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# **Particle Analysis and Display System (PADS):**

## **PCASP-X2 Module Manual**

**DOC-0295 A; PADS 3.5  
PCASP-X2 Module 3.5.0**



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For similar reasons, DMT recommends that you do not install or run other software on the dedicated instrument computer. Although the installation of some software may be unavoidable, it is particularly important not to run other software while the computer is acquiring data.

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## 1.0 Introduction

The Particle Analysis and Display System (PADS) is a software package that interfaces with instruments produced by Droplet Measurement Technologies (DMT) and other leading instruments used in the atmospheric sciences. This manual describes the PADS PCASP-X2 module version 3.5.0.

For an explanation of the basic PADS setup and instructions on how to acquire data using PADS, consult the *PADS Overview Manual, DOC-0300*. Definitions and calculations used in the PCASP-X2 module are also described in the *PADS Overview Manual*.

## 2.0 Configuration

Using PADS, you can configure both the software settings for the instrument and the instrument's data display in PADS. The following two sections explain how to do this. Configuring the instrument's software and display affects the default settings PADS uses when starting up. Some parameters can also be changed while PADS is running, but doing so affects the current session only.

### 2.1 Configuring the PCASP-X2

Your PCASP-X2 and data system should arrive preconfigured from DMT. In some cases, however, you may want to change the software configuration for the instrument. To do this, follow the steps below. *Note: Droplet Measurement Technologies STRONGLY recommends that customers contact our office prior to changing any of the parameters in the instrument configuration. Improper changes can result in communication failure and/or changes in PADS computation algorithms, which can compromise data validity.*

1. Click on the "PCASP-X2" tab.
2. From the **Configure** menu, select **Configure Instrument**. You will see the following window.

