Synergy Controller Pressure Applications
Vacuum Ovens, Altitude and Thermal Vacuum Chambers

Introduction

This application note covers Synergy Controller pressure control features including vacuum ovens, altitude chambers and thermal vacuum (space simulation) chambers.

Tidal Engineering's Synergy Controllers, including the Synergy Micro 2, Synergy Quattro, and the ¼ DIN Synergy Nano provide state-of-the-art usability and connectivity for environmental test control and data acquisition. They combine the functions of a chamber controller and a data logger. They are designed to improve test efficiency by supporting both factory automation and test and measurement protocols and standards. Offering the flexibility of multiple communication ports including Ethernet, GPIB, and RS-232 make these controllers perfect for today's changing testing environments.

The Synergy Controller software can process a range of transducer types for a variety of applications and units of measure as follows:

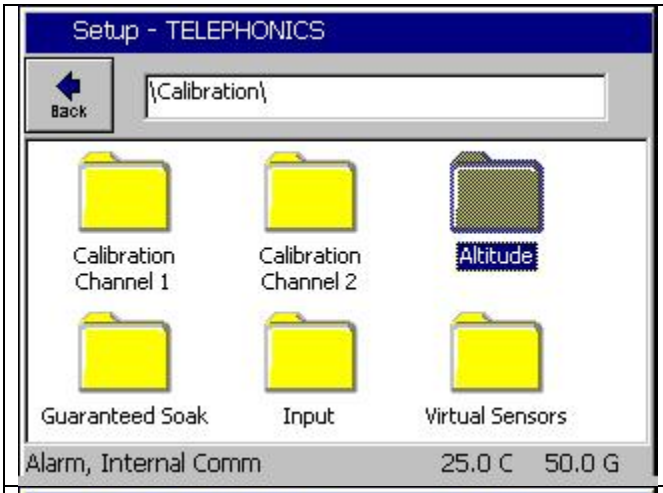
1. Granville Philips ion gauge for space simulation chambers.
2. Virtual Pressure Sensor; aggregates a High and Low Pressure transducer into one measurement.
3. Virtual Kft. Sensor; converts pressure; for example Torr to Kft. using NOAA equation.
4. Configurable pressure units including Torr, PSIG, mmHg, etc.

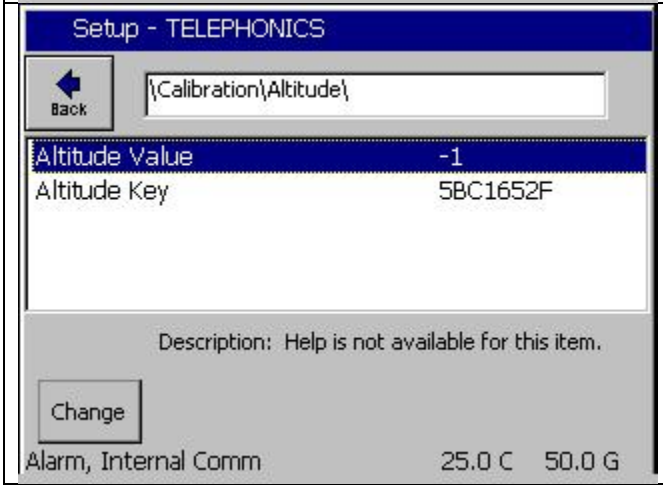
The Pressure Feature Registration Key (also known as the Altitude Key), P/N TE2013 is required to enable the pressure feature of the Synergy Controller. Contact Tidal Engineering for the Pressure Feature Registration Key for your controller.

Synergy Controller setup for pressure applications requires up to 5 steps as follows:

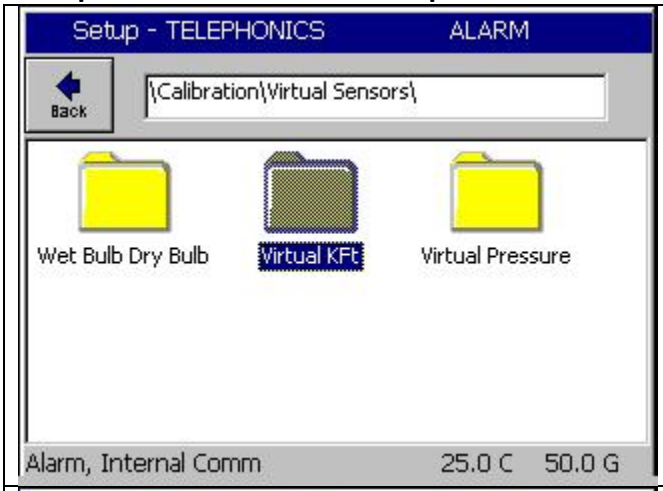
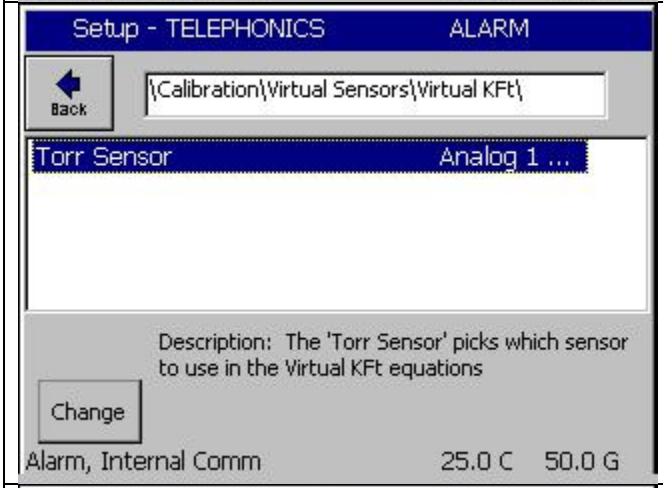
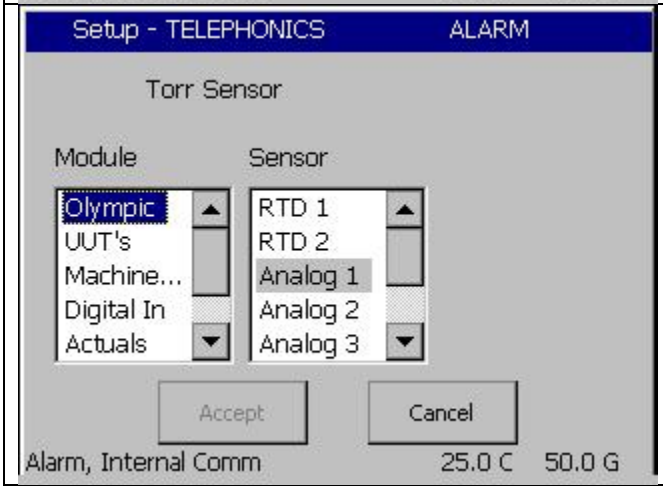
1. Enter the Pressure Feature registration key.
2. Load the chamber type; for example “Generic Temperature Pressure” or custom CDF.
3. Setup the input scaling for the sensor.
4. Set the pressure channel or channels to the sensor(s)
5. If required, load the Unit of Measure settings file to change units of measure from Torr or Kft. to another type such as mmHg, PSIG, etc.

