

Technical Bulletin

Seametrics Smart Sensors: Barometric Compensation *(with optional DTW setting)*



The Barometric Compensation Utility is specifically for the PT2X and LevelSCOUT sensors. It uses barometric data to compensate the data readings from an absolute sensor in order to give a true pressure or level measurement. It also has the option to enter a depth-to-water offset after the data has been collected.* This is especially useful when using cableless sensors where you cannot use the built-in Depth-to-Water setting utility. See page 9 for details on using Microsoft® Excel for conversion if you have a different type of sensor.

Introduction

The Seametrics standard gauge pressure devices utilize a vent tube in the cable to allow the device to reference atmospheric pressure. The resulting gauge pressure measurement reflects only the depth of submergence. When using absolute devices, however, the pressure measurement reflects the depth plus the atmospheric pressure. This atmospheric pressure must be subtracted from the absolute pressure to give the actual pressure due to depth.

In a typical absolute installation, one additional sensor (typically a PT2X-BV or a BaroSCOUT) will be used to measure the atmospheric pressure. Both the units should be set to collect data during the same time period, though the barometric sensor need not take samples as often.

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How Pressure is Measured

A fundamental law for a fluid (whether a gas, such as air, or a liquid, such as water) is that the fluid exerts an equal pressure in all directions at a given level. If we increase our elevation, the pressure exerted on our bodies decreases, as there is less of this fluid above us. Likewise, when an object is submerged in water, the pressure exerted on the object increases, as there is more of the fluid above it.

Absolute sensors (PSIA units) measure the pressure of the total fluid above the sensor, both the atmospheric (air) pressure and the water pressure. When using absolute sensors, you must subtract the atmospheric pressure from the sensor measurement to obtain just the water pressure. This atmospheric pressure can be measured with a barometric sensor, such as the PT2X-BV or LevelSCOUT.

Seametrics standard gauge sensors (PSIG units) utilize a vent tube in the cable to allow the device to reference atmospheric pressure. The resulting gauge pressure measurement reflects only the water pressure.

In the diagram on the next page, the PSIG (Gauge) unit would read just the pressure of the water, i.e., 10.2 psi. The PSIA (Absolute) unit would read the pressure of the water **and** the pressure of the air, i.e., 24.9 psi. The barometric sensor would read just the air pressure, i.e., 14.7 psi.

