You can find the date when the APS3 device was last calibrated at the factory by choosing the **Info Icon** in the ParticleSpectrum application.

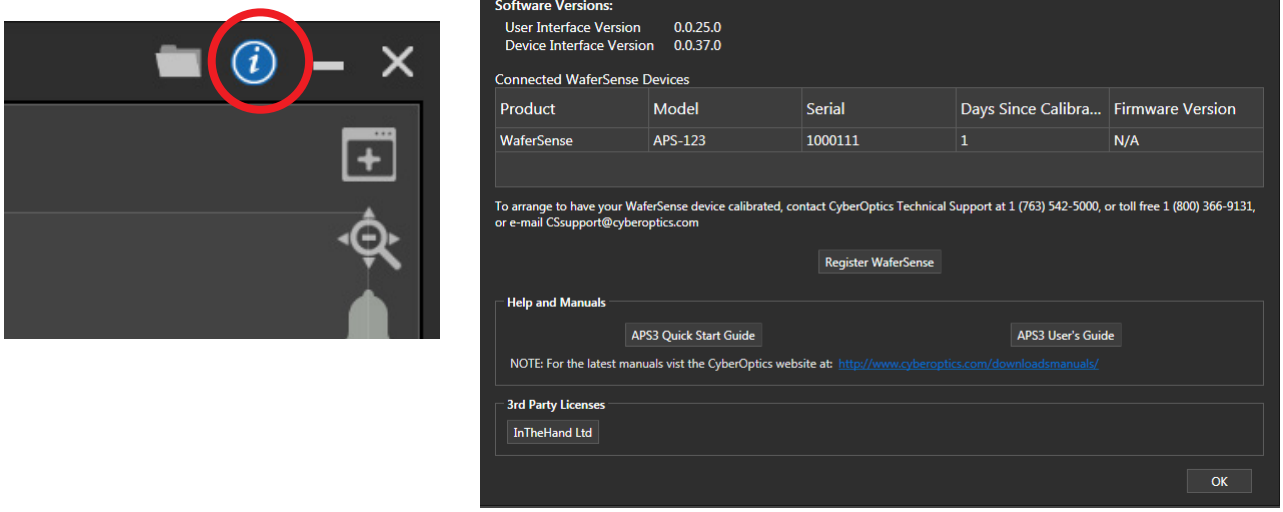


Figure 5.1: The About your APS3 Dialog

When the date for calibration approaches, the ParicleSpectrum application will occasionally notify you by displaying the APS3 device calibration status dialog, as shown in figure 5.2.

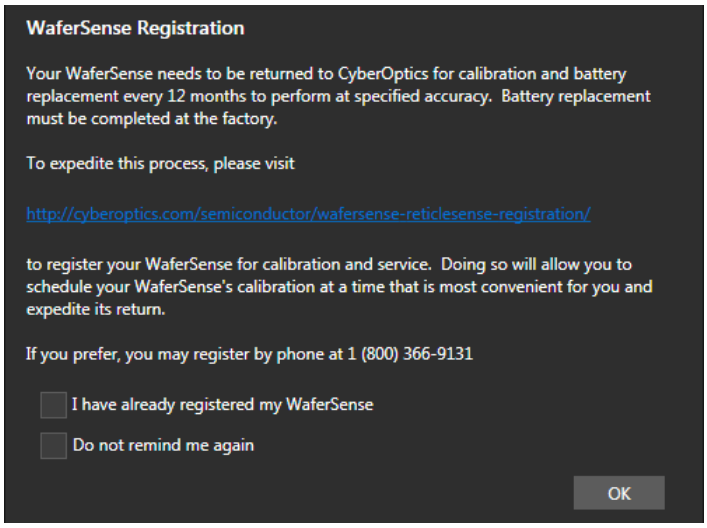


Figure 5.2: APS3 Calibration Status Dialog

If you drop the APS3 device or suspect that it is no longer in calibration, contact CyberOptics technical support. (see "Technical Support," on page 2.11.)

Battery Use and Disposal

Your APS3 device contains lithium-polymer battery. To avoid damage to the APS3 device, use the supplied charger only. Do not charge the APS3 device at temperatures outside the specified range (0 C to 45 C). Do not incinerate or dispose of the APS3 device into fire. Do not immerse the APS device when cleaning or spill liquids on the APS device.

For proper batter disposal, please return the APS device to CyberOptics.

Contact customer support. (see "Technical Support," on page 2.11)

Chapter 6

Specifications APS3

WaferSense APS3 Features

Wireless, wafer-shaped and battery-powered

Available in 300mm. Model #8025754.

Easy-to-use software: ParticleSpectrum
ParticleSpectrum: Displays real-time numeric and visual feedback, cumulative or differential counting modes and density or frequency modes. Replays log file data for review and analysis.

Highly accurate: Measures particles greater than 0.14µm Size channels: Reports particles in 0.1µm and 0.5µm bin sizes and larger particles in 2, 5, 10, and 30µm bin sizes.

Less than 5 false counts per hour

Durable housing: 300mm carbon fiber substrate coated with Parylene C. SEMI standard notch.

Lightweight: 185 grams (300mm)

Airflow 0.07CFM (2L/min)@ 1 atmosphere

Operating pressure 0.4 to 1.6 atmosphere, with the ability to go to 0 atmosphere

Operating internal temperature 15 deg C to 45 deg C non-condensing

Charging operating temperature range: 0 deg C to 45 deg C

Battery-operation >1.8 hour per charge. Battery performance degrades at temperatures outside the optimum operating temperature range. Inductive wireless charging and hands-free operation. Typical battery recharge cycles: approximately 400

Link Box: Bluetooth, Class 1, 2.4GHz connected via USB.

Chapter 6. Specifications

Systems requirements: Operating Systems - Windows 7, 8 or 10. One free high-powered USB 1.1 or USB 2.0 port.

Product components: Particle measurement device, charging clean case, carrying suitcase, USB communications link module, USB cable, application software CD, calibration certificate and start guide.

Calibration Factory: recalibration recommended annually. Consult factory for large particle calibration.

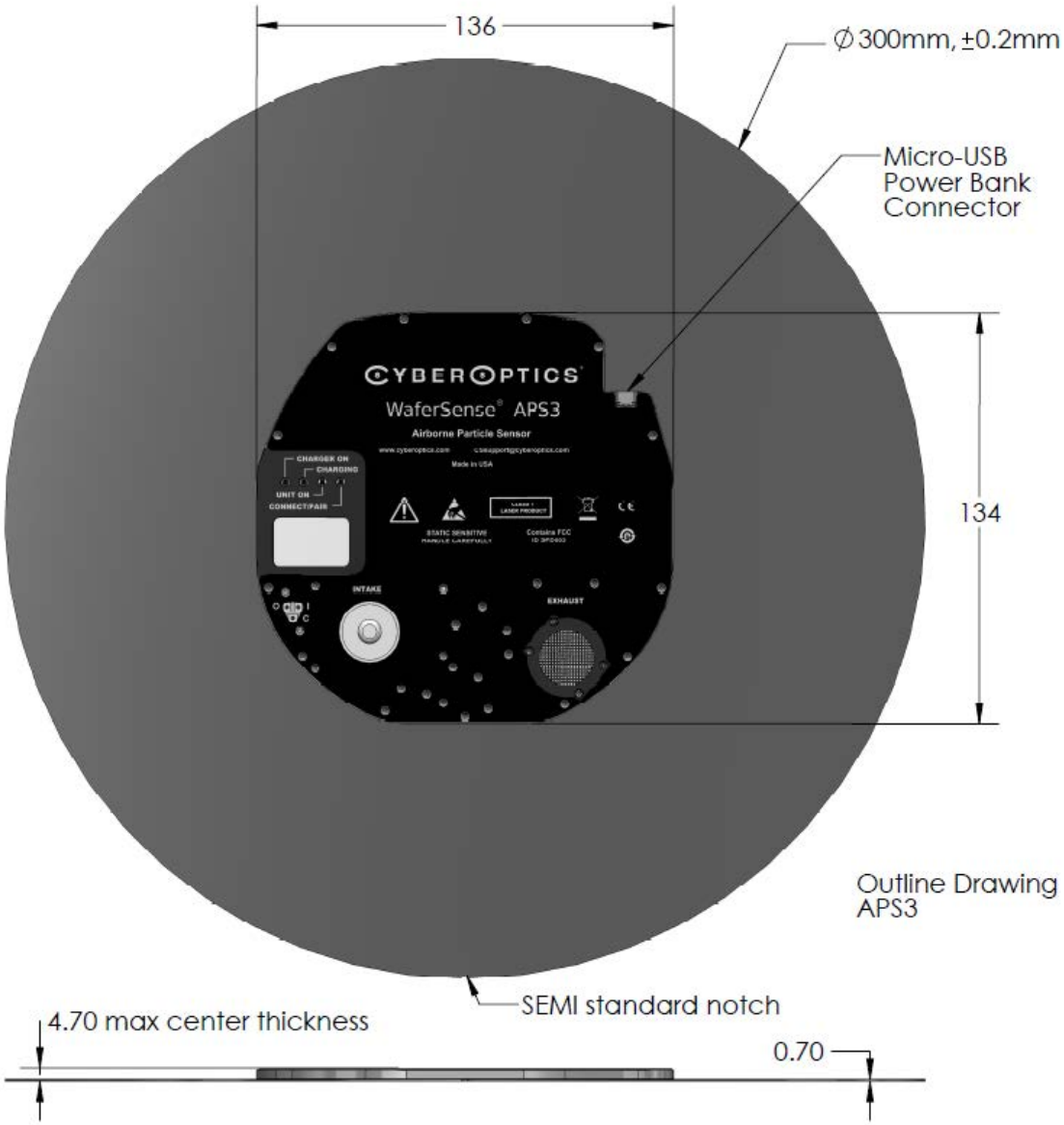
Laser - The APS3 is a Class 1 laser product employing an embedded Class 3B laser whose radiation is fully enclosed and not exposed to the user.