Enter the Pressure Feature Registration Key.

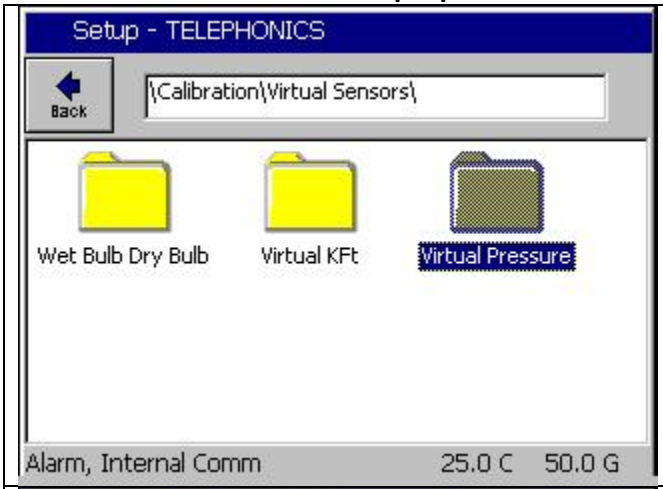
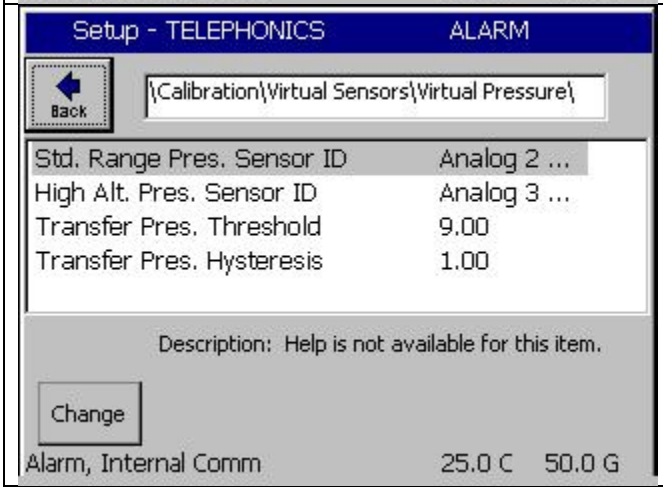
	Open the Setup screen and browse to the \Calibration\Altitude folder as shown at left.
	Contact Tidal Engineering with the S/N of your controller; press on the Registration Key field to open the Keypad.

	Enter the 8 digit Registration key and press Accept to close the keypad. Check the number in the Registration Key field and press **Register** as shown on the left.
	The Synergy Controller dialog "The Altitude key was successfully registered" will appear when the Registration key is accepted. Press **OK** to close the dialog. If there was a problem with the Registration key, check the number and try again or contact Tidal Engineering.
	Select the **Altitude Value** parameter and press the **Change** button. Set the value using the number pad to 0 for Vacuum Ovens and Altitude chambers. For Thermal Vacuum chambers that utilize logarithmic voltage scaling (for Granville Phillips Ion Gauge), set the Altitude value according to the scaling as shown in the next section. When the **Altitude Value** is set to -1, the process value will read **Off** indicating "Off-Scale".

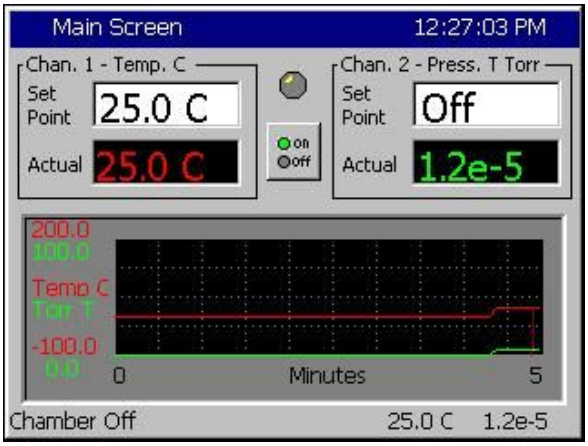
Setup the Virtual KFt. Sensor Option

	Browse to the Virtual KFt. folder in the Setup screen as shown on the left.
	Select the **Torr Sensor** parameter and press **Change** button.
	Select the sensor for the pressure Sensor from the Sensor Select Screen.

Virtual Pressure Sensor Setup Option

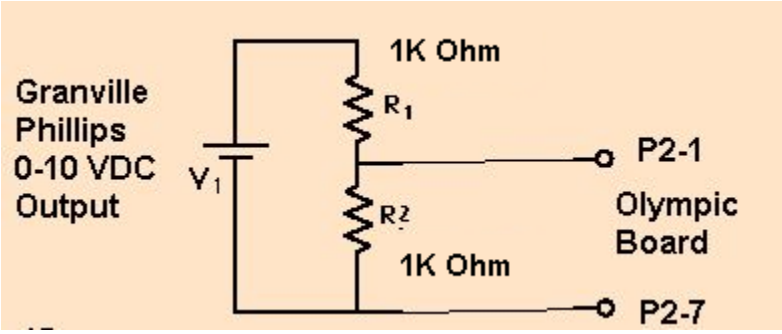
	Browse to the Virtual Pressure folder in the Setup screen as shown on the left.
	Select the pressure sensors for the Std. Range (high pressure) and High Alt. (low pressure) sensors. Then select the Transfer Pressure at which the virtual sensor switches to the High Alt. (Low Pressure). Enter a Hysteresis value to prevent chatter near the threshold.