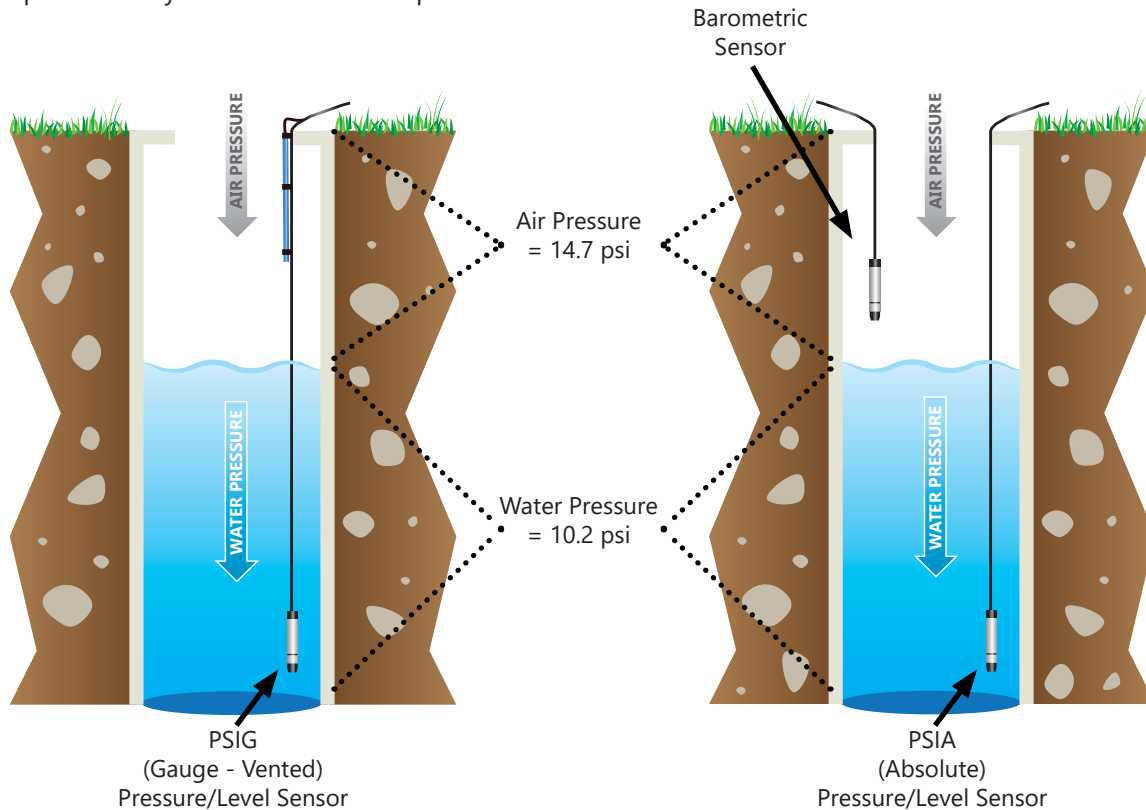
** Aqua4Plus versions prior to 1.9.10 and Aqua4Plus Lite versions prior to 2.1.4 do not have the depth-to-water option in the Barometric Compensation utility. To enter depth-to-water information for absolute sensors after data collection in earlier versions, see the "Compensating Seametrics Absolute Sensor Readings on Cableless Sensors" application note or install a newer version of the software. Both the application note and the current software are available on our web site at seametrics.com.*

To obtain just water pressure when using the PSIA (Absolute) unit, you would need to subtract the barometric reading from the PSIA reading. In this example:

PSIA unit = 24.9 psi

PT2X-BV = 14.7 psi

Water pressure only = $24.9 - 14.7 = 10.2$ psi.



