Model 9500 System Manual

Thunder Scientific Corporation

MODEL 9500
AUTOMATED TWO-PRESSURE
HUMIDITY GENERATOR

OPERATION AND
MAINTENANCE MANUAL

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Go to this website to register your Model 9500 Humidity Generator and download your software for FREE.

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Once you have registered your Model 9500 Humidity Generator, click the link on the same page, labeled

Click here if you need to download your FREE software.

Or go to this URL https://www.thunderscientific.com/software/

Next, click on which software type you need, and go to that page, then click the Download Now button.

After downloading your software, open the ZIP file and install your software.

This is a trusted download link form Thunder Scientific, Thank You for your purchase.

For:

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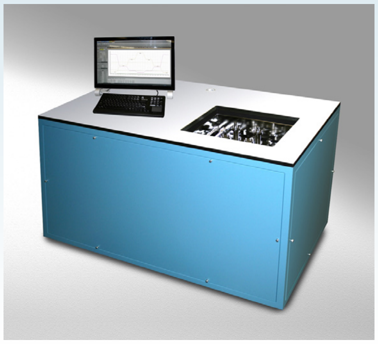
IMPORTANT CONTROLOG PASSWORD INFORMATION

User: 9500

Manager: 9500.1

Administrator: Contact Thunder Scientific Technical Support

(1-800-872-7728 or support@thunderscientific.com)



Model 9500

Humidity Generation and Calibration Equipment

THUNDER SCIENTIFIC® CORPORATION The Humidity Source

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U. S. A.

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Suomi

Tämä tuote noudattaa WEEE-direktiivin (2002/96/EY) merkintävaatimuksia. Kiinnitetty etiketti osoittaa, että tätä sähkö-/elektroniikkalaitetta ei saa hävittää kotitalousjätteissä.

Tuoteluokka: Viitaten WEEE-direktiivin liitteessä I mainittuihin laitteisiin, tämä tuote on luokiteltu luokan 9 "Tarkkailu- ja ohjauslaitteet" -tuotteeksi.

Ei saa heittää kotitalousjätteiden mukana!

Palauta tarpeettomat tuotteet ottamalla yhteyttä valmistajan websivustoon, joka mainitaan tuotteessa tai paikalliseen myyntitoimistoon tai jakelijaan.

Dansk

Dette produkt er i overensstemmelse med kravene om afmærkning i WEEE-direktivet (2002/96/EC). Det påhæftede mærkat angiver, at du ikke må bortskaffe dette elektriske/elektroniske produkt via husholdningsaffald.

Produktkategori: Med reference til kravene i WEEE-direktivets bilag I klassificeres dette produkt som et produkt til "overvågning og kontrolinstrumentering" i kategori 9.

MÂ ikke bortskaffes via husholdningsaffald!

Hvis du vil returnere uønskede produkter, skal du besøge producentens websted, som vises på produktet, eller den lokale forhandler eller distributør.

English

This product complies with the WEEE Directive (2002/96/EC) marking requirements. The affixed label indicates that you must not discard this electrical/electronic product in domestic household waste.

Product Category: With reference to the equipment types in the WEEE Directive Annex I, this product is classed as category 9 "Monitoring and Control Instrumentation" product.

Do not dispose in domestic household waste!

To return unwanted products, contact the manufacturer's web site shown on the product or your local sales office or distributor.

Français

Ce produit est conforme aux normes de marquage de la directive DEEE (2002/96/CE). La présence de cette étiquette indique que cet appareil électrique/électronique ne doit pas être mis au rebut avec les déchets ménagers.

Catégorie de EEE : Cet appareil est classé comme catégorie 9 parmi les « instruments de surveillance et de contrôle » en référence aux types d'équipements mentionnés dans l'Annexe I de la directive DEEE.

Ne pas éliminer avec les autres déchets ménagers !

Pour renvoyer les produits indésirables, contacter le site Web du fabricant mentionné sur le produit, ou son distributeur ou bureau de ventes local.