Setup and Wiring for Thermal Vacuum chambers with Granville Philips Ion Gauge transducer



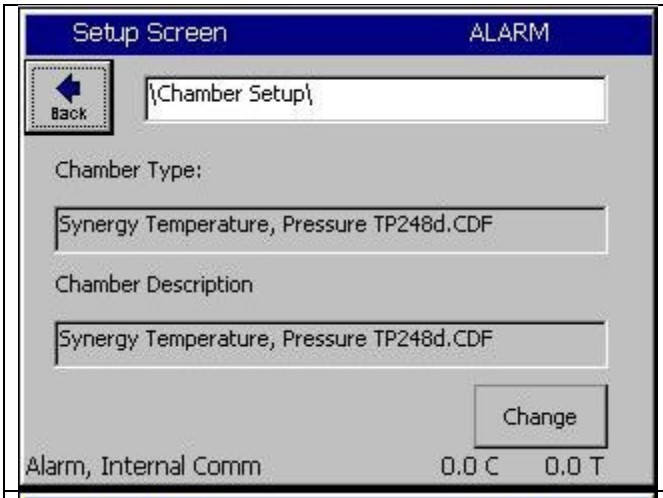
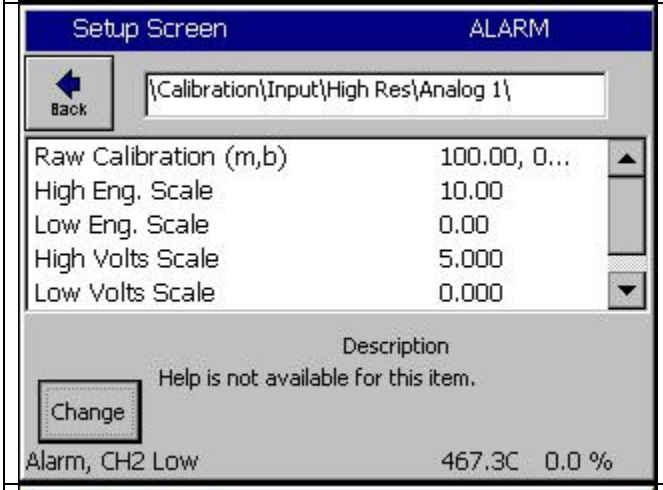
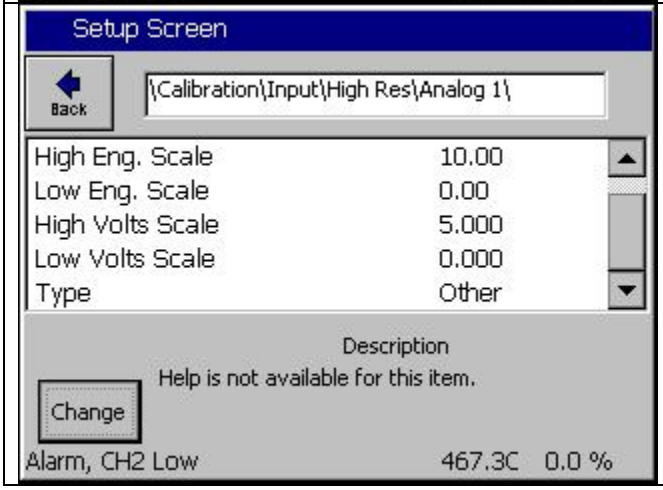
CAUTION! : The Analog inputs on the controller will be damaged if the 10 V transducer output is attached without a voltage divider.

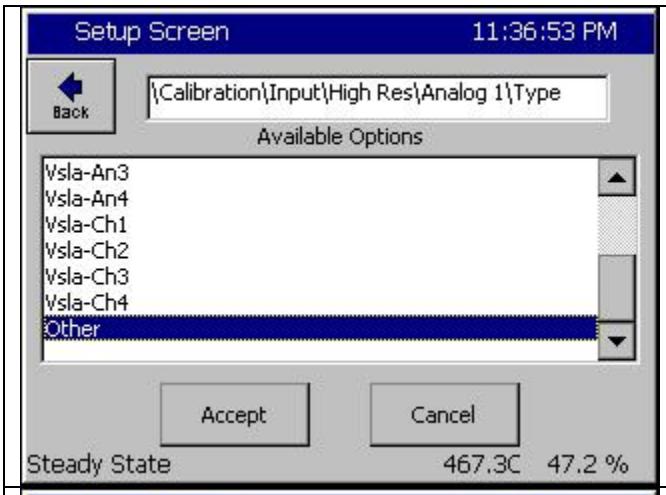
1. Wire the Granville Philips 10 Volt output thru a 2:1 voltage divider as shown below. (Analog inputs 2, 3, or 4 may also be used) Note: 1K/1K ohm resistor divider must be used. A precision 1% metal film resistor suitable for this application is the Panasonic ERO-S2PHF1001 available from Digikey.

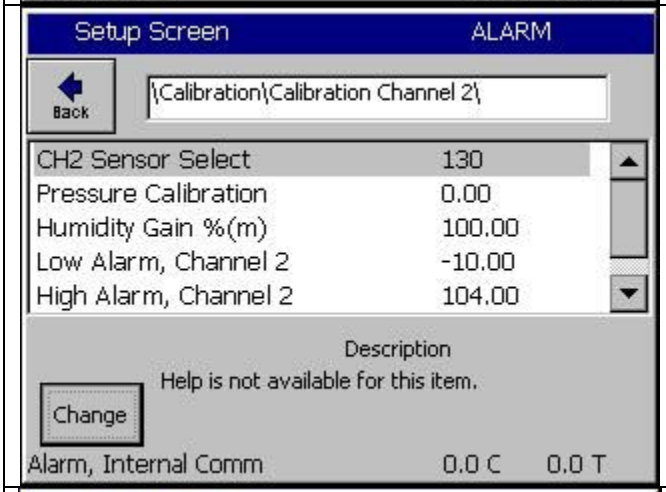


Signal	Olympic Board Connector-Pin	Reference
Analog Input 1	P2-1	P2-7
Analog Input 2	P2-5	P2-7
Analog Input 3	P2-6	P2-7
Analog Input 4	P2-11	P2-7

2. Select the chamber setup for Temperature Pressure as shown below and reboot as instructed.

	SETUP/Chamber Setup/ Select Generic Temperature, Pressure
	Setup the Hi Res input calibration for the input used as shown below. SETUP\Calibration\Input\Hi Res\Analog 1 (P2-1 to P2-7) Set High Eng. Scale to 10 Volts Set Low Eng. Scale to 0 Volts Set High Volts Scale to 5 Volts Set Low Volts Scale to 0 Volts
	Setup the Type to “Other” as shown below. Selecting a Temperature or Vaisala type would be inappropriate and would create erroneous readings.