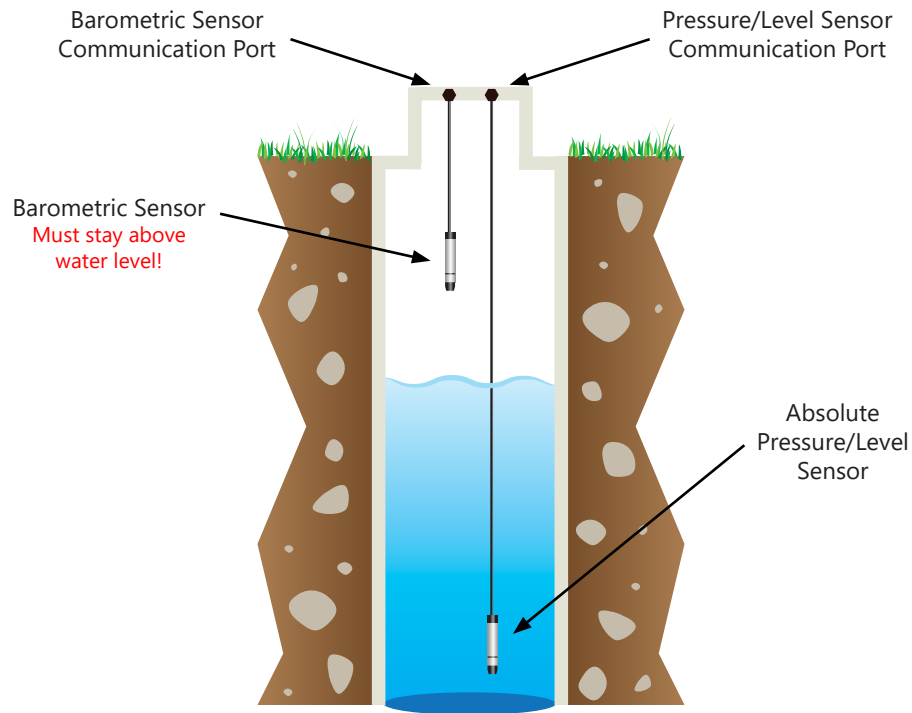
How Pressure is Measured

Sample Installations

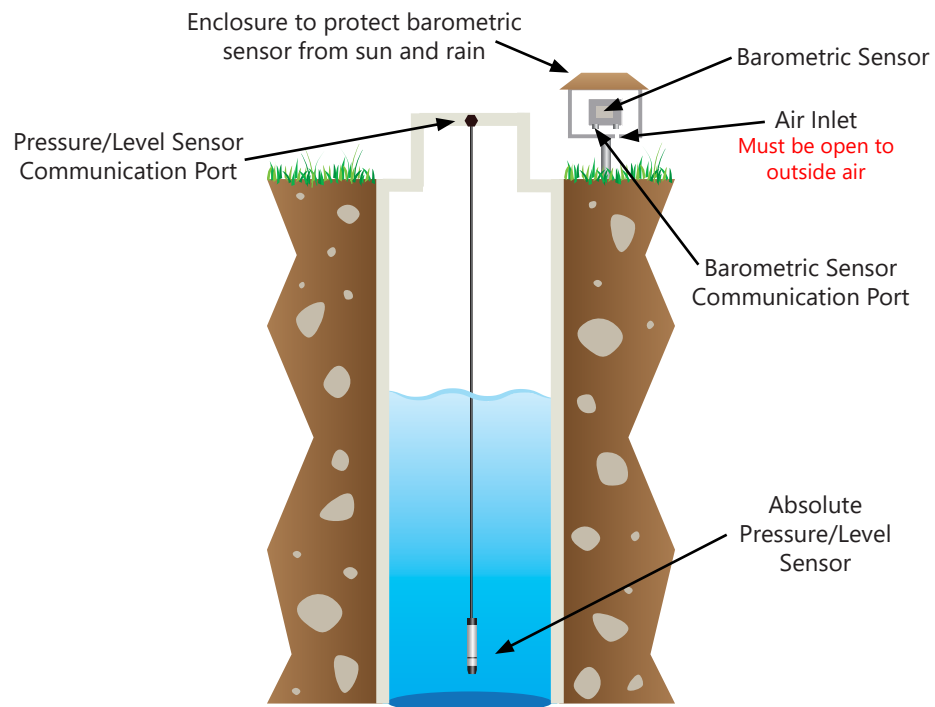
Seametrics manufactures the barometric sensors in two housings. One is a 316 stainless steel tube. The other is an ABS IP67 box.

The tube version can be installed inside the well casing in the air section to measure air pressure or in some cases vacuum pressure in the well. See the top diagram on the following page.

The box version is not designed to be submerged and can be installed near the well. The box should be protected from the sun and rain. Be sure the inlet is exposed to the outdoor air pressure. See the bottom diagram on the following page.



Sample Installation Using a Tube Version



Sample Installation Using a Box Version

Using the Barometric Compensation Utility

The Barometric Compensation Utility is specifically for the PT2X and LevelSCOUT sensors. It uses barometric data to compensate the data readings from an absolute sensor in order to give a true pressure or level measurement. It also has the option to enter a depth-to-water offset after the data has been collected*. This is especially useful when using cableless sensors where you cannot use the built-in Depth-to-Water setting utility. See page 9 for details on using Microsoft® Excel for conversion if you have a different type of sensor.



Tips

- When starting the logging, be sure to checkmark the box *Set Sensor Clock*. This will ensure that sensors are set to the same time.
- For best results in most situations, there should be at least one barometric reading within 60 minutes of each sensor reading. In areas where the barometric pressure changes rapidly, set the same recording frequency on both the barometric and level sensor.
- Refer to the Aqua4Plus or Aqua4Plus Lite software instructions for details in using the software.