CyberOptics is in compliance testing for listed markings.

Compliant to the Following Directives and Standards:

Directive	Standards
Low Voltage Directive 2014/35/EU	EN 61010-1:2010 3rd Edition, EN 60825:2007
EMC Directive 2014/30/EU	EN 61326-1:2013, Class B, Industrial
Radio Equipment Directive 2014/53/EU	EN 30.1:2012 Class B1 489-17 V2.2
	FCC 15.109:2014, Class B FCC 15.109(g):2014, Class B

Table 6.1: Compliance with Directives and Standards


136
∅300mm, ±0.2mm
Micro-USB
Power Bank
Connector
134
CYBEROPTICS
WaferSense® APS3
Airborne Particle Sensor
Outline Drawing
APS3
SEMI standard notch
4.70 max center thickness
0.70

Specifications APS-FPD

PanelSense APS-FPD Features

Wireless and battery-powered

Available in 135mm x 137mm x 4.7mm (L x W x H). Model #8025826.

Easy-to-use software: ParticleSpectrum
ParticleSpectrum: Displays real-time numeric and visual feedback, cumulative or differential counting modes and density or frequency modes. Replays log file data for review and analysis.

Highly accurate: Measures particles greater than 0.14µm Size channels: Reports particles in 0.1µm and 0.5µm bin sizes and larger particles in 2, 5, 10, and 30µm bin sizes.

Less than 5 false counts per hour

Durable housing: 30% Glass filled PEEK

Lightweight: 121g (± 7%)

Airflow 0.07CFM (2L/min)@ 1 atmosphere

Operating pressure 0.4 to 1.6 atmosphere, with the ability to go to 0 atmosphere

Operating internal temperature 15 deg C to 45 deg C non-condensing

Charging operating temperature range: 0 deg C to 45 deg C

Battery-operation >1 hour per charge. Inductive wireless charging and hands free operation. Micro-USB power bank connector, power bank provides >10 hours of additional operation

PanelSense Link: Bluetooth, Class 1, 2.4GHz SENA link

Systems requirements: Operating Systems - Windows 7, 8 or 10. One free high-powered USB 1.1 or USB 2.0 port.

Product components: Two APS-FPD devices, each with charging clean cases and carrying suitcase. Four power banks, SENA communications link module, extended range antenna and application software are also included.

Calibration Factory: recalibration recommended annually. Consult factory for large particle calibration.

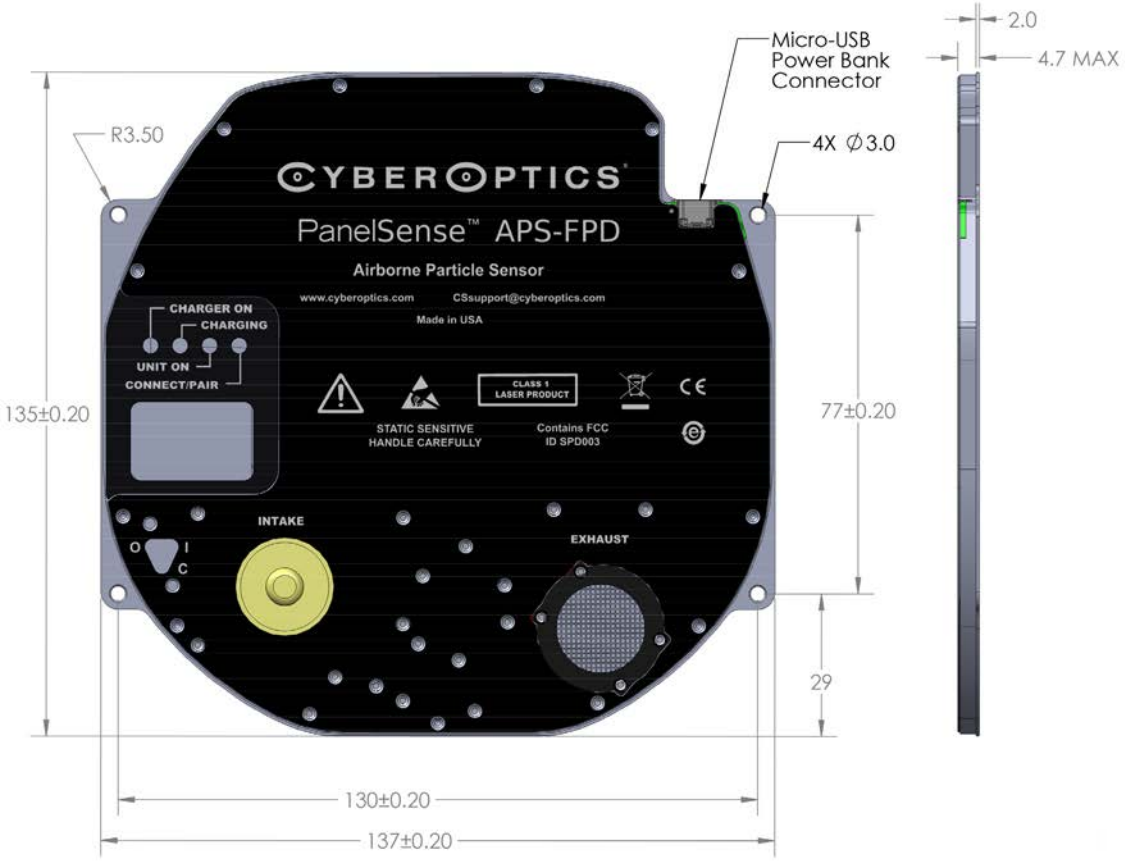
Laser - The APS-FPD is a Class 1 laser product employing an embedded Class 3B laser whose radiation is fully enclosed and not exposed to the user.

CyberOptics is in compliance testing for listed markings.

Compliant to the Following Directives and Standards:

Directive	Standards
Low Voltage Directive 2014/35/EU	EN 61010-1:2010 3rd Edition, EN 60825:2007
EMC Directive 2014/30/EU	EN 61326-1:2013, Class B, Industrial
Radio Equipment Directive 2014/53/EU	EN 30.1:2012 Class B1 489-17 V2.2
	FCC 15.109:2014, Class B FCC 15.109(g):2014, Class B

Table 6.2: Compliance with Directives and Standards



Appendix A

Large Particle Detection

The WaferSense APS3 and APS-FPD sensor are capable of large particle measurements.

General information about large particle detection: In some circumstances it is desirable to sense only large particles and not detect small particles. This may be the case in certain photolithography tools. The APS3, with the large particle, has two detector channels. Each has separate optics and amplifiers. One channel is for small particles and another for large particles.

In the normal small particle mode, the APS3 uses a high gain detector channel. When the large particle mode is selected, a second detector channel is enabled that has much lower gain and is optimized and calibrated for particles larger than 2 microns. The two different modes cannot be viewed at the same time. Also, since large particles are typically counted at a much lower rate than small particles, the large particle mode only counts particles in frequency mode.