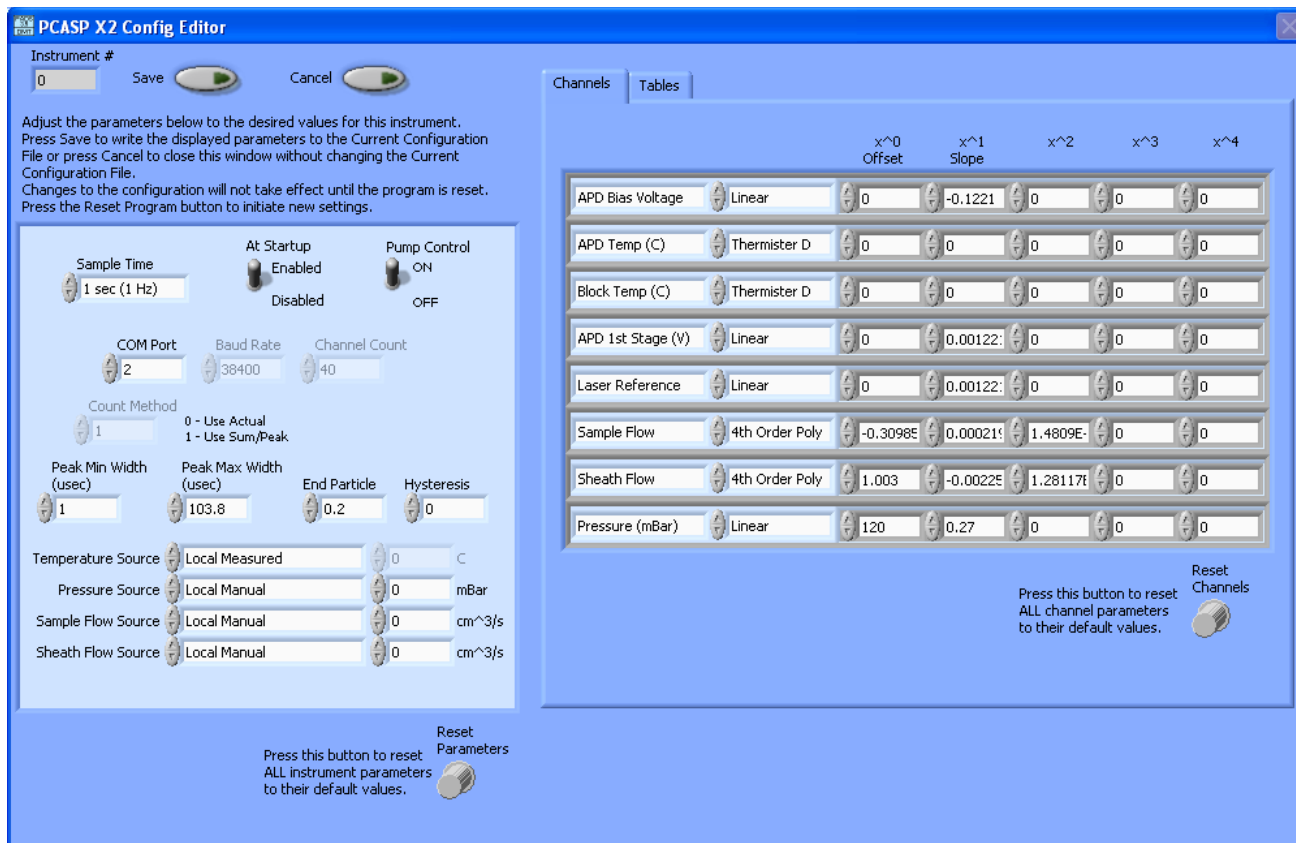


Figure 1: PCASP-X2 Configuration Editor Window

3. Now you can configure the instrument parameters to your desired specifications. See the definitions below for explanations of individual parameters. If at any time you would like to revert to the previously saved values for the PCASP-X2 parameters, press **Cancel** to exit the window without saving changes. Pressing **Reset Parameters** reverts parameters to their DMT-supplied default values.
4. When you are done configuring the PCASP-X2 parameters, press **Save** at the top of the Config editor window. Then press the green **Reset Program** button for the new configuration to take effect. Note that pressing the **Reset Program** button will clear any data currently being displayed.

### 2.1.1 PCASP-X2 Parameters

**Instrument #:** This lists the number corresponding to the instrument you are viewing, in this case the PCASP-X2. If your PCASP-X2 has been assigned instrument number one, you will see “1” in this field. You should not need to modify the instrument number, and in fact you are unable to do so from within PADS.

**Sample Time:** This parameter shows the time interval you'd like between samples. You can have the probe sample at intervals between 0.04 and 20 sec (25 to 0.05 Hz). Note that if you increase the sample time, you will still collect data for the same number of particles. This is because the probe collects data continuously and relays cumulative data at each sampling interval. For example, say you have the sample time set to .5 seconds. You might see four particles of size 5  $\mu\text{m}$  during the first sample, and five particles of this size during the second sample. If you had set your sample time to one second instead of .5 seconds, you would instead get one sample that showed nine particles of size 5  $\mu\text{m}$ . *Note:* Sample Time is most often set to 1 Sec. Higher sample rates may or may not work on a given data system, depending on the computer performance and the number and types of instruments PADS is configured to use.

**At Startup Enabled / Disabled:** If you want the PCASP-X2 to acquire data when PADS begins sampling, make sure this parameter is in the "Enabled" mode. In some cases, such as if the PCASP-X2 is inoperative, you may want to use this control to disable the probe. Disabling the PCASP-X2 allows data to transmit from other instruments without interference. Data will still be written to the disabled instrument's output file, but PADS will write "NaN" to all fields.

**Pump Control:** This control specifies whether the PCASP-X2's pump should turn on when PADS starts acquiring data. The default setting is on. In some cases, such as if the PCASP-X2 is being calibrated, the technician may want to use this control to turn off the pump.

**COM Port:** This is the serial communications port that the PCASP-X2 uses to connect with the computer. This number should match the computer hardware configuration for the particular computer you are using. If you are not using multiple computers, this number should not be changed.

**Baud Rate:** The baud rate for the probe is defined at manufacture. This parameter has been grayed out and you should not need to change it. If you reconfigure your hardware, however, the baud rate may change. If this occurs, contact DMT for help in changing your baud rate in PADS.

**Channel Count:** This number indicates how many sizing bins the PCASP-X2 uses to categorize particles. This number has been grayed out because it is preconfigured for your instrument and should not change.

**Count Method:** This parameter instructs the PCASP-X2 how to size counted particles. When Count Method is set to 0, the system uses particle width when counting particles. When set to 1, the system uses particle area divided by particle peak. The recommended default setting for this parameter is 0.