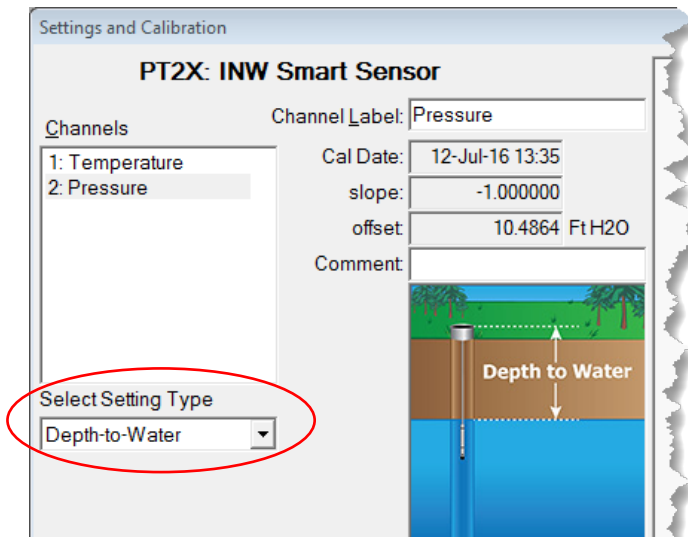
Setup

(If using automatic depth-to-water offset, sensor must be deployed before Step 1. If using a cabled sensor but entering a manual offset after data collection, sensor may be deployed anytime prior to step 5. Cableless sensors should be deployed at Step 4.)

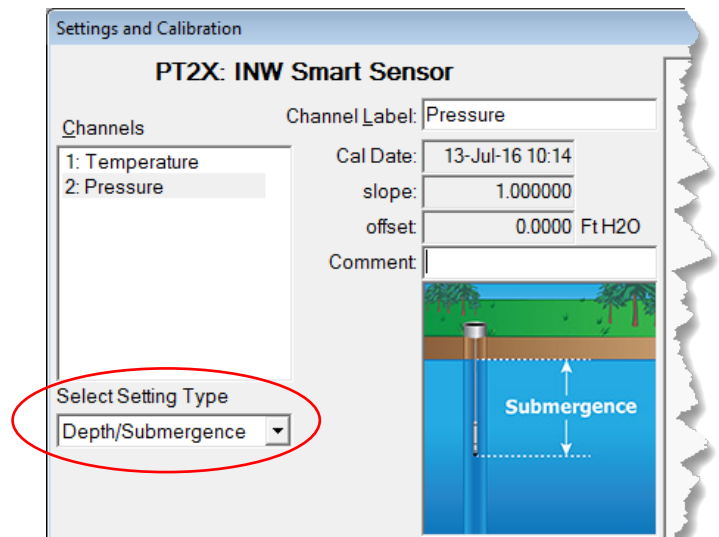
If you want to use a depth-to-water offset, start with Step 1 below; otherwise start with Step 2.

1. Preparing for depth-to-water offset on pressure/level sensor
 - **Cabled** sensors using **automatic** Depth-to-Water offset
 - Open the Settings and Calibration Window
 - Under Select Setting Type, select Depth-to-Water
 - Follow directions on the screen to complete your Depth-to-Water entry
 - This is the preferred method for cabled sensors, as it automatically adjusts for any slight variances in the sensor, as well as the exact depth.
 - **Cableless** sensors or **cabled** sensors where you want to **manually** enter a depth-to-water after data collection
 - Open the Settings and Calibration Window
 - Under Select Setting Type, select Depth/Submergence.
 - Verify that the slope is NOT negative. If it is, that means someone has entered a depth-to-water offset. You will need to manually set the Slope to 1 and the Offset to 0.
 - If the slope is not negative, but a calibration slope and/or offset had been entered, this is fine. The program will take these into consideration and no changes need to be made here.