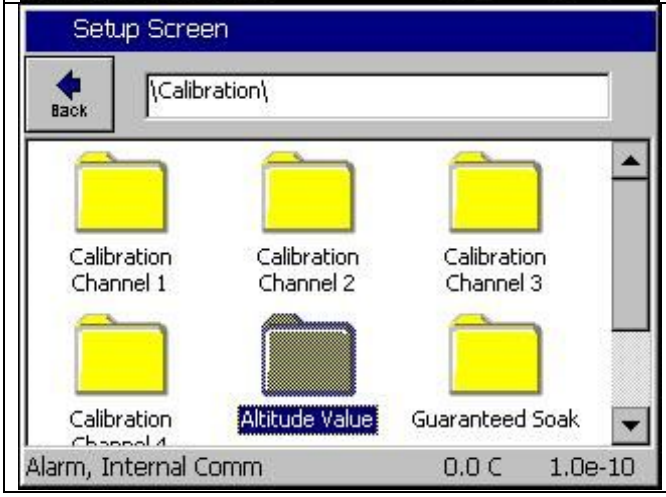




Select the channel sensor

SETUP\Calibration\Calibration Channel 2

Select Analog 1 for sensor (CH2 Sensor Select code 130)



Setup the Altitude calibration constant based on the Emission setting for the Granville Philips ION gauge as follows:

n = 12 for 10 mA
n = 11 for 1 mA
n = 10 for 0.1 mA

The UHV electrometer option (307016) switches in a preamplifier as pressure decreases at an ion (collector) current of 10^{-10} A. For example, this corresponds to a pressure of 10^{-9} Torr with 10 mA emission current. When this switching occurs, there will be a brief (about 2 s duration) drop in the analog output signal. After the electrometer has settled out, the signal is, again, proportional to the common logarithm of pressure as shown by the UHV ONLY area of Figure 2-4.

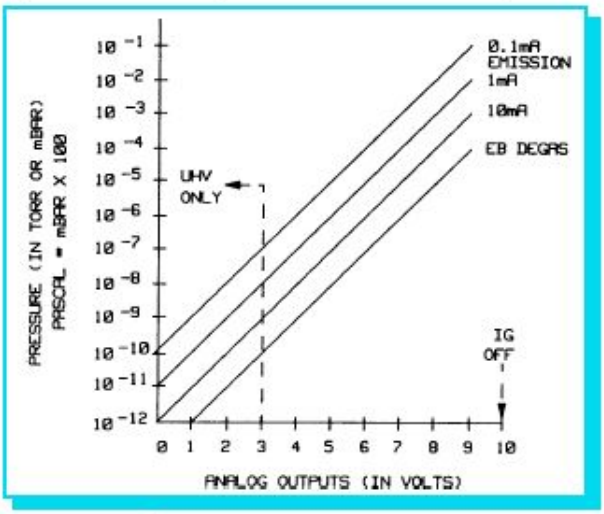


Figure 2-4 *Ion Gauge Pressure Analog Output.*

A standard 1/8 in. miniature phono jack connector and plug are supplied.

The characteristics of this type of analog output voltage are ideal for applications requiring closed loop control. The voltage signal is smooth and continuous throughout all the decades of pressure measurement. This format is useful for computerized data acquisition because a simple equation (finding the common antilogarithm) may be programmed to calculate pressure from the voltage output.

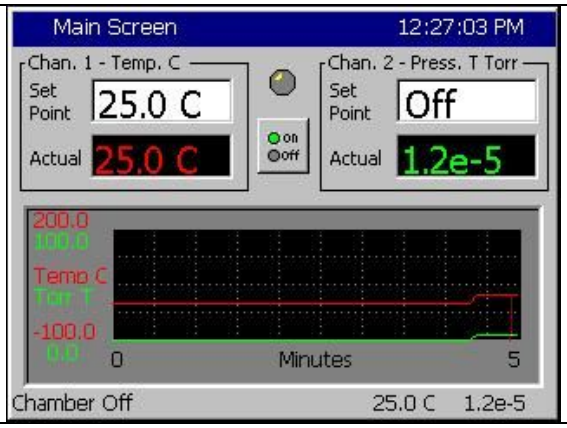
The equation is:

$$P = 10^{(V-n)}$$

Where V = analog output voltage;
n = 12 for the 10 mA emission current range;
n = 11 for the 1 mA emission current range;
n = 10 for the 0.1 mA emission current range.

For example, if emission current is set to the 1 mA range and the analog output voltage is 3.25 volts, the pressure (in units selected) may be determined by raising 10 to the power (V-11) or

$$P = 10^{(3.25-11)} = 1.8 \times 10^{-8} \text{ (Torr, for example)}$$

		Pressure is displayed on Chan. 2 in scientific notation as shown below.

6. The log file also records pressure in scientific notation in units of Torr.

7. Now that the controller is setup, confirm displayed values using the table below.

Output in Torr is 10^((Voltage*2)-n)

With n =12 and 5 volts on the Olympic board input, the controller will show 1.0e-2
With n =11 and 5 volts on the Olympic board input, the controller will show 1.0e-1
With n =10 and 5 volts on the Olympic board input, the controller will show 1.0e-0

With n =12 and 0 volts on the Olympic board input, the controller will show 1.0e-12
With n =11 and 0 volts on the Olympic board input, the controller will show 1.0e-11
With n =10 and 0 volts on the Olympic board input, the controller will show 1.0e-10

With n =12 and 2.1 volts on the Olympic board input, the controller will show 1.6e-8
With n =11 and 2.1 volts on the Olympic board input, the controller will show 1.6e-7
With n =10 and 2.1 volts on the Olympic board input, the controller will show 1.6e-6

Note: Software version 2.4.81 or higher is required for Granville Phillips features.