**Peak Max Width (usec):** This parameter is used as a filter to remove signals that are either noise or produced by particles that are recirculating in the sample cavity. The instrument's pump maintains a constant flow velocity, and the length of time a particle is in the beam should also be approximately constant. The transit time of each particle is measured, and if it exceeds the peak max width it will be rejected. Excessively long transit times can be caused by coincidence, i.e. multiple particles in the beam at the same time, or by particles in the sample cavity that recirculate and pass through the beam at a lower velocity than the main airflow. See Figure 4 for a diagram of how Peak Max Width and other parameters determine particle events. The setting for this parameter depends on your individual instrument and should be listed in your calibration data packet.

**Peak Min Width (usec):** This parameter is used as a filter to remove signals that are electronic noise or produced by particles that pass through the edges of the laser beam. An aerodynamic nozzle that uses clean sheath air to focus the aerosol stream is used to direct the aerosols through the center of the laser; however, there will be the occasional particle that passes near the edge of the laser where the intensity is lower. See Figure 4 for a diagram of how Peak Min Width and other parameters determine particle events. The setting for this parameter depends on your individual instrument and should be listed in your calibration data packet.

**Hysteresis:** This parameter is defined in digital units, and it allows the program to filter out minor signal variations that are due to noise. After a particle is detected, the primary signal must go below [ADC Threshold - Hysteresis] before the program looks for another event. The ADC threshold is listed in the **Tables** tab under "ADC Lower Threshold." See Figure 4 for a diagram of how Hysteresis and other parameters determine particle events. The setting for this parameter depends on your individual instrument and should be listed in your calibration data packet.

**End Particle:** This parameter allows the program to filter noise. It acts similarly to **Hysteresis** but applies to time, and it prevents double-counting of peaks. After the end of a peak, [End Particle]  $\mu$ sec must elapse before another particle event is recognized. See Figure 4.