Because the large particle scale covers a wider range of particle sizes, there are 4 bins. The bin sizes are for particles larger than 2, 5, 10 and 30 microns.

The APS3 large particle mode is calibrated by measuring dry glass micro-spheres dispersed via a venturi aspiration technique. As with all airborne particle detectors, the size is calibrated to an "equivalent" test particle, in this case glass micro-spheres. Real world contamination particles may have non-spherical shapes and may respond differently than glass micro-spheres.

Large Particle Mode Selection

Large Particle Mode is selected on the Settings menu using the Large Particle Mode menu button. When the menu button is selected "on" you are in Large Particle Mode and the ParticleSpectrum display will show four bins as shown in Figure A.2. Large Particle Mode selection is in ParticleSpectrum and is used to select the mode for particle measurement. Review conforms to the mode the log file was recorded in.

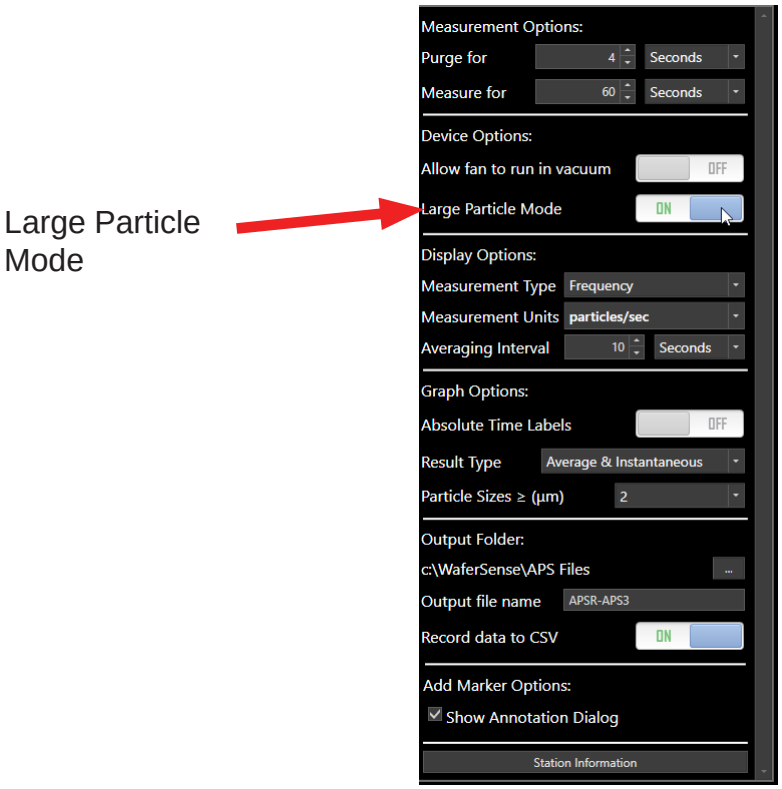


Figure A.1: Large Particle Mode Selection

Reading the ParticleSpectrum Display

In Large Particle mode, you will have the same Settings Menu but the **Graph Particle Sizes** will change to 4 bin sizes. You will also no longer have selection control between Density and Frequency, because all large particle charts display using frequency mode (the number of particles per unit time). All other display controls operate the same in large particle mode.

Large Particle Chart

For large particles mode differential particle measurements are charted, whereas in the small particle mode cumulative particle measurements are charted. Differential particle measurements assign and chart a given particle to one and only one "bin" based on the particles size. Cumulative particle measurements include all particles of a given size or larger. ParticleSpectrum charts only one bin size on the graph.

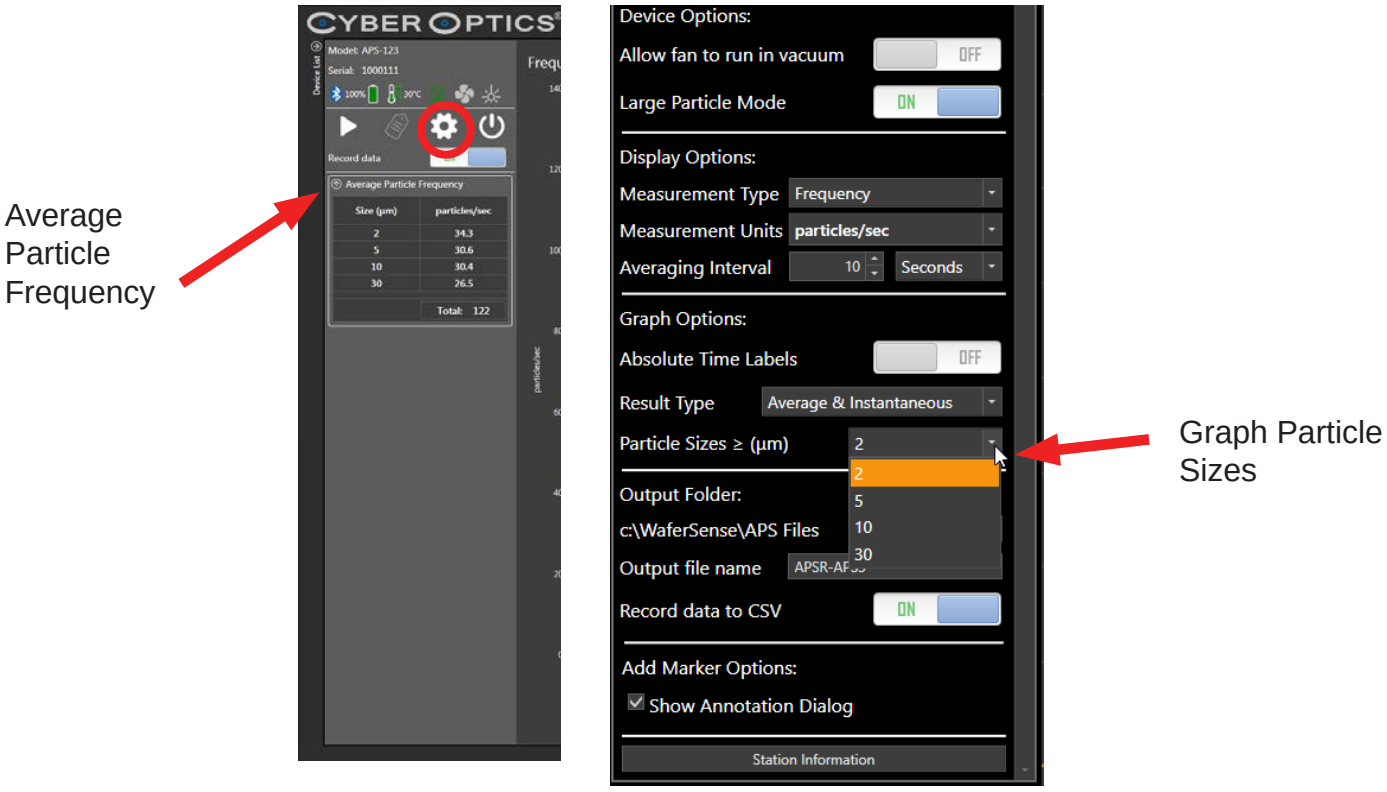


Figure A.2: Large Particle - ParticleSpectrum Display

Go/No-Go Threshold dialog

The large particle Go/No-Go threshold dialog (see Figure A.3) functions are almost identical to the small particle dialog. The difference is the Threshold Type selection. For large particle Threshold Type selection the choice is only Frequency.

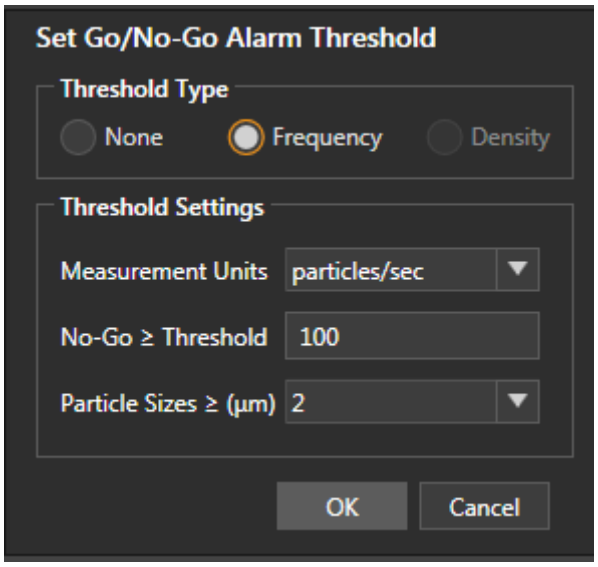


Figure A.3: Go/No-Go Threshold dialog

Viewing the log file

In Review, the display will switch to the particle mode in which the log file was generated. When a log file is recorded in ParticleSpectrum in large particle mode and opened in Review, the display will configure to large particle mode (see Figure A.4). Also, the Go/No-Go Threshold dialog will open to the appropriate particle mode format.