Español

Este producto cumple la Directiva WEEE (2002/96/EC) sobre requisitos de las marcas. La etiqueta que lleva pegada indica que no debe desechar este producto eléctrico o electrónico con los residuos domésticos.

Categoría del producto: con referencia a los tipos de equipo del anexo I de la Directiva WEEE, este producto está clasificado como categoría 9 de "Instrumentación de supervisión y control".

¡No lo deseche con los residuos domésticos!

Para devolver productos que no desee, póngase en contacto con el sitio Web del fabricante mostrado en el producto, o con la oficina de ventas o distribuidor local.

PN 2566073, 1/2006

Deutsch

Dieses Produkt stimmt mit den Kennzeichnungsanforderungen der WEEE-Richtlinie (2002/96/EC) überein. Das angebrachte Etikett weist darauf hin, dass dieses elektrische/elektronische Produkt nicht in Hausmüll entsorgt werden darf.

Produktkategorie: In Bezug auf die Gerätetypen in Anhang I der WEEE-Richtlinie ist dieses Produkt als Kategorie 9 "Überwachungs- und Kontrollinstrument" klassifiziert.

Nicht in Hausmüll entsorgen!

Zur Rückgabe von unerwünschten Produkten die auf dem Produkt angegebene Website des Herstellers oder die zuständige Verkaufsstelle bzw. den zuständigen Fachhändler konsultieren.

Italiano

Questo prodotto risponde ai requisiti sull'etichettatura stabiliti nella Direttiva RAEE (2002/96/CE). Il simbolo apposto indica che non si deve gettare questo prodotto elettrico o elettronico in un contenitore per rifiuti domestici.

Categoria del prodotto: con riferimento ai tipi di apparecchiature elencate nell'Allegato 1 della Direttiva RAEE, questo prodotto rientra nella categoria 9 "Strumenti di monitoraggio e di controllo".

Non gettare in un contenitore per rifiuti domestici.

Per restituire prodotti non desiderati, visitare il sito Web del produttore riportato sul prodotto o rivolgersi al distributore o all'ufficio vendite locale.

Português

Este produto está em conformidade com as exigências de rotulagem da Directiva WEEE (2002/96/EC). O rótulo afixado indica que o utilizador não deve deitar este produto eléctrico/electrónico fora juntamente com o lixo doméstico.

Categoria do produto: No que se refere aos tipos de equipamento listados no Anexo I da Directiva WEEE, este produto está classificado como produto da categoria 9, "Instrumentação de monitorização e controlo".

Não deite fora juntamente com o lixo doméstico!

Para devolver produtos indesejados, contacte o fabricante através do Website constante do produto ou contacte o seu representante de vendas ou distribuidor local.

Nederlands

Dit product voldoet aan de merktekenvereisten van de AEEA-richtlijn (2002/96/EG). Het aangebrachte merkteken duidt erop dat dit elektrische/elektronische product niet met het huishoudelijk afval mag worden afgevoerd.

Productcategorie: Met betrekking tot de apparatuurcategorieën van bijlage I van de AEEA-richtlijn, valt dit product onder categorie 9 'meet- en controle-instrumenten'.

Niet afvoeren met huishoudelijk afval!

Om ongewenste producten te retourneren, neemt u contact op met de website van de fabrikant die op het product staat vermeld, of met uw plaatselijke verkoopkantoor of distributeur.

Svenska

Denna produkt uppfyller märkningskraven enligt WEEE Directive (2002/96/EC). Märkningsetiketten anger att du inte får kassera denna elektriska/elektroniska produkt tillsammans med vanliga hushållssopor.

Produktkategori: Med hänvisning till utrustningstyperna i WEEE Directive Annex I, är denna produkt klassad som kategori 9 "Monitoring and Control Instrumentation" (Instrument för övervakning och styrning).

Får ej kasseras tillsammans med vanliga hushållssopor!

Returnera ej önskvärda produkter genom att gå till tillverkarens webbplats, vilken anges på produkten, eller till det lokala försäljningskontoret eller distributören.