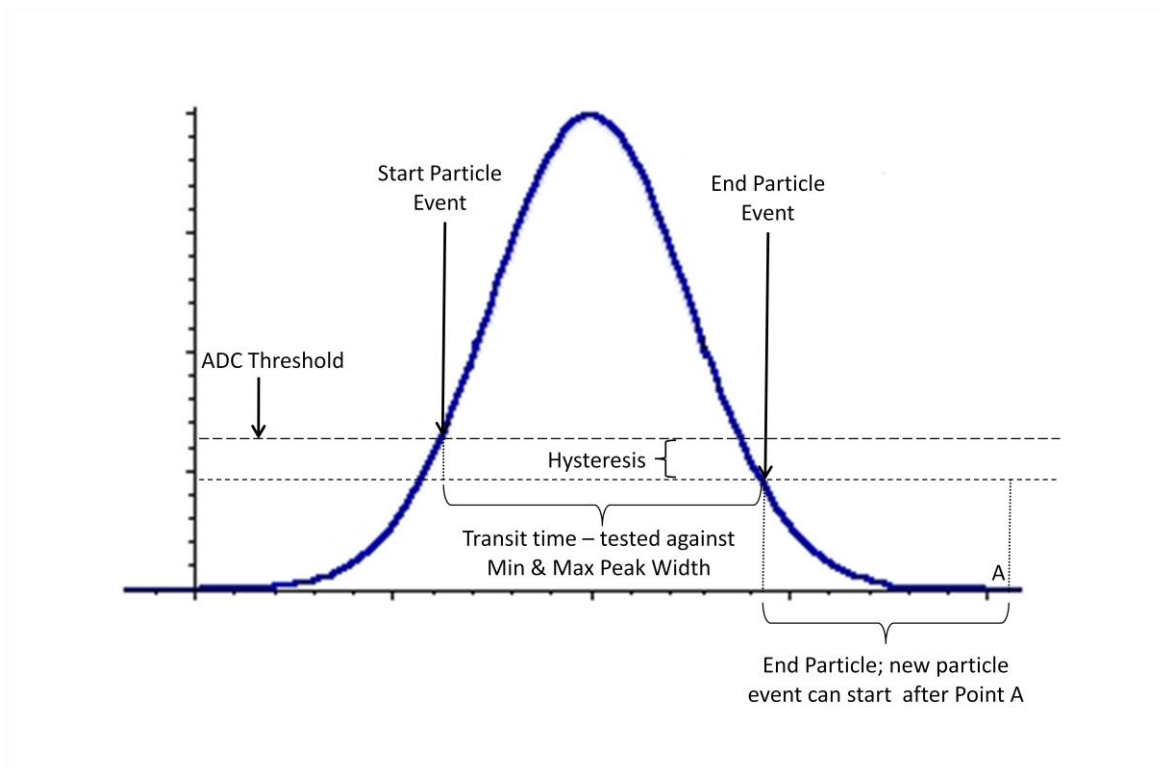


Figure 2: Config Editor Parameters Used in Identifying Particle Events. Note that ADC Threshold is listed under the **Tables** tab (“ADC Lower Threshold” field)

The **Source controls** allow you to set the source for flow-related parameters that can be measured by instruments or entered manually. For instance, the **Temperature Source** control specifies from which of the following sources the system should obtain the applied ambient temperature used in calculating volumetric flows from mass flows:

- 1.) The local measured value (i.e., the value measured by the PCASP-X2)
- 2.) A measurement obtained from another instrument in the PADS system
- 3.) A manually entered value:
  - a. A “Local” value, which at start-up is the value entered in the box to the right of the source control. This number can be changed from the instrument display while the program is running.
  - b. A “Global” value entered on the **Setup** tab

Similarly, you can instruct the system to use different sources for the sample and sheath flows and for the static pressure used in calculating volumetric flows. “Local Measured” uses the instrument’s measurement, while “Local Manual” uses manually entered values—initially the ones to the right of the source controls, which can be changed from the **Tools** tab when the program is running.

## 2.2 Channels Tab

The channels listed in the Channels table are configurable. These are A/D housekeeping channels that measure a 0-5 V range from one of the instrument’s internal sensors, for example a pressure or temperature sensor. A conversion equation converts the A/D counts into other, more meaningful units (e.g., mBar or °C). You can specify this equation in the Channels table.

**Note:** While it is possible to use the Channels table to rename output channels, in most cases your system is preconfigured so that the channels in the table correctly match output from your instrument(s). While minor rescaling of output channels can improve data accuracy, DMT does not recommend altering your basic channel configuration.

The second column in the table indicates the type of equation that PADS should use—linear, polynomial, or none. (“Thermister D” and “Thermister G” are complicated, pre-set equations used by some instruments, while the “Custom” options are reserved for future use.) “Linear” indicates a linear equation, while “4<sup>th</sup> Order Poly” indicates a higher order polynomial equation with up to five terms. “None” means the digital value (between 0 and 4095) will be returned without any scaling.

The right-hand fields in the channels table indicate the coefficients to be used in the conversion equation. Figure 2 shows the setup for a hypothetical channel with the second-order polynomial conversion equation, as follows:

$$\text{New\_Channel} = 34.01 + 0.061 x + 0.0092 x^2$$

where x is the digitized analog value returned by the A/D converter.

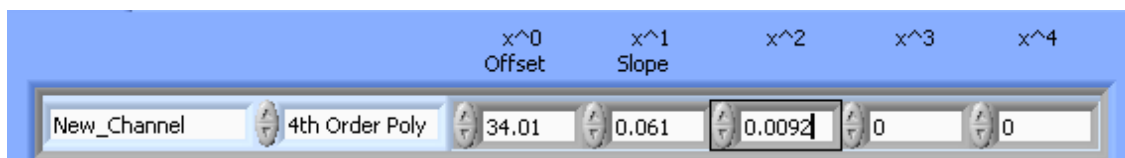


Figure 3: Example Channel Specifications in the Config Editor Window

The number of coefficients that PADS uses depends on the equation type. “None” does not use any coefficients. “Linear” uses the first two coefficients, which are listed in the first two table cells after the equation type. “4<sup>th</sup> Order Poly” uses one to five coefficients.

In cases where there are non-zero numbers in cells that are not used in the function, PADS ignores these numbers. For instance, if you specify “Linear” as your function and have .32 in the farthest right cell, the program will just ignore this value.

Clicking the **Reset Channels** knob at the bottom of the PCASP-X2 Parameter window will reset all the channel parameters to their DMT-supplied default values.

After making changes to the Channels tab, you will need to press the **Save** button and then click the green **Reset Program** to activate these changes. Clicking **Reset Program** will clear any data PADS is currently displaying.