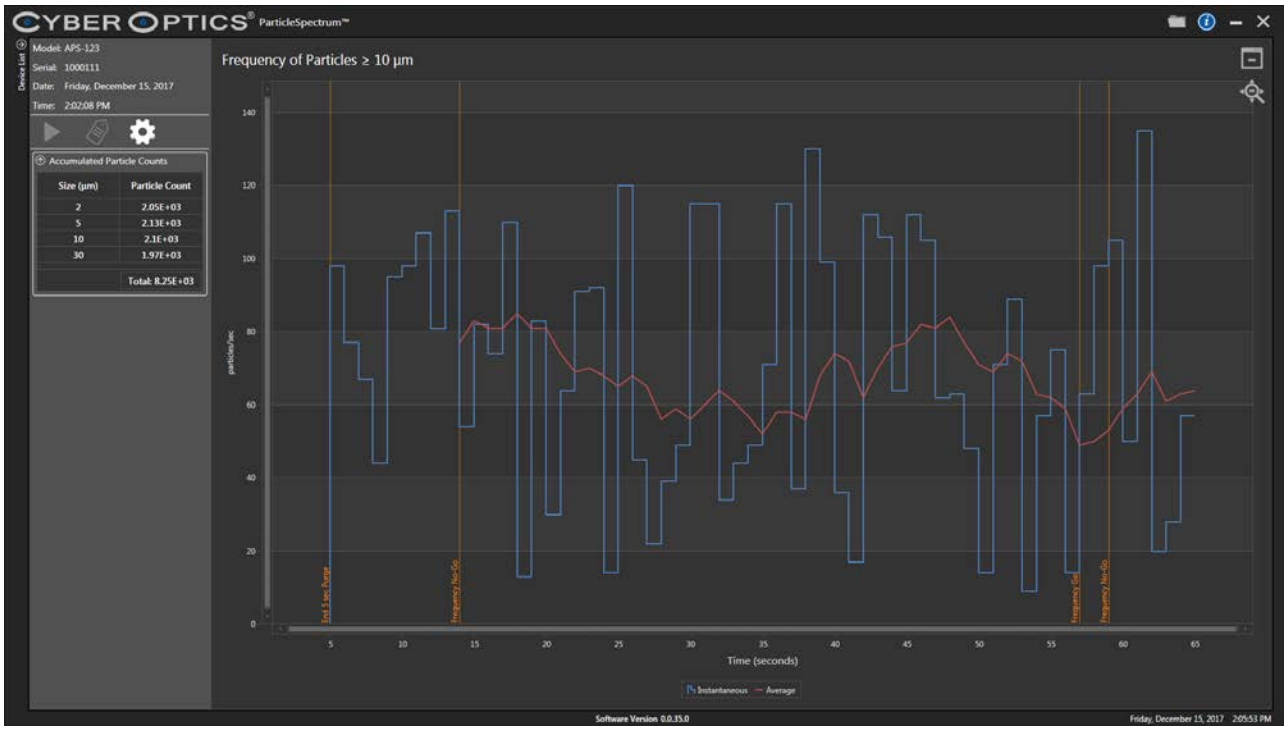


Figure A.4: Review Large Particle Display

Appendix B

PanelSense™ APS-FPD

The PanelSense APS-FPD sensor is primarily used for particle detection in Flat Panel Display manufacturing processes.

General information about PanelSense APS-FPD: The APS-FPD operates the same as an APS3, but is in a different form factor and comes with additional components that enable simultaneous measurement using multiple APS-FPD devices.

General operation of the APS-FPD device and reviewing log files are the same as APS3. See chapters 3, 4, and 5.

This Appendix explains the installation and operation of multiple APS-FPD devices being used simultaneously.

- APS-FPD components
- Charging the battery and external battery packs
- Installing the ParticleSpectrum software and SENA Link
- Pairing the APS-FPD to the SENA Link in ParticleSpectrum
- Multiple device windows and linking devices
- Using ParticleSpectrum with linked devices
- Log files of linked devices

APS-FPD Components

The APS-FPD and its components are as follows:

- Two APS-FPD units
- Two Charging Cases with charging cables
- One SENA link with Extended Range Antenna
- One 3 meter USB cable for PC to SENA Link
- ParticleSpectrum Software installation CD
- Two USB link cables for APS-FPD to External Battery pack

  Note: The link cable is designed specifically for connection between the APS-FPD device and the External Battery Pack. Using any other cable not specified may cause damage to the APS-FPD device.
- Four External Battery Packs with micro USB charging cables
  - Two USB plug adapters (used with External Battery Pack with micro USB charging cable)
- Four sets, Universal Plugs for USB Plug adapters

APS-FPD units

Charging Case

SENA Link

Software

Link Cable

External Battery Pack with Plug Adapater

Universal Plugs

Figure B.1: APS-FPD Components

Charging the Battery and External Battery Packs

The Li-Ion battery in the APS-FPD devices must be fully charged before first use. A discharged battery can take several hours to charge. Connect the battery charger to the charging case. Plug the charger into a 100-240VAC outlet. The "Charger On" and "Charging" status lights will remain on while the unit is charging. When the "Charging" light goes off, the battery is cully charged.

- Charging the External Battery Packs: The battery pack comes partially charged, but should be charged completely before using. Use the included USB charging cable, and connect the micro USB end to the battery pack. Connect the USB end to the USB Plug Adapter with appropriate Universal Plug. Active charging is indicated by a flashing LED. The number of lit LEDs show the current charge level of the battery pack during charging. When fully charged, all LEDs are on.

Installing the ParticleSpectrum Software

To install and run the APS software ParticleSpectrum, your computer must have the following:

- Windows 7 (32-bit or 64-bit), Windows 8, Windows 10 operating systems
- One free high-power USB 1.1 or USB 2.0 port

To install the APS software, do not plug in the SENA link before you start. The software must be installed first using the following steps as listed in Installing the WaferSense APS Software," on page 2.2.

Installing the SENA Link Hardware

Before starting the wireless link installation, complete the Installing the WaferSense APS Software," on page 2.2. The ParticleSpectrum Software must be installed prior to connecting and installing the SENA Link. Locate the SENA Link USB module.

Figure B.2: SENA Link Components

Note: If remote positioning of the SENA Link is desired, use the included 3 meter USB cable. If extended radio range is desired, use the extended range antenna on the end of the SENA Link module.

If your computer has an onboard Bluetooth radio, you must disable it in the Device Manager before installing the SENA Link.

To disable/enable onboard Bluetooth:

1. Right click on the Windows Start button and select "Device Manager"

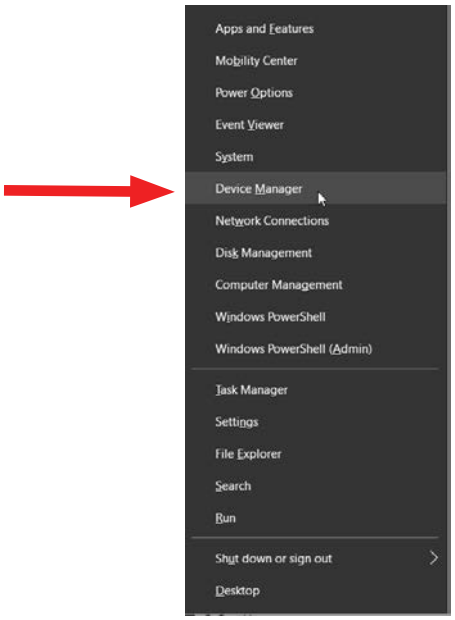
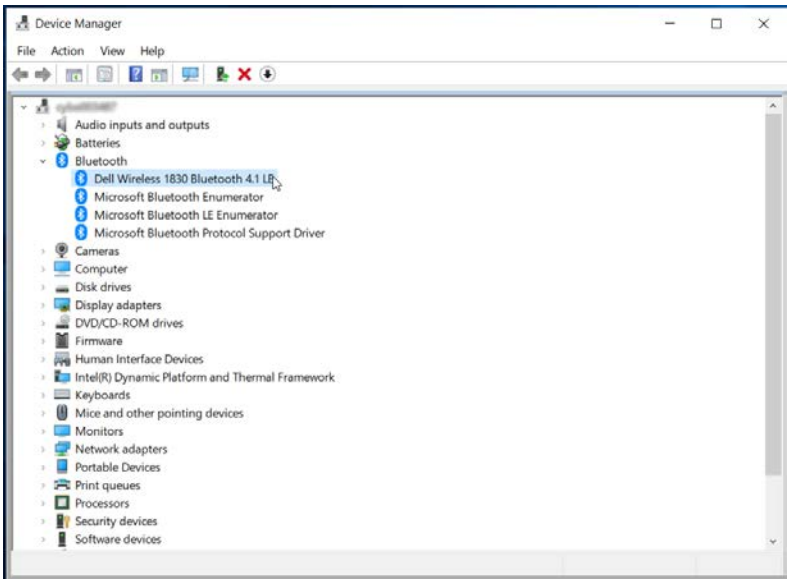


Figure B.3: Device Manager Dialog

2. Locate the Bluetooth drop down menu and select the Bluetooth Radio for your computer.

   Note: You can ignore Microsoft Enumerator and Microsoft Support Drivers, if listed.