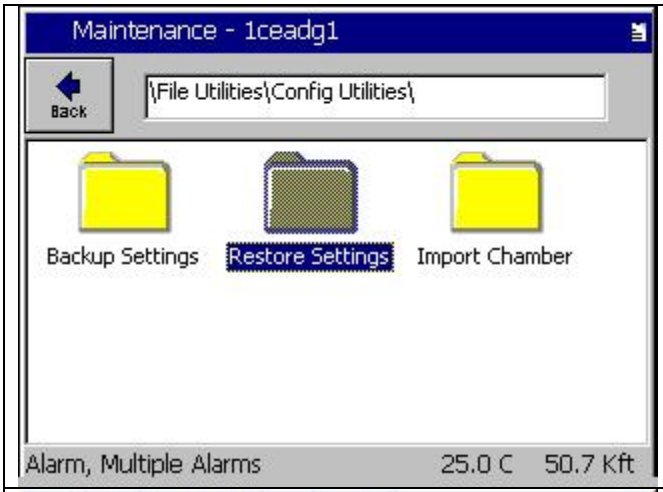
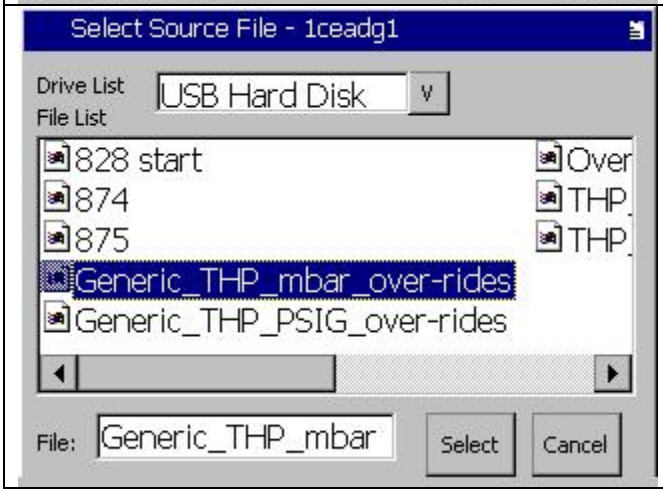
Setup for Alternative Units of Pressure

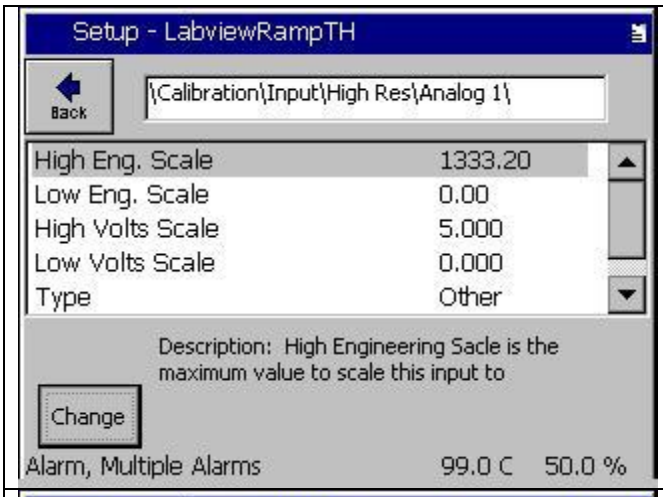
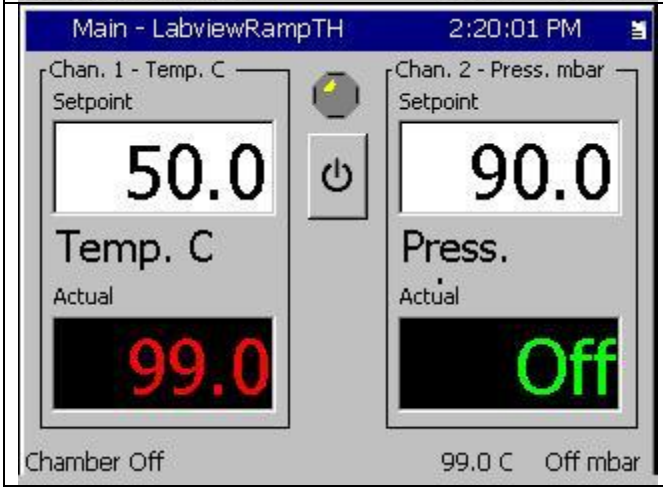
The Synergy controller family is capable of controlling virtually any environmental test chamber including a variety of altitude chambers and vacuum ovens.

The two built-in (Generic) configurations for these systems are:

1. Generic Temperature Pressure
2. Generic Temperature Humidity Pressure

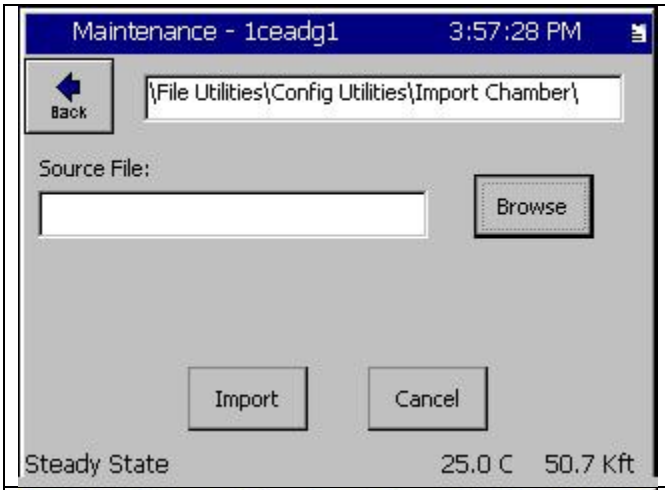
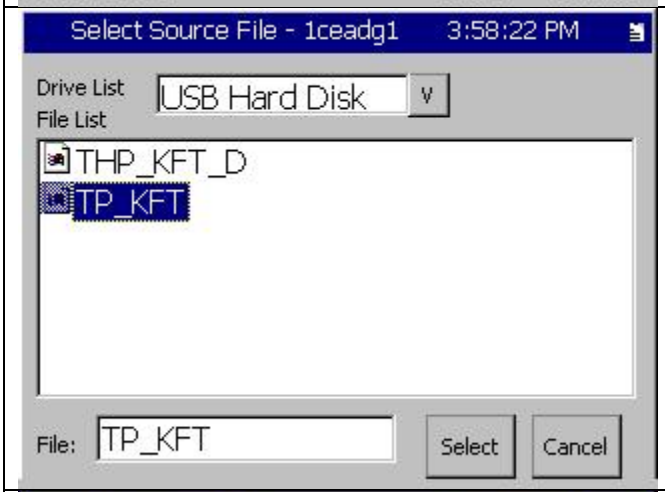
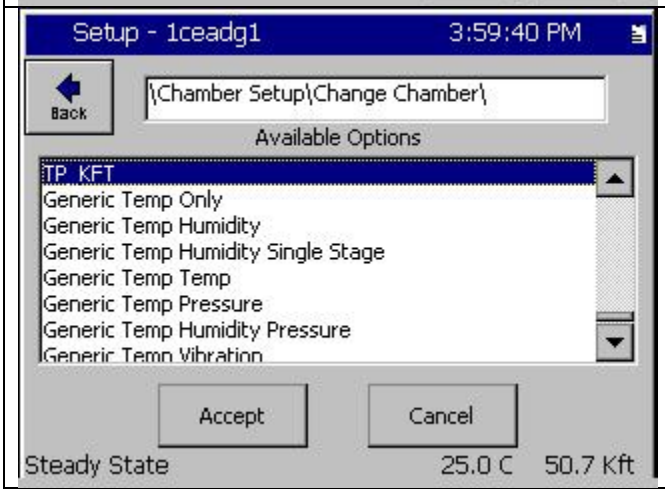
The default unit of measure for pressure for these configurations is Torr. These Generic configurations can also be setup for alternate units of measure including PSIG and mbar (millibar) using configuration files such as "Generic_THP_mbar_over-rides.CFG" which are available from the factory and are easily loaded using the \File Utilities\Config Utilities function in the Maintenance screen as shown in the steps below:

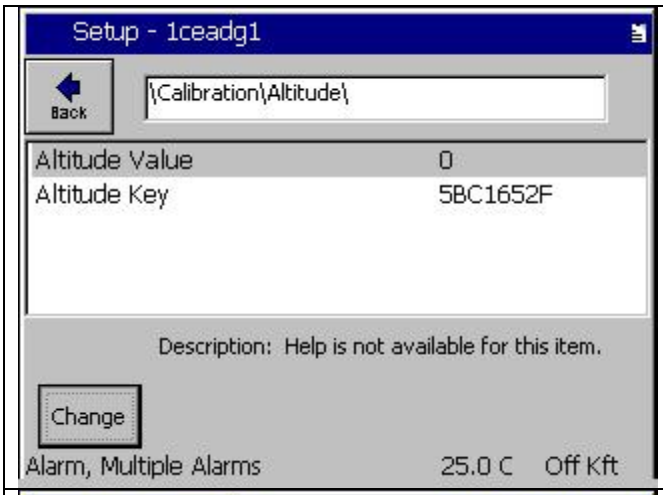
	Put the appropriate Settings File on the USB flash drive and place the drive in the controller's USB port. Then Browse to the Restore Settings folder.
	Restore the "Generic_THP_mbar_over-rides.CFG" to change the displayed units from Torr to mBar.

	Set the High Engineering scale for the appropriate Synergy Controller High Res Analog input (for the pressure transducer input) to 1333.2 in the Setup\Calibration\Input\High Res\Analog screen. 1000 Torr = 1333.22 millibars
	The Main Screen of the Synergy Controller on the left is displaying pressure in units of millibar.

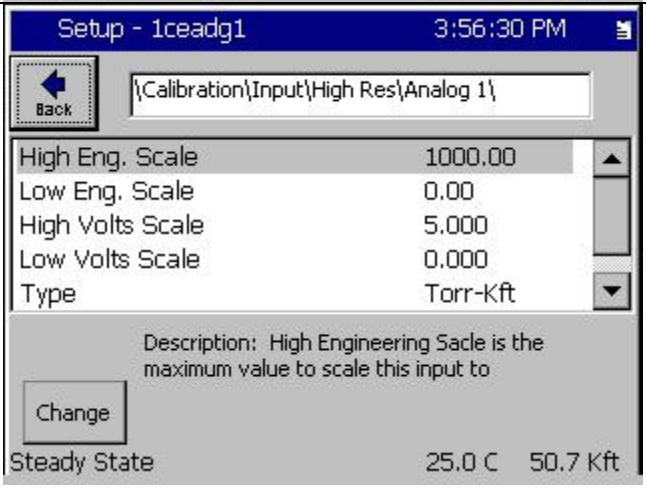
Synergy Controller Pressure control setup for KFt. Units of Measure.

In addition to displaying pressure in units of Torr, PSIG , and millibars, to display pressure in units of K feet (Kft.), you can load the THP_KFT and TP_KFT Chamber Definition Files (CDF).

	Insert the USB Flash Disk in the controllers USB port and browse to the Maintenance Screen\File Utilities Folder as shown on the left.
	Select the chamber type TP_KFT from the Chamber Setup Folder on the Setup Screen, the reboot the controller as instructed.
	Browse to the Chamber Setup Folder on the Setup Screen, select the new CDF file, and then reboot the controller as instructed.



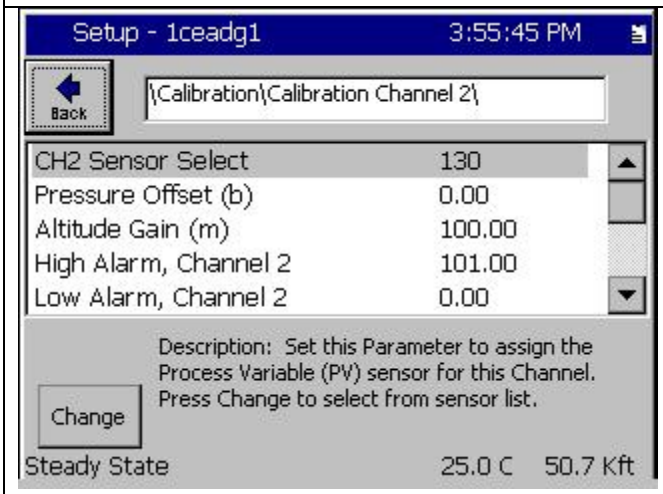
Check the Setup\Calibration\Alt folder and to make sure that the Altitude Value is set to 0. You may need to re-enter the Altitude Key (Pressure Feature Registration) value to access this screen.