## 2.3 Tables Tab

The **Tables** tab lists the threshold tables that allow the PCASP-X2 to bin particles according to size. **Bin 1 Lower Thresh.** lists the lower size limit in  $\mu\text{m}$  of the smallest bin. **ADC Threshold** indicates the smallest peak A/D value a particle can have and still be sized by the instrument. Small digital peaks can occasionally occur in the absence of particles, and the ADC Threshold can be used to eliminate such noise. Both of these parameters can be changed by typing a new value into the text box or by using the control arrows to the left.

The table below consists of three columns. The left-hand column lists the bin number. The middle column lists the upper size limit in microns for that bin. (Lower size limits are the upper limit of the previous bin, except for bin 1, whose lower boundary is listed above the table.) The right-hand column in the table lists the A/D count that corresponds to this upper size limit. Note that bin numbers are fixed, but you can modify both the upper size boundary and the corresponding A/D count values. To modify a cell, either type in a new value, or use the arrows to the left. The scrollbar to the right allows you to access other rows in the table.

The **Reset Tables** knob restores table values to their DMT-supplied defaults.

After making changes to the Tables tab, you will need to press the **Save** button and then click the green **Reset Program** to activate these changes. Clicking **Reset Program** will clear any data PADS is currently displaying.

## 2.4 Configuring the PCASP-X2 Display

To configure the PCASP-X2 display, click on the PCASP-X2 tab if you have not already done so. Then select **Configure** from the menu bar and click on **Configure Display**. This will bring up the following window.

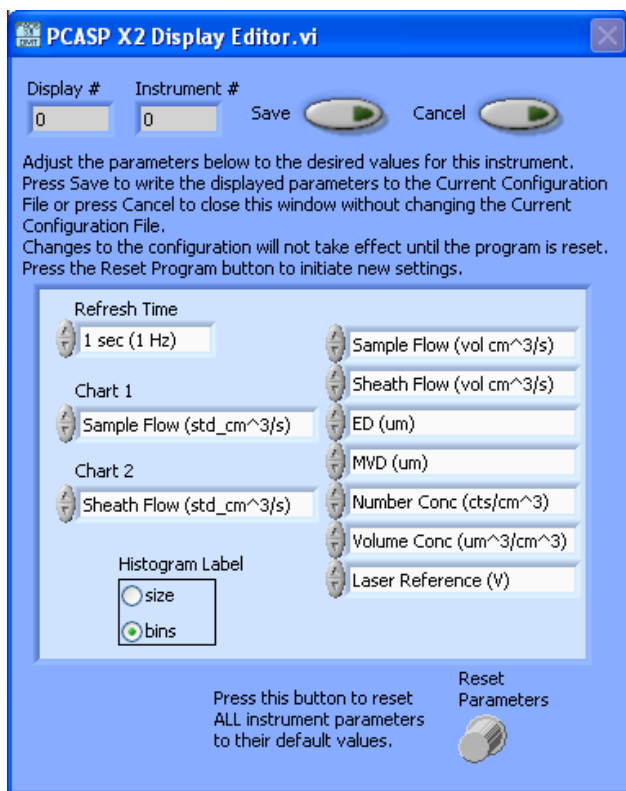


Figure 4: PCASP-X2 Display Editor Window

You do not need to modify the **Display #** or **Instrument #**. Changing the **Refresh Time** allows you to set the time intervals for data display during acquisition mode; you can choose any time that is equal to or greater than the sample time. (Choosing a time less than the sample time is not useful, since the same data will be displayed multiple times.)

**Chart 1** and **Chart 2** allow you to select channels graphed on the **Selectable Charts** tab.

The **Histogram Label** radio buttons allow you to select how you would like the x-axis of the histogram labeled - by size ( $\mu\text{m}$ ) or bin number.

The channels listed on the right control which channels PADS displays in the upper right of the PCASP-X2 window.

Note that many of the settings listed above can also be changed while PADS is acquiring data by using the controls on the main PCASP-X2 window. Modifying these parameters on in the Display Editor changes the values used upon start-up.