3. Right click on the Bluetooth Radio, and select "Disable Device"

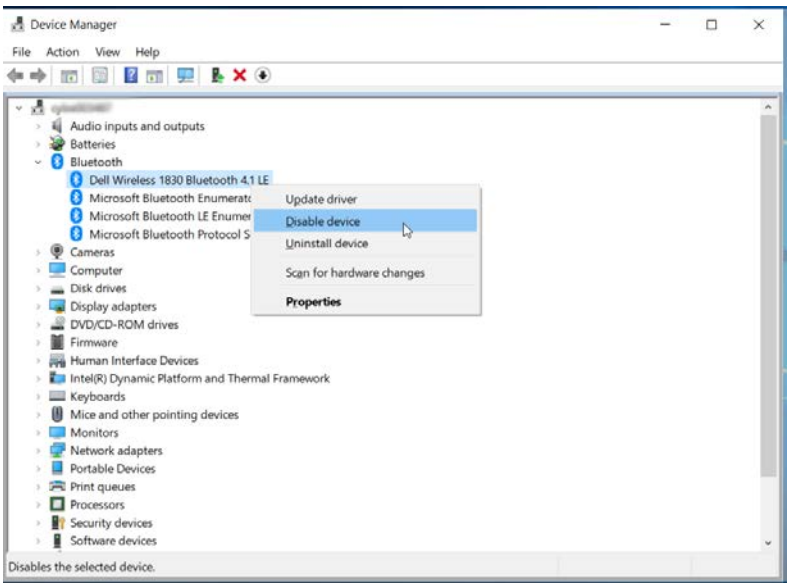


Figure B.4: Device Manager Dialog

To install the SENA link:

1. Connect the SENA Link module to a high power USB port directly to your PC

2. Windows will recognize the SENA Link module and the "Found New Hardware" wizard will appear. Select "Install the software automatically (Recommended)", if prompted.

Note: Use Windows generic Bluetooth Radio Driver only. Other Drives (BlueSoleil, etc.) may not be compatible with ParticleSpectrum.

Pairing APS-FPD to the SENA Link in ParticleSpectrum

To complete the installation, verify that the APS-FPD and SENA Link can communicate and connect/pair.

1. Run the ParticleSpectrum application by navigating to Start Menu > Programs > CyberOptics > ParticleSpectrum

2. To connect/pair the APS-FPD, ensure the device is turned on. Locate the "C" button on the unit and press with a key to initiate pairing mode.

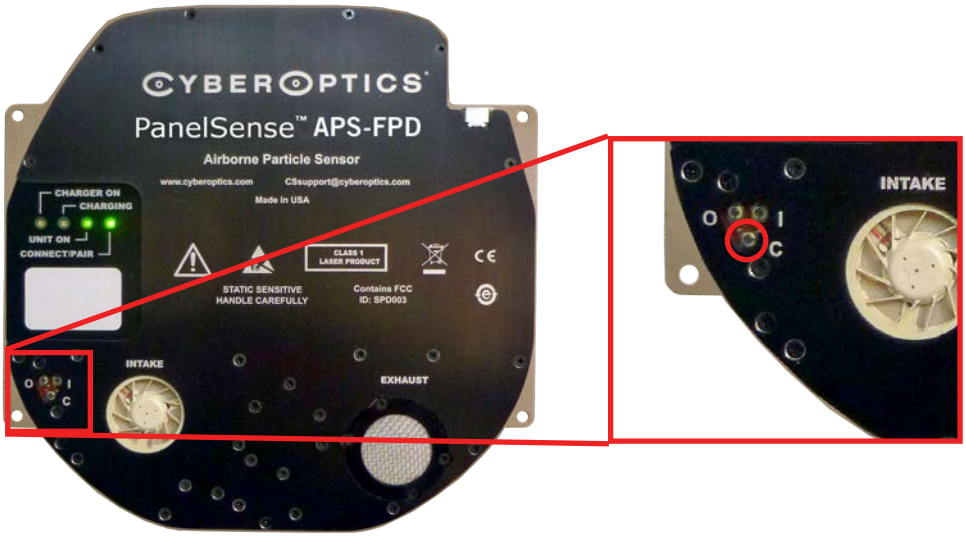
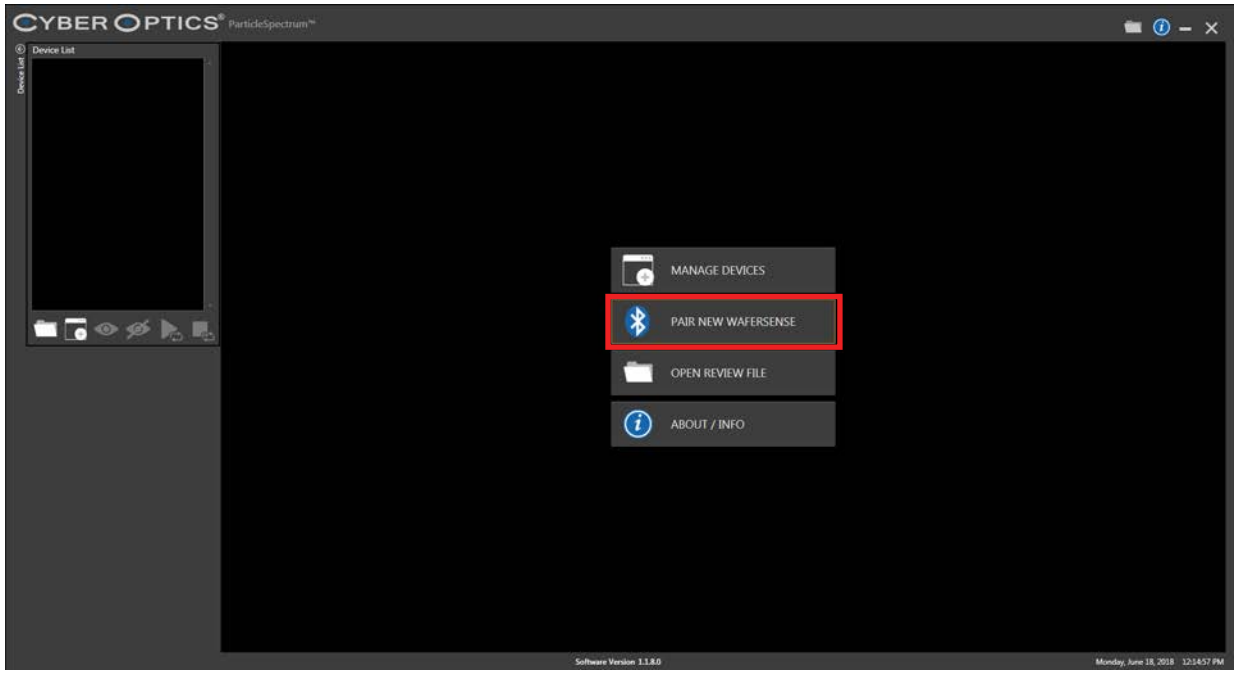