Norsk

Dette produktet oppfyller bestemmelsene ifølge WEEE-direktiv (2002/96/EC) med krav til merking. Påsatt merke viser at det ikke er tillatt å kassere dette elektriske/elektroniske produktet sammen med husholdningsavfall.

Produktkategori: På grunnlag av utstyrstypene i WEEE-direktivet, vedlegg I, er dette produktet klassifisert i kategori 9, "Instrumentering for overvåking og kontroll".

Må ikke kastes sammen med husholdningsavfall!

Ved behov for returforsendelse av uønskede produkter må du gå til produsentens nettside som er angitt på produktet, eller du må kontakte det lokale salgskontoret eller den lokale forhandleren.

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2 GETTING STARTED

This section provides the user with information about the Model 9500 humidity generator, where to obtain technical support, software license agreement, specifications, uncertainty, facility requirements, and installation. The following sections provide further details on using and operating the Model 9500 generator using the ControLog software.

Note - *All pressures are absolute unless noted otherwise.*

2.1 ABOUT

The Thunder Scientific Model 9500 Humidity Generator produces known humidity values using the fundamental, NIST proven, “two-pressure” principle. The Model 9500 uses this fundamental “two-pressure” principle to continuously supply a known relative humidity, dew point, frost point, parts per million, or other calculated value for instrument calibration and evaluation and precision environmental testing.

The Model 9500 humidity generator encompasses a high-performance stand-alone Data Acquisition Computer that performs all humidity generation and control functions and a second dedicated Human Machine Interface (HMI) computer that runs ControLog. ControLog is a software application that fully automates the operation of the Model 9500 humidity generator and allows various device connections through several different interfaces. Data from the generator and connected device or devices is automatically retrieved and stored for viewing in either numerical or graphical format in real-time or post-process. Data can transfer off the system via a USB drive for further viewing, post-processing, and printing. The ControLog software also provides the primary interface to the operator via the multi-point touch display and keyboard.

Key features of the ControLog software are:

- The ControLog software stores recorded data into individual data sheets (tab). Each data sheet contains a spreadsheet-type view consisting of a date/time stamp and the measured data items corresponding to that date/time stamp. Data sheets consist of three similar but different types: Device Data, File Data, and Data Summary. Each type has the same spreadsheet view and operation, but all three have different data sources.
- Graphing is a powerful tool for viewing recorded data or monitoring current data in real-time. The graph works hand in hand with the data sheets. While the generator is operating, data sheets store the most recent data points from the generator and connected devices at the desired interval. A graph then creates a visual picture of this stored data.
- The Auto Profiling feature is very similar to the Generate mode, with the main exception that profiling relies on a predefined list of setpoints referred to as a profile. The user-configurable profile is ControLog's road map during Auto Profile operation. It defines each setpoint, what rate to go from one setpoint to another, and how long to stay at a specific setpoint before moving to the next setpoint.
- ControLog supports a customizable interface that works with most devices. ControLog allows the user to create a new device connection using the “Connection Wizard” or open previously saved connections. The wizard opens a separate dialog window containing various steps that guide the user in defining the communication required to receive the desired data items from the

device. The user can create as many (up to 60) or as few data items as they see fit for any device. Each data item can be uniquely named and, once connected, recorded in its own data sheet. ControLog also allows the user to save these interfaces for future use.

2.2 Notice

The specifications listed and the information contained in this document are subject to change without notice. Screen shots in this document may differ slightly from the actual product or might be from a similar product and are only to show the functionality of the examples, procedures, and program. Thunder Scientific Corporation makes no warranties, express or implied, regarding the examples, procedures, and programs or the fitness of these examples, procedures, or programs for a particular purpose. The examples, procedures, and programs are made available solely on an “as is” basis, and the entire risk of their quality and performance rests with the user. Thunder Scientific Corporation shall not be liable for any incidental or consequential damages in connection with or arising from the furnishing, use, or performance of the examples, procedures, or program.