**Reset Parameters** reverts the display parameters to their DMT-supplied defaults.

When you are done configuring the PCASP-X2 display, click on **Save** to update the configurations or **Cancel** to revert to the previous configuration. After you reset PADS,

you will be able to see any changes you have made. Note that clicking **Reset Program** will clear out any data currently being displayed.

## 3.0 The PCASP-X2 Window

The different parts of the PCASP-X2 Window are discussed below. For explanations of the **Enable** button, **COM Port** indicator, and **Fault/No Fault** button, see the “Instrument Tabs” section of the *PADS Overview Manual*.

The **Pump Control On/Off** buttons at the top right of the screen (Figure 5) allow you to turn the instrument’s pump on and off. You can change the default on-off setting for the pump by going to the **Configure** menu, selecting **Configure Instrument**, and setting the **Pump Control** as desired.



*Figure 5: Pump Control*

Just below the pump control buttons is the flow status indicator. When air is flowing properly through the PCASP-X2 pump, this indicator should be green and read “Pump Flow OK.” When there is a problem with pump flow, this indicator will turn yellow and display “Pump Flow Below Threshold Level.” *Note that PADS only updates the flow status indicator when data are being acquired or when you are in playback mode. If you are in acquisition mode but not sampling data, the flow status indicator will display an outdated and possibly incorrect value.*

## 3.1 Sub-tabs

The PCASP-X2 window has seven sub-tabs, which are described below.

### 3.1.1 Data

Important PCASP-X2 channels are displayed in the **Data** sub-tab. These data are specific to the time listed in the upper-right of the PADS window.

The channels listed in the left panel are measured channels, while the right panel displays the calculated volumetric Sample and Sheath Flows (vol cm<sup>3</sup>/sec).

The PCASP-X2 channels are described in Appendices A and B of the *PADS Overview Manual*.

Note that the block temperature listed in the data window can differ from the temperature channel (**Applied Ambient Temperature**) that PADS uses to convert mass flows to volumetric flows. Likewise, the static pressure listed in the data window can differ from the pressure channel (**Applied Pressure**) used in the conversion equation. The tables below provide additional information on this topic.

<i>If Temperature Source Listed on Tools Tab is:</i>	<i>Then Block Temp (C) channel is taken from:</i>	<i>and Applied Ambient Temperature, the temp. used in the flow conversion equation, is:</i>
<i>Local Measured</i>	PCASP-X2 temp. sensor reading	PCASP-X2 temp. sensor reading
<i>Local Manual</i>	Manually set temperature (Default set on PCASP-X2 Config Editor Screen, overrides made on the Tools tab)	Manually set temperature (Default set on PCASP-X2 Config Editor Screen, overrides made on the Tools tab)
<i>Global Manual</i>	PCASP-X2 temp. sensor reading	Global temperature source specified on the Setup screen
<i>[Another PADS instrument]</i>	PCASP-X2 temp. sensor reading	Reading from other PADS instrument

*Table 1: Temperature Source Settings in the PCASP-X2*

<i>If Pressure Source Listed on Config Editor Screen is"</i>	<i>Then Static Pressure channel is taken from:</i>	<i>and Applied Pressure, the pressure used in the flow conversion equation, is:</i>
<i>Local Measured</i>	PCASP-X2 press. sensor reading	PCASP-X2 press. sensor reading
<i>Local Manual</i>	Manually set pressure (Default set on PCASP-X2 Config Editor Screen, overrides made on the Tools tab)	Manually set pressure (Default set on PCASP-X2 Config Editor Screen, overrides made on the Tools tab)
<i>Global Manual</i>	PCASP-X2 press. sensor reading	Global pressure source specified on Setup Screen
<i>[Another PADS instrument]</i>	PCASP-X2 press. sensor reading	Reading from other PADS instrument

*Table 2: Pressure Source Settings in the PCASP-X2*

The **Block Temperature** and **Static Pressure** channels record PCASP-X2 temperature and pressure. So these channels can be set to “Local Measured” or “Local Manual.” The **Applied Ambient Temperature** and **Applied Pressure** channels record which temperature and pressure are used in flow calculations. These can be either from the PCASP-X2 (“Local Measured” or “Local Manual”), from a “Global Manual” specified on the

Setup tab, or from another instrument that PADS is configured to use that can measure and supply temperature and pressure.