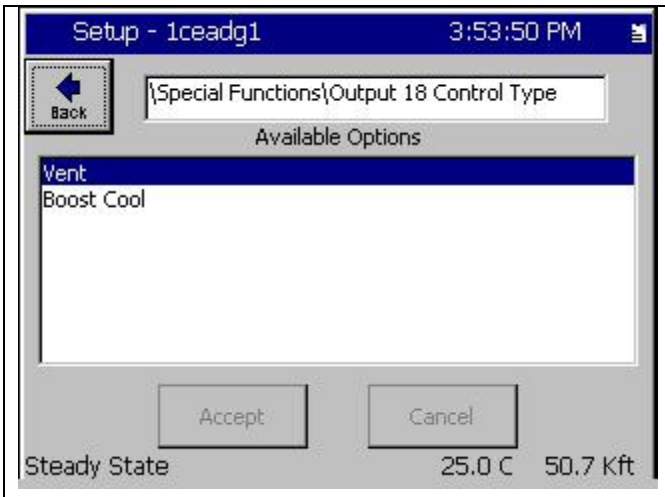
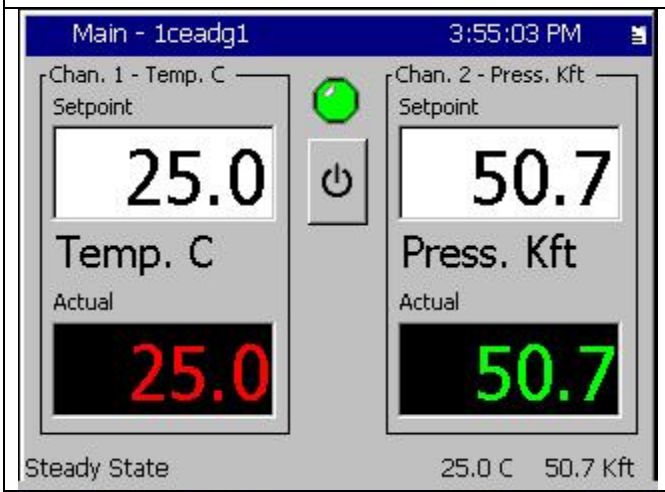
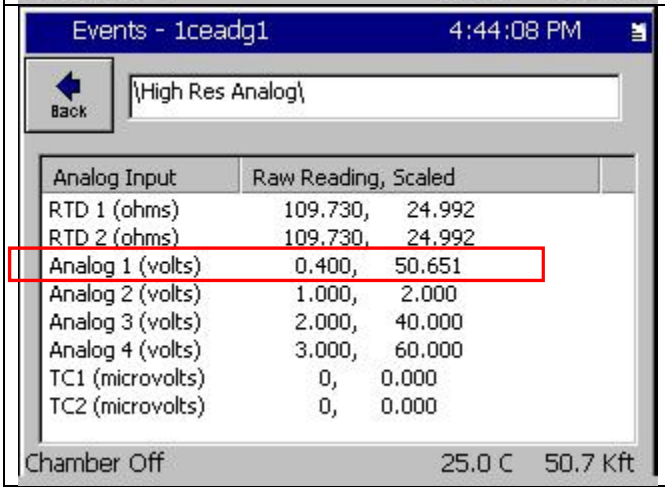
Setup the Analog Input

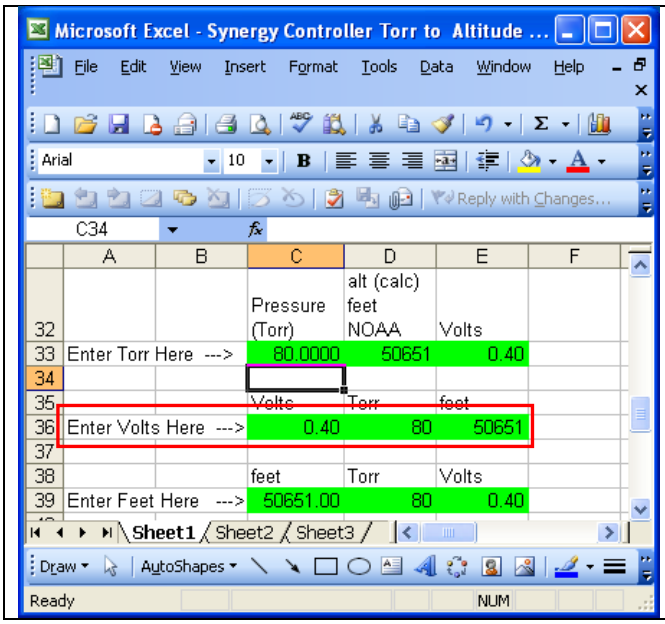
Browse to the Setup Screen and Open the Calibration\Input\High Res\Analog1\ Folder and adjust to the appropriate High Engineering and Low Engineering Scale for your transducer output in units of Torr.

Scroll to the bottom of the screen and set the Type to Torr-Kft. as shown on the left.



Setup the pressure channel as shown at the left.

	Check the Output 18 control Type,
	And finally, go to the Main screen using the Main button and verify the units of display.
	The Raw Reading for the Analog Voltage input and the scaled value in Kft. can be verified in the Events\High Res Analog folder against the spreadsheet: Synergy Controller Torr to Altitude conversion Rev B.xls



When 0.40 volts is entered, the calculated value for Torr and feet are 80 and 50561 (50.7 Kft.) as shown at the left.

Notes:

1. The convention for Synergy Controller CDF files is that THP_KFT and TP_KFT CDFs are for full sized controllers including Synergy Micro, Synergy Micro 2 , Synergy Quattro and Synergy Nano TE1858-4 (Expanded mode versions) . NANO_THP_KFT and NANO_TP_KFT are for the standard ¼ DIN Versions (the TE1858-1, TE1858-3, and TE1858-3).