2.3 Safety Information

Important safety guidelines need observing when operating this equipment. Precautions are highly advisable so that no personal injury occurs during the operation and maintenance of the system. Observation of local and national regulations must be adhered to regarding safety standards.

2.3.1 Live Power Source

Warning! Ensure all power sources are off before making internal adjustments or replacing any components. Only authorized technicians should perform any maintenance or repairs to equipment.

2.3.2 Electrostatic Discharge

Caution! Electrostatic discharge (ESD) could damage or destroy solid-state parts when exposed to static electric discharges. Be aware because electrostatic discharges may not be seen, felt, or heard at levels less than 4,000 volts.

2.3.3 Compressed Gas

Compressed gas is used in this system and, if not adequately vented, may create an environment where the state of foreign matter is propelled. Proper safety precautions must be followed when applying any pressure to the system. Before applying any pressure to the system, ensure that all pneumatic connections are properly secured and tightened. Ensure all pressure settings are set to the proper specifications before operating, testing, calibrating, or maintaining.

2.3.4 Personal Protective Equipment

Safety glasses must be worn when performing any maintenance, repairs, or calibration when system panels have been removed. Gloves may be needed for some maintenance or repairs.

2.3.5 Safety Symbols

Symbols used in this manual for safety and other disciplines can be found in table 1-1.

Safety terminology used for identification of any safety conditions are as follows:

Warning indicates a potential hazard, and the user should be cautious.

Caution! Identifies a condition or action that may cause damage to the system or the user.

Symbol	Description
	The equipment has this symbol displayed and indicates that the equipment meets the requirements of the European safety directives.
	This symbol is shown from the WEEE directive and indicates do not dispose of this product in any municipal waste area.
	This symbol means Caution should be observed or important information.
	This symbol indicates a potential shock hazard may exist.
	This symbol means Earth Ground.

Table 1-1

2.4 TECHNICAL SUPPORT

If the user requires assistance with any aspect of the 9500 Humidity Generating System or the ControLog application, technical support can be obtained by contacting Thunder Scientific Corporation by any of the following means:

Web: www.thunderscientific.com

Email: support@thunderscientific.com

Tel : 1-505-265-8701

FAX : 1-505-266-6203

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2.9 SPECIFICATIONS

Relative Humidity Range (Test Chamber @ 14.7 psiA).. 5 to 98 %RH
Dew Point Temperature Range (Test Chamber @ 14.7 psiA) .... -35 to 70 °C
Frost Point Temperature Range (Test Chamber @ 14.7 psiA) .... -32 to 0 °C

Bath Temperature Range[1] .... 0 to 72 °C
Bath Temperature Control Stability[2] .... 0.002 °C
Bath Temperature Heating Rate from 0 to 72 °C.. 0.5 °C per Minute (average)
Bath Temperature Cooling Rate from 72 to 0 °C .... 0.5 °C per Minute (average)

Chamber Temperature Uniformity:[3].. 0.008 °C

Gas Type .... Air
Gas Pressure Rating (MAWP)..350 psiG
Gas Flow Rate Range.. 10 to 100 L/min
Gas Flow Rate Specification ....±2% of full scale

Supply Pressure Specification: ....±1.25 psiG

Saturation Pressure - Low Range ....Ambient to 45 psiA
Saturation Pressure - High Range ....>45 to 325 psiA
Test Chamber Pressure Range ....Ambient to 15 psiA

Display Resolution.. 0.001

Test Chamber Dimensions .... 12” x 12” x 12” (304.8 mm x 304.8 mm x 304.8 mm)
Physical Dimensions..............................38.25” H x 60” W x 36” D (971.6 mm x 1524.0 mm x 914.4 mm)

[1] Using glycol/water as the temperature bath heat transfer fluid from 0 to 5 °C and water as the temperature bath heat transfer fluid from 5 °C to 72 °C.