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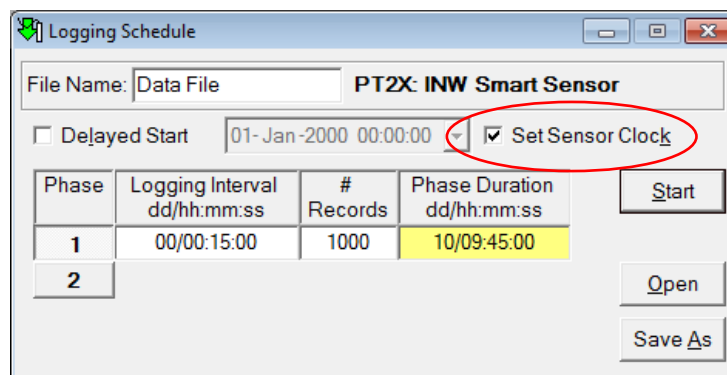


Use this option when using automatic DTW settings



Use this option when entering DTW information after data collection

2. Set up Barometric Unit (BaroSCOUT or PT2X-BV):
 - Set the Logging Schedule on the barometric unit.
 - **Remember to checkmark Set Sensor Clock on the Logging Schedule Screen!**
3. Set up Pressure/Level Sensor (LevelSCOUT or PT2X):
 - Set the Logging Schedule on the sensor.
 - **Remember to checkmark Set Sensor Clock on the Logging Schedule Screen!**

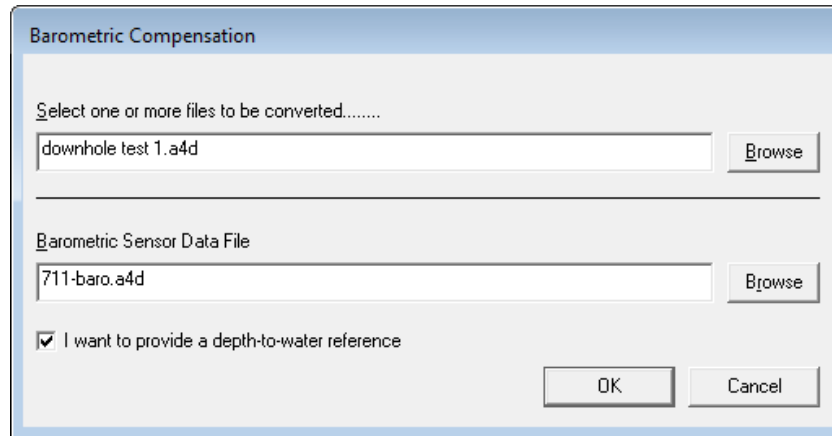


Setting the sensor clocks when starting the logging will help ensure that all data can be properly synchronized

4. Deploy the sensor. **Note: It is very important to deploy the sensor before proceeding with the next step** as the sensor's displacement will affect the depth-to-water, especially in small diameter wells.
5. If you are going to manually enter a depth-to-water measurement after data collection, then use an alternate water level measuring device, such as a dip meter, and carefully obtain the current depth-to-water from the top of the well or other specific location. **Record this value and the exact time in your field notes.** You will need this later when adjusting the data after export.

Data Retrieval and Compensation

1. When done collecting data, retrieve the data from the pressure/level sensors and the barometric sensor.
2. Open the Barometric Compensation Utility. (Aqua4Plus: on the Utility Menu. Aqua4Plus Lite: on the Program Configuration Menu.) The following dialog box will open:

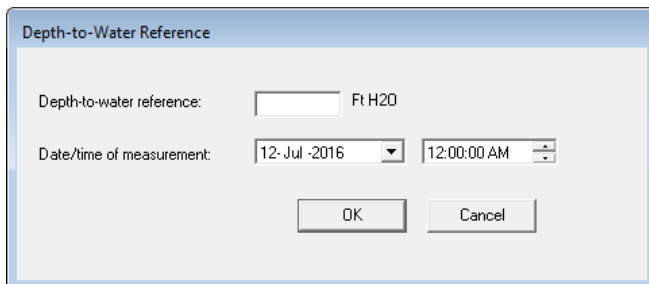


The dialog box titled "Barometric Compensation" contains the following elements:

- A text field labeled "Select one or more files to be converted....." with the value "downhole test 1.a4d" and a "Browse" button.
- A text field labeled "Barometric Sensor Data File" with the value "711-baro.a4d" and a "Browse" button.
- A checkbox labeled "I want to provide a depth-to-water reference" which is checked.
- "OK" and "Cancel" buttons at the bottom right.