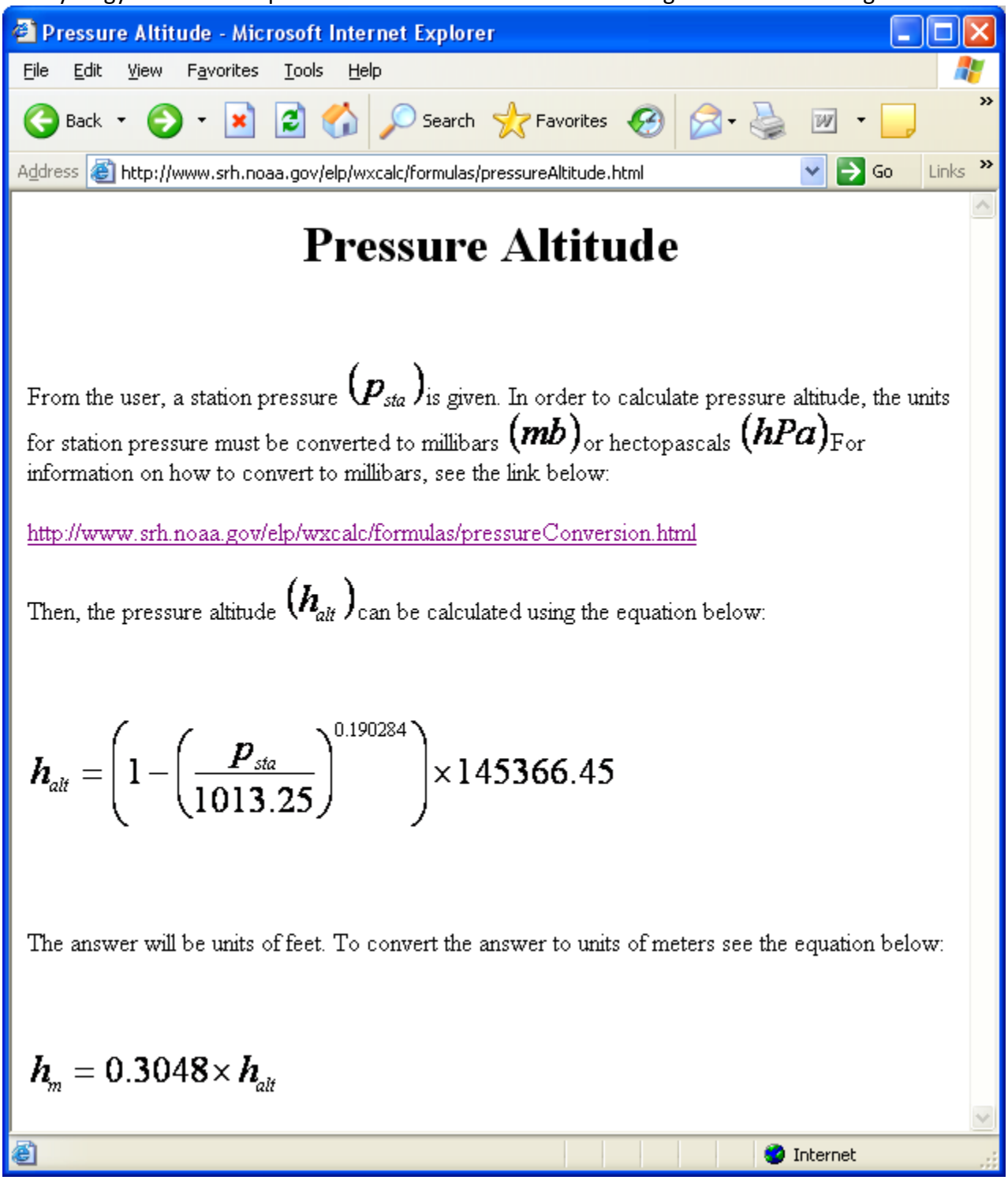
2. KFT capabilities are available on controller versions 2_8_6_Build_683 and newer. Contact the factory for information regarding upgrades.

3. Contact Tidal Engineering for the spreadsheets, CDF files, and the CFG files described in this application note.

4. Different Chamber Definition Files (CDF) are required because the Altitude/Pressure channel loop direction is inverted when we switch from Torr to KFt. because altitude is inversely related to pressure.

5. The Synergy Controller implements the Torr to Kft. conversion algorithm from noaa.gov as follows:

The Synergy Controller implements the Torr to Kft. conversion algorithm from noaa.gov follows:



Pressure Altitude

From the user, a station pressure (p_{sta}) is given. In order to calculate pressure altitude, the units for station pressure must be converted to millibars (mb) or hectopascals (hPa) For information on how to convert to millibars, see the link below:

http://www.srh.noaa.gov/elp/wxcalc/formulas/pressureConversion.html

Then, the pressure altitude (h_{alt}) can be calculated using the equation below:

$$h_{alt} = \left(1 - \left(\frac{p_{sta}}{1013.25}\right)^{0.190284}\right) \times 145366.45$$

The answer will be units of feet. To convert the answer to units of meters see the equation below:

$$h_m = 0.3048 \times h_{alt}$$

About the Synergy Controller Family

Tidal Engineering's Synergy Controllers; the ¼ DIN Synergy Nano, the Synergy Micro 2, and the Synergy Quattro provide state-of-the-art usability and connectivity for environmental test control and data acquisition. They combine the functions of a chamber controller and a data logger and are designed to improve test efficiency by supporting both factory automation and test and measurement protocols and standards.

Synergy Controller feature highlights includes:

- ➔ Color touch screen
- ➔ Ethernet, RS-232 and GPIB communications
- ➔ Built in 100 MB Data logger with USB drive support
- ➔ Data Acquisition, up to 64 T-type thermocouples (Optional)
- ➔ Built-in Web Server for remote control; WebTouch Remote ™
- ➔ Compatible with Synergy Manager for PC based control, monitoring and programming.
- ➔ Built-in FTP Server for factory automation and test and measurement applications

For more information regarding these controllers please see the full Synergy Controller Technical Manual on our website at http://www.tidaleng.com/synergy.htm

About Tidal Engineering

Headquartered in Randolph, NJ, Tidal Engineering Corporation has been designing and building award-winning embedded hardware and software for test and measurement and data acquisition applications since 1992. The company is recognized for technical expertise in such areas as Embedded IEEE 488, and turnkey SCADA (Supervisory Control and Data Acquisition) systems.

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