[2] Temperature Control Stability is defined as the maximum deviation from a best fit line, as measured by the bath fluid temperature control sensor. If data is logged digitally, the best fit line will be defined as the average value over the 10-minute period. All measurements made with an insulated cover in place over bath.

[3] Chamber Temperature Uniformity is defined as the maximum temperature difference between any two locations over the temperature range of 0 °C to 72 °C when using a thermal insulator over the bath, such as hallow bath balls. Locations are defined at the center of the chamber lid access ports, approximately 5" into the chamber.

2.10 UNCERTAINTY [4] [5] [6]

Relative Humidity:
5 to 98 %RH, 10 to 100 L/min .... 0.17% * R + 0.016

*Example 1: If the %RH reading is 50 %RH. The uncertainty would then be: 0.17% * 50 + 0.016 = 0.101*
*Example 2: If the %RH reading is 10 %RH. The uncertainty would then be: 0.17% * 10 + 0.016 = 0.033*

Dew Point:
-27 °C to +70 °C Dew Point *(Ps <= 140 psiA)*, 10 to 100 L/min .... 0.03 °C
-35 °C to < -27 °C Dew Point *(Ps > 140 psiA)*, 10 to 100 L/min.. 0.05 °C

Frost Point:
-22 to 0.01 °C Frost Point *(Ps <= 100 psiA)*, 10 to 100 L/min.. 0.03 °C
-32 to < -22 °C Frost Point, *(Ps > 100 psiA)*, 10 to 100 L/min .... 0.05 °C

Temperature[7]:
0 to 72 °C.. 0.015 °C

Test Chamber Pressure:
Ambient to 15 psiA .... 0.0021 psiA

Low-Range Saturation Pressure:
Ambient to 45 psiA .... 0.0042 psiA

High-Range Saturation Pressure:
>45 to 325 psiA .... 0.03 psiA

[4] Refer to "Model_9500_Uncertainty_Analysis_Rev3.2.pdf" for more information.
[5] Uncertainty is not specified at flow rates below 10 slpm and above 100 slpm.
[6] Uncertainty values represent an expanded uncertainty using a coverage factor, k=2, at an approximate level of confidence of 95%.
[7] Includes saturation temperature, chamber temperature, bath fluid temperature, pre-saturator temperature, and exp-valve temperature.

2.11 Facility Requirements

2.11.1 Environment

Operating Temperature: .... 15 to 30 °C

Storage Temperature: .... 0 to 50 °C

Humidity: .... 5 to 95% RH Non-condensing

2.11.2 Floor Space

An area of five feet by ten feet is recommended. This area allows two feet of access to the sides and rear console panels.

Refer to drawing: 9500D901-2,

Note – *of the two feet of access to the rear of the generator, 29"x16" of the floor space can be used for the air booster system.*

2.11.3 Power

Electrical Power required is 208-240 VAC, 60 Hz, 3 phase, 20 Amp, 4 wire service.

2.11.4 Air Supply

Instrument quality air with a maximum pressure of 350 psiG (minimum pressure of 325 psiG to generate 5 %RH @ 0 °C and 15 psiA Pc). A flow rate capability of 100 L/min and a pressure dew point of 2 °C or less are recommended.

The 9500 can support two supply pressure inputs when an air booster system is required to achieve high pressure. The low range supply is directly connected to the facility air supply (<325 psiG), and the high range supply is connected to an air booster to achieve the higher supply pressures (325 psiG). This two-supply input feature helps limit the operation of the air booster as the system usually operates on the low supply pressure input and switches to the high supply pressure input (air booster) when required (running low %RH).

The system automatically switches to the high supply pressure input whenever the required saturation pressure setpoint exceeds the low supply reading minus 5 psi. This pressure switch is done immediately upon a setpoint change to minimize any disturbance caused by switching supply inputs while the system transitions to the new setpoint. The system switches back to the low supply pressure input once the saturation pressure setpoint and actual saturation pressure have fallen outside a 10-psi window from the initial switch point.