Figure B.5: APS-FPD Pairing

3. Select the "Pair New WaferSense" button in ParticleSpectrum



4. Select the "Yes" in the following menu to continue pairing.

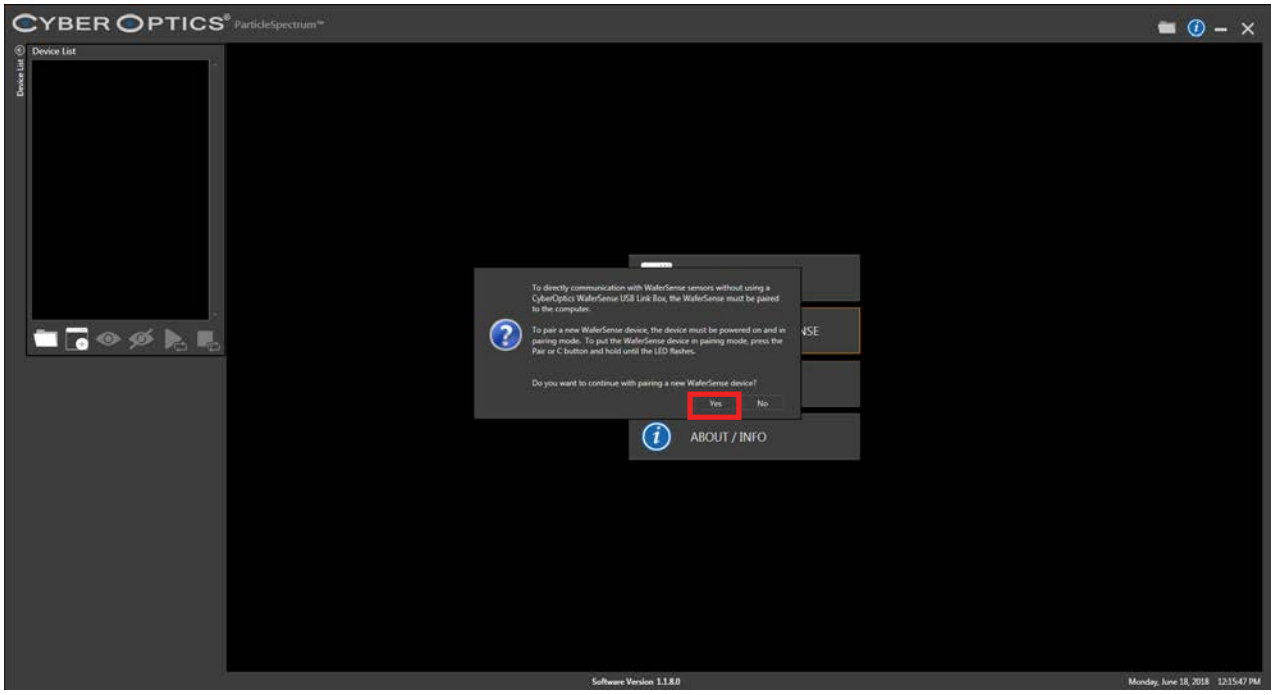
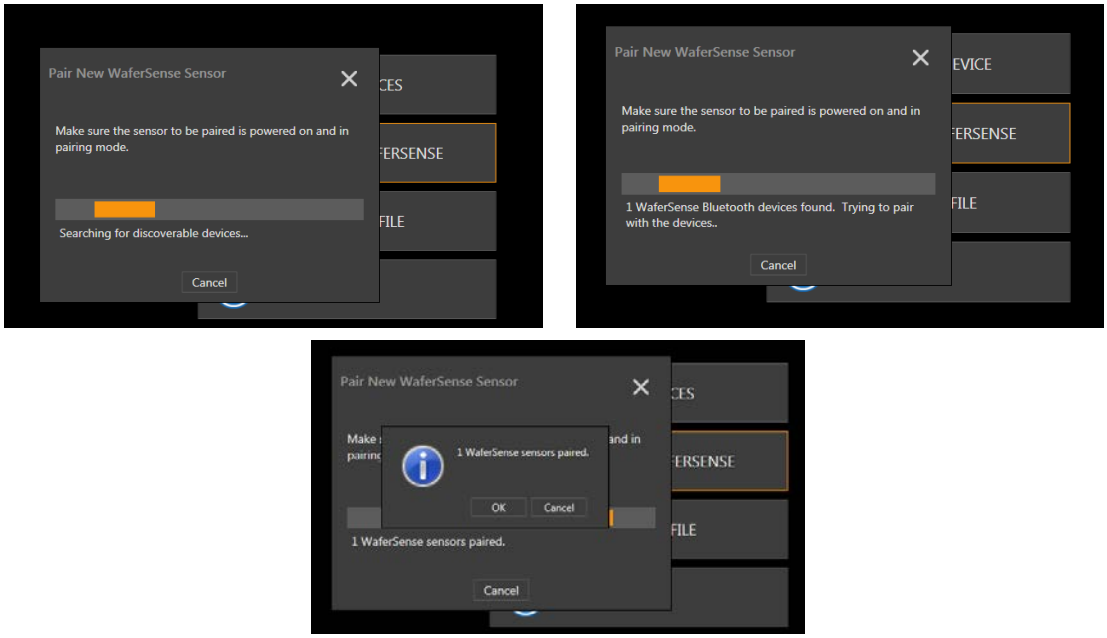
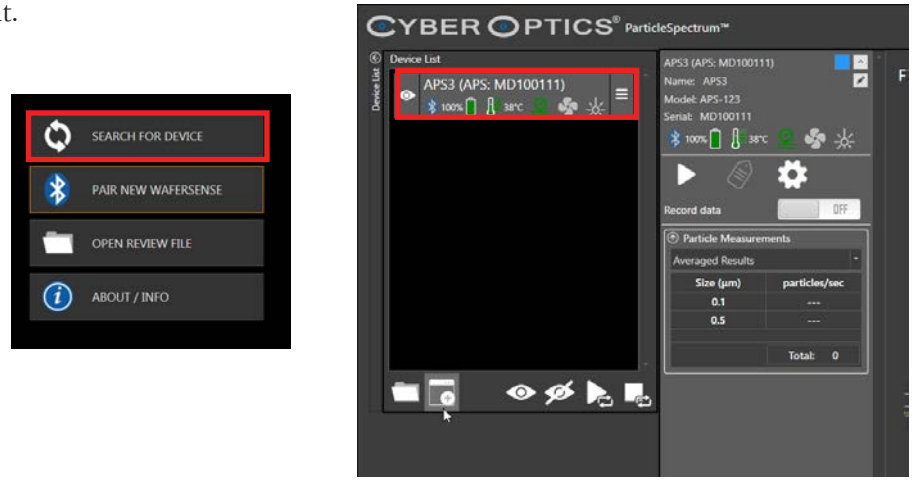


Figure B.6: APS-FPD Pairing in ParticleSpectrum

5. ParticleSpectrum will recognize the APS-FPD unit and will confirm that the sensor is paired successfully. **Note: Ignore any Windows Bluetooth pop up messages about pairing Bluetooth devices or "Configuring Bluetooth Services"**



6. If you are unable to pair the device, repeat the Connect/Pair process (steps 1-4)
7. If the Device List does not refresh after pairing the APS-FPD unit, select the "Search for Devices" button from the main window. The Device List will populate with the newly paired APS-FPD unit.



Note: You can also restart the ParticleSpectrum application and the Device List will populate with the paired device(s).
This completes the installation of you APS-FPD system.

Figure B.7: APS-FPD Pairing in ParticleSpectrum

Multiple Device Windows and Linking Devices

ParticleSpectrum enables APS-FPD devices to have the ability to run simultaneously. The APS-FPD devices can be shown as individual device windows, or linked together where they can be recorded on the same graph.

To run devices as multiple device windows:

1. Normal operation as listed in Chapter 3 on page 3.4 should be followed if you would like units to be run individually. You can also select the **Start All Devices** icon in the **Device List** menu to initiate all active devices.

Note: Settings for each device will need to be set, as they are independent from each other. Recorded data will be saved as individual log files, and individual CSV files.