Barometric Compensation File Selection Box

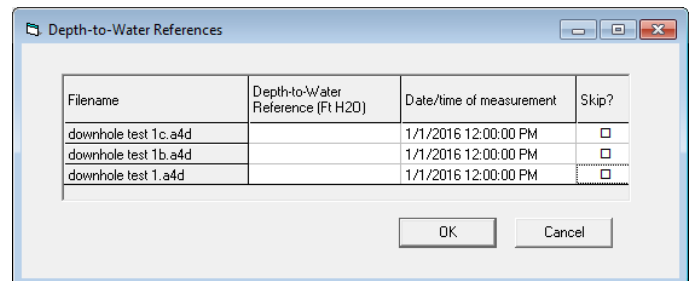
3. First, select one or more absolute data files to be converted. Click the top Browse button and navigate to the file(s) you want to convert. To select one file, simply double-click on the file name. To select two or more files, click on the first file, then hold down the Ctrl key and click on each of the other files you want to convert. Then click OK.
4. Next, select the barometric file you wish to use for the compensation. Click on the lower Browse button and navigate to the file you want to use. Double-click on the file name.
5. If you do NOT want to enter a manual depth-to-water reading, skip to the next step, otherwise, checkmark the box "I want to provide a depth-to-water reference". One of the following boxes will display, depending on whether you are converting one or many data files.



The "Depth-to-Water Reference" dialog box contains the following elements:

- A text field labeled "Depth-to-water reference:" with a unit dropdown set to "Ft H2O".
- A date/time field labeled "Date/time of measurement:" with a date dropdown set to "12-Jul-2016" and a time dropdown set to "12:00:00 AM".
- "OK" and "Cancel" buttons at the bottom.

Depth-to-Water Reference for a Single Sensor



The "Depth-to-Water References" dialog box contains a table with the following data:

Filename	Depth-to-Water Reference (Ft H2O)	Date/time of measurement	Skip?
downhole test 1c.a4d		1/1/2016 12:00:00 PM	<input type="checkbox"/>
downhole test 1b.a4d		1/1/2016 12:00:00 PM	<input type="checkbox"/>
downhole test 1.a4d		1/1/2016 12:00:00 PM	<input type="checkbox"/>

"OK" and "Cancel" buttons are at the bottom.

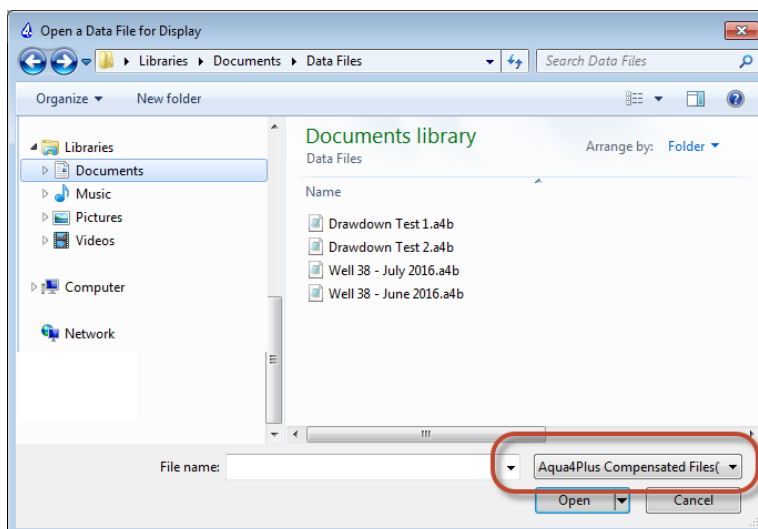
Depth-to-Water Reference for Multiple Sensors

For each sensor, enter the date/time and measurement you took previously. If you are converting several files, you have the option to enter depth-to-water offsets for each sensor or to checkmark the box in the Skip column, if not needed for a particular sensor. Click OK to continue.