For example, if the user has 100 psi on the low supply input and 325 psi on the high supply input. The system switches from the low to the high input as soon as the user enters a humidity setpoint that requires pressures above 95 psi (100 – 5), such as low %RH (< 15%RH). The system switches back from high to low input once the required saturation pressure setpoint and actual saturation pressure have fallen below 85 psi (95 – 10).

Note – *The internal 9500 regulator must be set to regulate the high range pressure. The low-range supply pressure input <u>must be externally regulated</u> before entering the 9500.*

Refer to section 2.12.10 Setting Supply Pressure Regulator, for detailed instructions on how to set the supply pressure regulator and how to configure the system based on the connected supply inputs.

2.11.4.1 Air Booster

The Model 9500 can be supplied with an air booster system to amplify the input supply pressure when the user's facility air does not meet the 325 psiG required for low humidity generation. Refer to the air booster system documentation for more information on the air booster system's installation, operation, and maintenance.

2.11.5 Cooling Water Supply

Cooling water at the console inlet shall be a minimum of two gallons per minute, at approximately 21 °C, with a minimum pressure of 35 psiG and a maximum pressure of 150 psiG. The cooling water outlet shall be connected to a wastewater drain or closed-loop system cooling return. The outlet pressure of a closed system is not to exceed 50 psiG.

Note – *Cooling water temperatures below ambient DP must be avoided to eliminate condensation on condenser piping.*

2.11.6 Distilled Water Supply

A gravity or pressure feed (25 psiG maximum pressure) distilled water supply, at a flow rate of 1/2 gallon per minute minimum, is recommended.

2.11.7 Wastewater Drain

A floor-type wastewater drain for draining bath fluid during maintenance is recommended.

2.11.8 Propylene Glycol

The appropriate amount of propylene glycol (approximately 5 gallons of 70% propylene glycol) must be added to the temperature bath fluid if the system is to be operated below 5 °C. Check bath fluid protection level using a glycol refractometer for a temperature minimum of -10 °C

2.12 Installation

2.12.1 Uncrating

Before uncrating, carefully inspect the crate and skid to be sure the unit was not subjected to damage. If there is damage, proceed no further and notify your inspection department and the shipping agent.

If the crate appears satisfactory:

1. Remove steel strapping.
2. Using a “Clip Removal Tool” or thin pry-bar, remove the top cover clips, then remove the top panel.
3. One panel at a time, remove the panel clips, then remove the panel.
4. Remove polyethylene covering from the unit.
5. Inspect for any visible damage.
6. Remove all accessory boxes and hoses located under the equipment and on the countertop before approaching the equipment with a forklift.
7. Using a forklift or another suitable lifting device, lift the unit from the skid and place it on the floor.

CAUTION!

BEFORE APPROACHING THE EQUIPMENT WITH THE FORKLIFT, VISUALLY LOCATE ANY HARDWARE WHICH MIGHT PROJECT INTO THE PATH OF THE FORKS. PLACE FORKS AS WIDE AS POSSIBLE TO AVOID DAMAGE TO THE FRAME.

8. The unit may now be rolled to its point of installation.

2.12.2 Positioning

1. Position the system to allow access to all sides of the console. Actuate wheel brakes to prevent console movement.
2. Remove all cover panels and inspect for any visible damage that might have occurred during shipment.
3. If the floor is uneven or not level, install leveling legs and raise the wheels off the floor to hold the system stationary. Level the system using the countertop as a reference. Tighten the leveling leg locking nuts against the frame.

2.12.3 Touch Panel PC (HMI)

1. Unbox the touch panel PC, desktop stands, keyboard, MOXA UPort USB-to-serial converter, USB hub, etc., from the shipping boxes.
2. Install desktop stands on the touch panel PC, then set the touch panel PC on the countertop of the generator near the left edge and away from the bath opening.
3. Remove the left side console panel. Locate and insert the DC power plug and RS232 serial cable through the countertop opening.
4. Install the DC power plug into the back of the touch panel PC.
5. Install RS232 serial cable to the COM1 connector on the back of the touch panel PC.
6. Place and then plug the USB keyboard into one of the USB 2 slots (not blue) on the back of the touch panel PC.