### 3.1.2 Volume Conc / # Conc

This sub-tab shows time-series charts of volume concentration ( $\mu\text{m}^3/\text{cm}^3$ ) and number concentration ( $\#/\text{cm}^3$ ). Volume concentration is graphed in green, with its axis on the left side. Number Concentration is graphed in blue, with its axis on the right side.

### 3.1.3 ED / MVD

This sub-tab shows time-series charts of effective diameter ( $\mu\text{m}$ ) and median volume diameter ( $\mu\text{m}$ ). ED is graphed in green, with its axis on the left side. MVD is graphed in blue, with its axis on the right side.

### 3.1.4 Selectable Chart

The **Selectable Chart** tab displays two charts with user-specified channels plotted as a function of time. To change the channels plotted in the selectable charts, you have two options:

- 1.) To change the charts for the current session only, click on the **Selectable Charts tab** and use the control in the upper left of the chart to select the channel you desire. You can either click on the text control to the right, which brings up a selectable list of channels, or you can use the button on the left to scroll between channels.
- 2.) To change the channels shown in the chart's display when PADS starts, go to the **Configure** menu, select **Configure Display**, and choose the desired channel. Then press the **Reset Changes** button to apply this configuration.

### 3.1.5 Volumetric Flows

This sub-tab shows time-series charts of sample flow and sheath flow, both given in volumetric  $\text{cm}^3/\text{sec}$ . Sheath flow is graphed in green, with its axis on the left side. Sample flow is graphed in blue, with its axis on the right side.

### 3.1.6 Standardized Flows

This sub-tab shows time-series charts of sample flow and sheath flow, both given in standard  $\text{cm}^3/\text{sec}$ . (Standard flow is the mass flow rate of the sample gas at standard pressure and temperature conditions, usually 1013.25 mBar and 0° C.) Sheath flow is graphed in green, with its axis on the left side. Sample flow is graphed in blue, with its axis on the right side.

### 3.1.7 Tools

The Tools tab lists various **Source** controls. If these controls are grayed out, click on **Press to Enable Source Changes** to enable them.

The **Source** controls allow you to set the source for flow-related parameters that can be measured by instruments or entered manually. For instance, the **Temperature Source** control specifies from which of the following sources the system should obtain the applied ambient temperature used in calculating volumetric flows from mass flows:

- 1.) The local measured value (i.e., the value measured by the PCASP-X2)
- 2.) A measurement obtained from another instrument in the PADS system
- 2.) A manually entered value:
  - a. A “Local” value, which at start-up is the value entered in the box to the right of the source control. This number can be changed from the instrument display while the program is running.
  - b. A “Global” value entered on the **Setup** tab

Similarly, you can instruct the system to use different sources for the sample and sheath flows and for the static pressure used in calculating volumetric flows. “Local Measured” uses the instrument’s measurement, while “Local Manual” uses manually entered values.

Changing the source settings here changes them for the current session only. (To change the default values used upon start-up, do so from the **Configure > Configure Instrument** menu.) After you have finished specifying new sources, click on the **Press to Lock Source Changes** button to disable further changes.

## 3.2 Selectable Channels Display

The right side of the PCASP-X2 window displays current data for seven user-selectable channels. New channels can be selected by clicking on the name of a current channel and selecting a replacement from the drop-down list. To make permanent changes to this list, edit the settings on the Display Editor (select **Configure > Configure Display**).

### 3.3 Histogram Data Window

Below the PCASP-X2 chart displays is the histogram display of PCASP-X2-acquired particle data. Like the channel data display, the histogram shows time-specific data. The x-axis labels indicate either the upper boundary of each size bin or the bin number, depending on the **x-axis label** setting (in the bottom right). Bin boundaries are determined by the threshold tables described in section 2.3. If PADS is displaying the x-axis as bin numbers, the size in  $\mu\text{m}$  for each bin is displayed at the top of the histogram bars.

On a standard PCASP-X2 with forty bins, bins have a width ranging from 0.01  $\mu\text{m}$  for small bins to 1  $\mu\text{m}$  for large bins. This system enables the instrument to detect a wide size range of particles yet still provide nuanced sizing for smaller particles.

As a result of the PCASP-X2's uneven bin widths, the histogram distribution may not be a smooth curve. When the bin width increases, the bins capture many more particles.