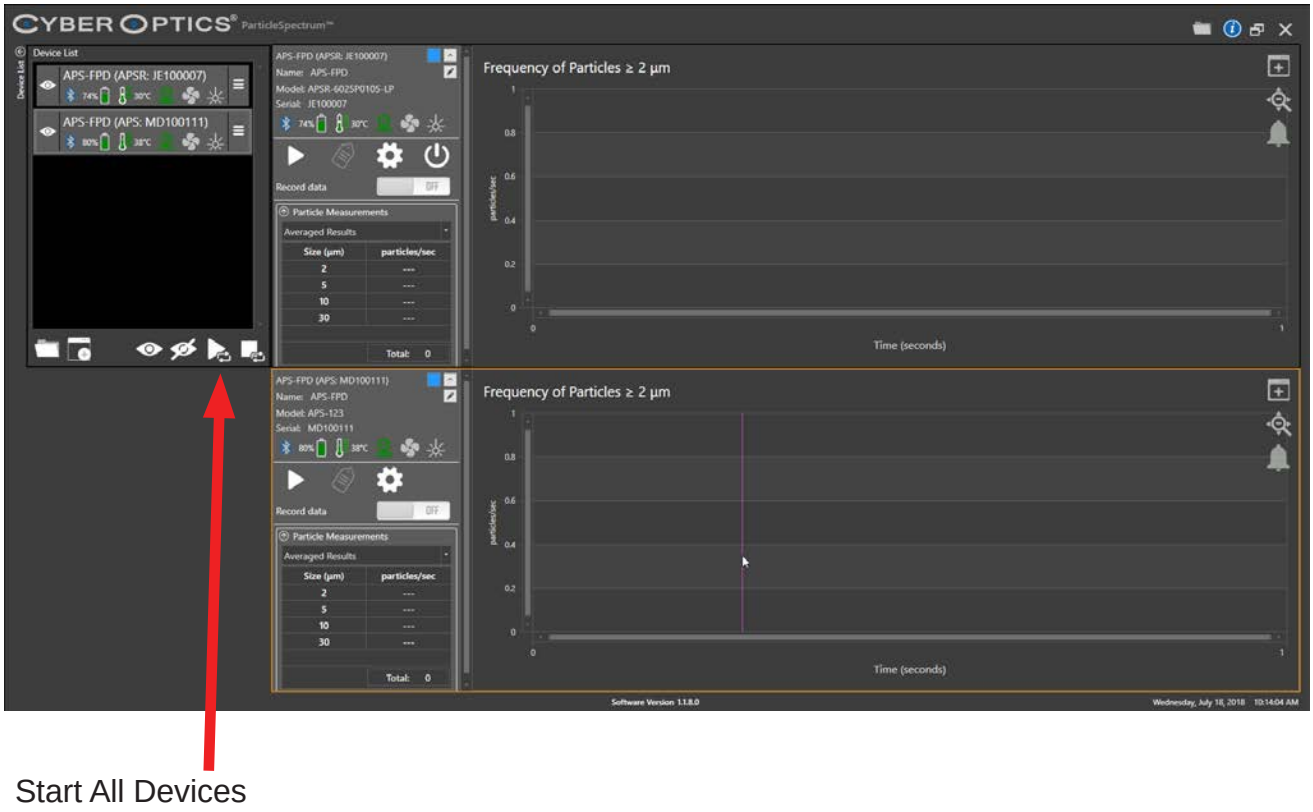


Figure B.8: Multiple Devices Windows

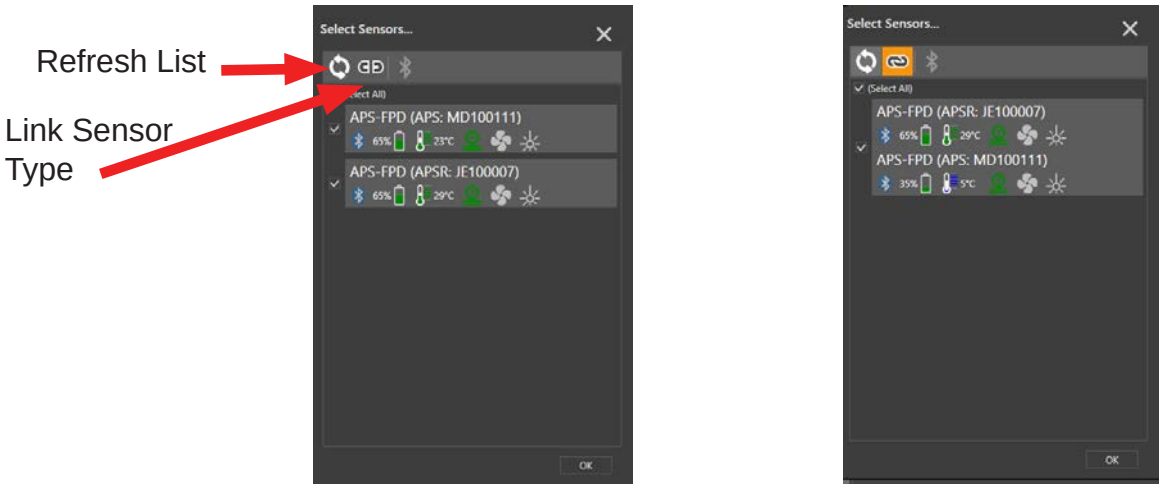
You are able to link sensors by type in ParticleSpecturm. By linking devices, you are able to chart multiple devices on the same graph. Settings and other functions affect both devices.

To link devices:

1. From the **Device List** window, select **Manage Device List**.

2. The **Select Sensors** menu will pop up. You can **Refresh List**, and **Link Sensor Types by Type**. The active and connected devices will be listed below. You can select the individual devices you want to link, or check **Select All**. Once the devices have been selected, click the **Link Sensor Type by Type** icon, and click OK to close the menu.

Note: You are able to link up to six sensors together. More than six sensors linked may cause performance issues

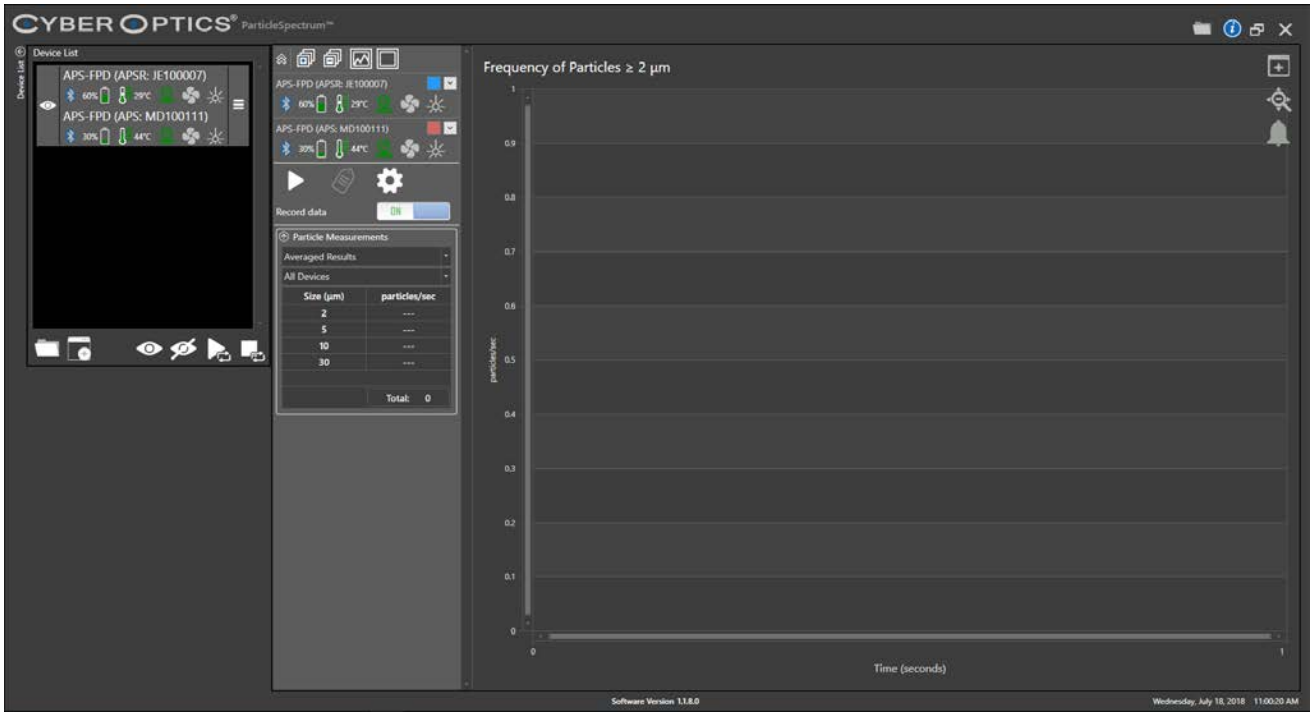


Individual Sensors

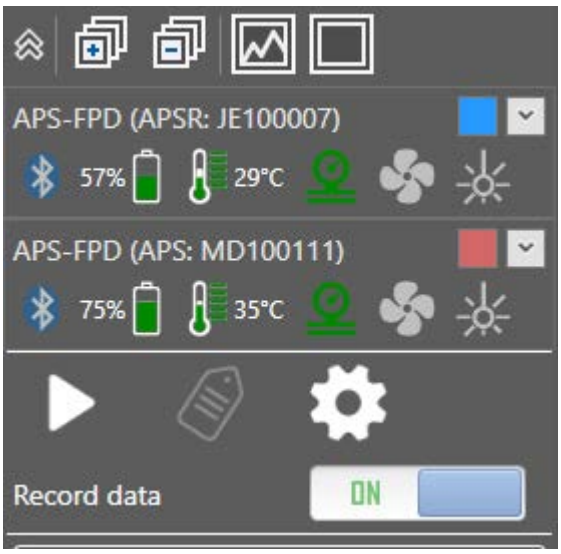
Sensors grouped after linking

Figure B.9: Linking Devices in ParticleSpectrum

3. The Graph Window and the Device List Window will update to show the devices are now linked.



The user interface changes when devices are linked together. In the **Graph Window** for the linked devices, each device is automatically assigned a line color that will be charted on the graph. There is also a small menu bar at the top of the devices that provides visibility functions for descriptions and charting.