6. To begin the conversion, click OK.
7. Aqua4Plus/Aqua4Plus Lite will take each record in the absolute data file, apply the depth-to-water offset (if applicable) and the barometric reading closest in time to that reading, and then create a new, converted file. The original data files will have an extension of .a4d. The compensated files will have the same file names but with an extension of .a4b. A compensated file will be created for each original data file.

Viewing the Compensated Data

1. To view your newly compensated files, click on the Open button . A File Open box will be displayed.



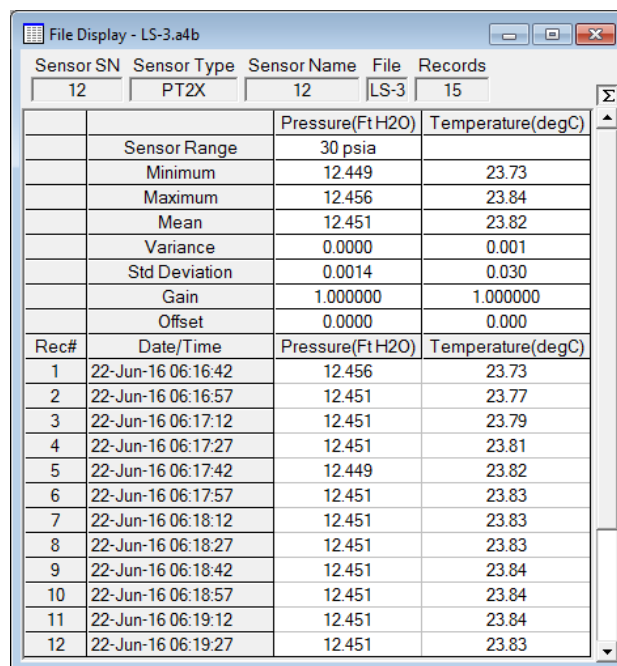
File Open Dialog Box

2. On the file type box, click the down arrow and select "Aqua4Plus Compensated Files." The box will then list your compensated files. (If you select "Aqua4Plus Data Files" instead, original data files will be listed.) Double-click on the file you want to open. Your data will display in the File Display window.

Columns represent the following:

Rec#:	Record number in the original data file
Date/Time:	Date and time of sample from original data file
Pressure:	Barometrically compensated pressure
Temperature:	Temperature

If the barometric file being used does not have a reading within one hour of the date/time for a record in the data file, that record(s) will be displayed in red.



Sensor SN	Sensor Type	Sensor Name	File	Records
12	PT2X	12	LS-3	15

	Pressure(Ft H2O)	Temperature(degC)
Sensor Range	30 psia	
Minimum	12.449	23.73
Maximum	12.456	23.84
Mean	12.451	23.82
Variance	0.0000	0.001
Std Deviation	0.0014	0.030
Gain	1.000000	1.000000
Offset	0.0000	0.000

Rec#	Date/Time	Pressure(Ft H2O)	Temperature(degC)
1	22-Jun-16 06:16:42	12.456	23.73
2	22-Jun-16 06:16:57	12.451	23.77
3	22-Jun-16 06:17:12	12.451	23.79
4	22-Jun-16 06:17:27	12.451	23.81
5	22-Jun-16 06:17:42	12.449	23.82
6	22-Jun-16 06:17:57	12.451	23.83
7	22-Jun-16 06:18:12	12.451	23.83
8	22-Jun-16 06:18:27	12.451	23.83
9	22-Jun-16 06:18:42	12.451	23.84
10	22-Jun-16 06:18:57	12.451	23.84
11	22-Jun-16 06:19:12	12.451	23.84
12	22-Jun-16 06:19:27	12.451	23.83