If you want to see a normalized histogram curve, click on the **Normalized** button in the Y-axis controls to right of the histogram itself. The normalization will take effect and you will see each bin of data divided by the width of that bin in  $\mu\text{m}$ .

The y-axis and x-axis controls to the right of the histogram also allow log scaling and autoscaling. By default, both axes are scaled linearly and the y-axis is autoscaled. If autoscaling is enabled, PADS will automatically select an appropriate scale with which to display the current data. For instance, if the probe is not currently detecting many particles, the y-axis range will decrease. On the other hand, if you disable autoscaling, the scale of the axes will remain constant. In this case, the range will always be the same as it was when autoscaling was disabled.

The number in the upper right of the histogram shows the total particle count across the entire histogram.

### 4.0 Zooming In and Out

There are several ways to zoom in or out on PCASP-X2 charts and the histogram. As described in the *PADS Overview Manual*, you can use the time-range controls (Figure 6) to zoom. To zoom in on the data, move the green and red controls close to the white control, which will narrow the range of displayed data. To zoom out, move the two colored controls away from the white control.

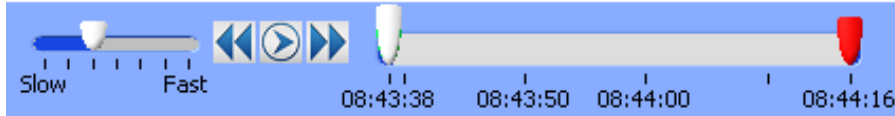


Figure 6: Time-Range Controls

On the chart itself, you can also type numbers directly into the first and last labels on the x and y axis to change the scaling.

*Note:* Do not right-click on chart and change the auto-scaling using the drop-down menu. This can interfere with the chart display. PADS autoscales most charts automatically. You can turn off autoscaling on the histogram using the buttons in the lower right of the window.

## Appendix A: PCASP-X2 Channels

A list of output channels for a standard 40-bin PCASP-X2 appears below. The PCASP-X2 output file will contain data values for each channel for each sampling instance. You can also plot each of these channels against time using the PCASP-X2 Selectable Charts tab.

For definitions of the channels, consult *Appendix A* of the *PADS Overview Manual*.

End Seconds	<i>Pressure (mBar)</i>
Day Of Year	Spare 1 - 8
Year	Number Conc (cts/cm <sup>3</sup> )
Status	Volume Conc (um <sup>3</sup> /cm <sup>3</sup> )
Avg Transit Time (us)	MVD (um)
Transit Time Rejects	ED (um)
Oversize Rejects	Sample Flow (vol cm <sup>3</sup> /s)
<i>APD Bias Voltage (V)</i>	Sheath Flow (vol cm <sup>3</sup> /s)
<i>APD Temp (C)</i>	Applied Pressure (mbar)
<i>Block Temp (C)</i>	Applied Ambient Temp (C)
<i>APD 1st Stage (V)</i>	Bin 1 - 40
<i>Laser Reference (V)</i>	UTC Seconds / GPS Time
<i>Sample Flow (std_cm<sup>3</sup>/s)</i>	Date
<i>Sheath Flow (std_cm<sup>3</sup>/s)</i>	Time

The PCASP-X2's eight housekeeping channels are depicted in italics in the list above. These channels have a 0-5 V scale measured by a 12-bit A/D converter that gives integer values from 0 to 4095.

If there is no instrument in the system that reports **GPS Time**, or if such an instrument exists but the user has selected on the PCASP-X2 Config Editor to show UTC Seconds, the output channel file will contain **UTC Seconds**. Otherwise, it will report **GPS Time**.

Two additional channels, **Date** and **Time**, may be listed after **GPS Time/ UTC Seconds** if **Write Date & Time Stamp** is enabled on the **Setup** tab.

PCASP-X2 channels fall into several broad categories:

- Time channels
- Housekeeping channels
- Bin channels (particle-size data)
- Statistical and calculated channels
- Spare (unused) channels

## Appendix B: Revisions to Manual

Rev. Date	Rev. No.	Summary	Section
2/17/11	A-1	Removed channel definitions and incorporated them into <i>PADS Overview Manual</i> , DOC-0300.	Appendix C

This document replaces DOC-0207, the *PADS PCASP-X2 Operator Manual* for PADS version 2.X. All sections have been updated.