Hide Sensor List - collapses sensor list in the Graph Window

Expand all sensor descriptions

Collapse all sensor descriptions

Chart all sensor data

Hide all sensor chart data

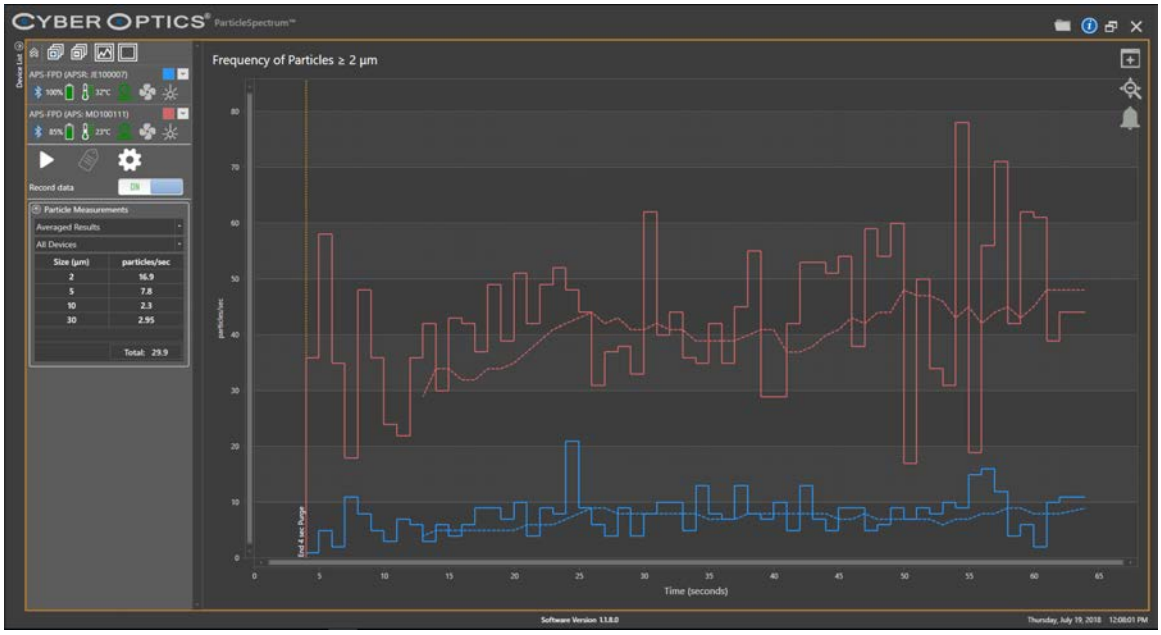
Figure B.10: Linking Devices Interface

Using ParticleSpectrum with Linked Devices

Normal operation as listed in Chapter 3 on page 3.4 should be followed for starting and recording a measurement run. All settings options **(Measurement Options, Device Options, Display Options, Graph Options, and Output Folder)** affect all devices that are linked together.

To run linked devices:

- Begin a measurement run by selecting the **Start** icon. The devices will begin to chart on the graph with the assigned color associated with the device. When the measurement run is complete, Average and Instantaneous charting results will be shown for all linked devices.
- The P**article Measurements Menu** in the Device Window will give you the same options to review the A**veraged Results, Instantaneous Results, and Accumulated Particle Counts**. You will also be able to view all devices, or select the specific device.



Menu | Result / Count Type | Device Selection

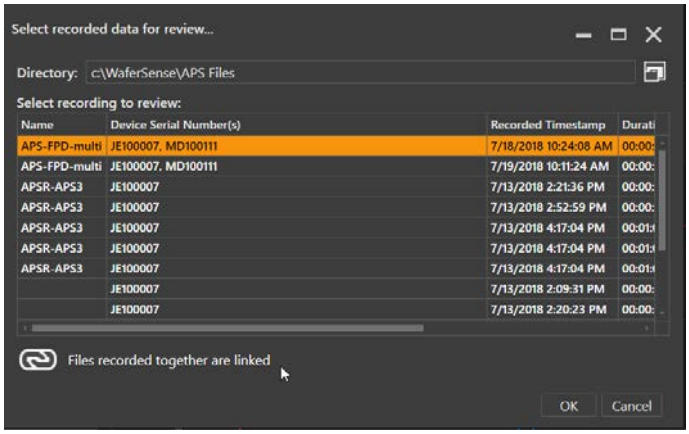
Figure B.11: Using Linked Devices

Log Files of Linked Devices

Linked devices follow the same processes and procedures as listed in Chapter 4 on page 4.1. When selecting a log file for review, you have the option to load the linked log file or the individual log files of each device. When you record the data to a CSV, each column is designated by Name (if added), Device Type, and Device Serial Number.

To view Linked Log files for review:

- The initial **Select recorded data for review** window pops up, there is a link icon located in the bottom left corner that says Files recorded together are linked. The Name is listed and the Device Serial Number(s) are grouped together.
- Select the file, and click OK.



To view Linked Log files for review as individual files:

- Select the **Link Icon** , to list files individually. You can also select the **Link Icon** again to view **Files recorded together**.
- Select the file, and click OK.

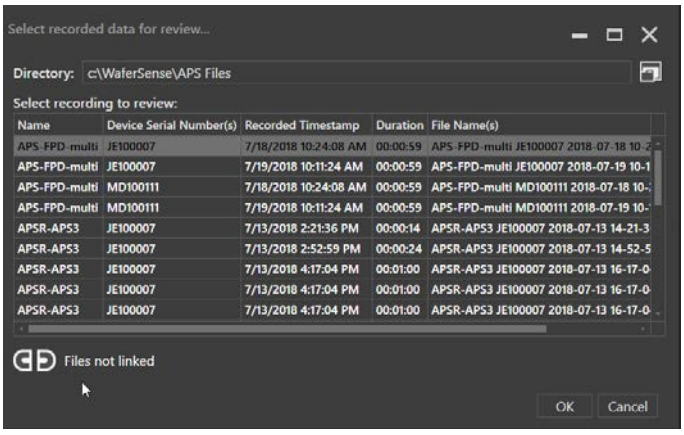


Figure B.12: Linked Log files

To view Linked CSV file:

- Navigate to the folder directory the recorded files were saved to
- The top row of the CSV file will list the Device Name with Device Serial Number.

Example of data from first device

Example of data from second device

	H	I	J	K
	APS-FPD (APSR: JE100007) 10.0um/sec	APS-FPD (APSR: JE100007) 30.0um/sec	APS-FPD (APS: MD100111) 2.0um/ft^3	APS-FPD (APS: MD100111) 5.0um/ft^3
2	0	0	0	0
3	0	0	840	900
4	0	0	1560	1200
5	0	0	840	540
6	0	0	660	300
7	0	0	1800	420
8	0	0	780	660
9	0	0	720	360
10	0	0	660	480
11	0	0	1080	540
12	0	0	1380	780
13	0	0	900	420
14	0	0	1380	720
15	0	0	1260	720
16	0	0	1020	840
17	0	0	1380	840
18	0	0	1020	660
19	0	0	1860	720
20	0	0	1260	780
21	0	0	960	1500
22	0	0	2040	840
23	0	0	1440	1200
24	0	0	1200	960
25	0	0	960	360
26	0	0	1260	600
27	0	0	1500	480
28	0	0	900	540
29	0	0	2040	1140
30	0	0	1200	600
31	0	0	1380	780
32	0	0	900	720
33	0	0	780	780

Figure B.13: Linked CSV files

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