Data Display Window

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Barometric Compensation (with optional DTW setting)



- To view your data as a graph, click the Graphing button . Graphs will show the compensated pressure values. (Refer to the graphing section of the software instruction manual for details on using graphing features.)
- To export your data to a comma separated value file or an Excel file, click the Export button . Exports will show general file information and calibration values for both the original data file and the barometric file that was used to do the conversion. The data will be displayed in the following columns.

Rec#: Record number in the original data file
 Date/Time: Date and time of sample from original data file
 Pressure: Barometrically compensated pressure
 Temperature: Temperature
 Sensor Pressure: Pressure from the original data file (absolute pressure)
 Barometric Date/Time: The time of the reading in the barometric file that was used for each line in the data file.

31	DTW Entry:	6/22/2016 6:15:00	12.456			
32	Statistical Data		Pressure(Ft H2O)			
33		Sensor Range	30 psia			
34		Minimum	12.449			
35		Maximum	12.456			
36		Mean	12.451			
37		Variance	0	0.001		
38		Std Deviation	0.0014	0.03		
39	Rec #	Date/Time	Pressure(Ft H2O)	Temperature(degC)	SensorPressure(Ft H2O)	Barometric Date/Time
40	1	6/22/2016 6:16:42.0	12.456	23.73	33.977	6/22/2016 6:16:33.00
41	2	6/22/2016 6:16:57.0	12.451	23.77	33.982	6/22/2016 6:16:33.00
42	3	6/22/2016 6:17:12.0	12.451	23.79	33.982	6/22/2016 6:17:33.00
43	4	6/22/2016 6:17:27.0	12.451	23.81	33.982	6/22/2016 6:17:33.00
44	5	6/22/2016 6:17:42.0	12.449	23.82	33.984	6/22/2016 6:17:33.00

Manual depth-to-water date/time and measurement, if used.

Compensated pressure data

Original pressure data

Date/time of record that was used from the barometric file.

Exported Data from the Compensated File

Using Microsoft® Excel to Convert Absolute Readings

If you do not want to use the Barometric Conversion Utility, are obtaining the barometric data from another device, or have a sensor other than a PT2X or LevelSCOUT, you can use Microsoft® Excel, or any similar spreadsheet, to do the barometric compensation, as shown below.

Original Sensor Data					Added Columns	
Rec #	Date/Time	Temperature(degC)	Conductivity(µS/cm)	Pressure(psi)	Barometric Pressure (psi)	Compensated Pressure (psi)
1	6/3/2015 11:15:09	22.72	631.7	15.173	14.712	0.461
2	6/3/2015 11:15:10	22.72	632.3	15.178	14.713	0.465
3	6/3/2015 11:15:11	22.72	632.3	15.180	14.710	0.470
4	6/3/2015 11:15:12	22.72	632.5	15.181	14.715	0.466
5	6/3/2015 11:15:13	22.72	631.9	15.182	14.716	0.466
6	6/3/2015 11:15:14	22.73	631.9	15.183	14.717	0.466
7	6/3/2015 11:15:15	22.72	631.6	15.183	14.716	0.467

Original pressure data

Enter barometric pressure data

Subtract barometric from original pressure data

Using Excel to Compute Barometrically Compensated Pressure

1. Retrieve your data files, as normal.
2. From the Data Display window in Aqua4Plus or Aqua4Plus Lite, export your file to Excel.
3. Open the Excel file. Starting with the first record number, the columns will show the original sensor data.
4. In the first column after the data, enter the barometric data corresponding to the records.
5. In the next column, subtract the barometric pressure from the original pressure to get the barometrically compensated pressure. NOTE: If you set the automatic depth-to-water setting in the sensor, you will need to ADD rather than subtract the barometric pressure to obtain your depth-to-water value.