7. Place and then plug in the MOXA UPort USB-to-serial converter to one of the USB 3 slots (blue) on the back of the touch panel PC.
8. Plug the USB hub into one of the USB 3 slots (blue) on the back of the touch panel PC.

CAUTION!

ALWAYS PROPERLY SHUTDOWN THE TOUCH PANEL PC BEFORE
SWITCHING OFF THE MAIN POWER.

2.12.4 Facility Connections

Refer to drawing: 9500D901-4

2.12.4.1 Air/Gas Supply

1. If your facility air can meet the required supply pressure without the use of a booster:
   a. Connect your single high-pressure (facility) to “AIR IN HIGH PRESS” fitting (3/8” FNPT) with a line sized equal to or larger than the 3/8” tubing on the system.
   b. Leave the “AIR IN LOW PRESS” unconnected.
2. If your facility air can’t meet the required supply pressure and requires an air booster:
   a. Connect your low-pressure gas supply (facility) to the “AIR IN LOW PRESS” fitting (3/8” FNPT) with a line sized equal to or larger than the 3/8” tubing on the system.
   b. Connect the high-pressure gas supply (air booster) to the “AIR IN HIGH PRESS” fitting (3/8” FNPT) with a line sized equal to or larger than the 3/8” tubing on the system.
3. If needed, connect a 3/4” tube (Tygon or plastic is sufficient) to “AIR OUT” and run this line to an area where a possible high humidity discharge will not harm. If installed, this line must be sloping downward from the console due to possible condensation and should be as short as possible (use larger tubing for long runs).

CAUTION!

DO NOT RESTRICT OR BACK-PRESSURE GAS SUPPLY OUTLET.

Refer to section 2.11.4 Air Supply for gas requirements.

2.12.4.2 Cooling Water

1. Connect the cooling water supply line to the “WATER IN” fitting (1/2” FNPT) on the system.
2. Connect the “WATER OUT” fitting (1/2” FNPT) to the closed cooling system return or wastewater drain.

Refer to section 2.11.5 Cooling Water Supply for cooling water requirements.

2.12.4.3 Distilled Water

1. Connect a distilled water supply (do not use deionized water) to the “DISTILLED WATER IN” fitting (1/2” VCO Face Seal) located in the center rear of the countertop. This distilled water supply may be gravity fed via a funnel or a 5-gallon/20-liter bottle placed on the countertop. The distilled water supply can also be connected to a pressurized distilled water system. Initial fill upon installation requires approximately 32 gallons.

Refer to section 2.11.6 Distilled Water Supply for distilled water requirements.

2.12.4.4 Wastewater Drain

1. If a closed-loop cooling system is not used, connect the “WATER OUT” fitting (1/2” FNPT) to a wastewater drain.
2. Connect a garden hose or plastic tube to the “BATH DRAIN” fitting (hose bib fitting or 1/2” FNPT located under bath) to an open wastewater drain or water container. Connect a hose or plastic tube to the “HEATER/PUMP DRAIN” fitting (1/4” FNPT located under the insulated heater housing) to an open wastewater drain or water container. These connections are only required when the bath is emptied of water.
3. Connect a 3/8” hose or plastic tube to the “SAT/RES OPEN DRAINS” fitting (1/4” FNPT) to an open wastewater drain or open wastewater container. This connection is only required when or if the Reservoir and/or Pre-Sat is emptied of distilled water.

Refer to section 2.11.7 Wastewater Drain for wastewater requirements.

2.12.4.5 AC Power

1. Connect the power cable to a source of 208-240 VAC, 60 Hz, 3 phase, 20 Amp, 4 wire service (in accordance with the specifications on the identification label on the rear of the system).

Refer to section 2.11.3 Power for power requirements.

2.12.4.6 Pump Rotation Test

Refer to section 5.5 Pump Rotation Test, for detailed instructions on how to perform the pump rotation test.

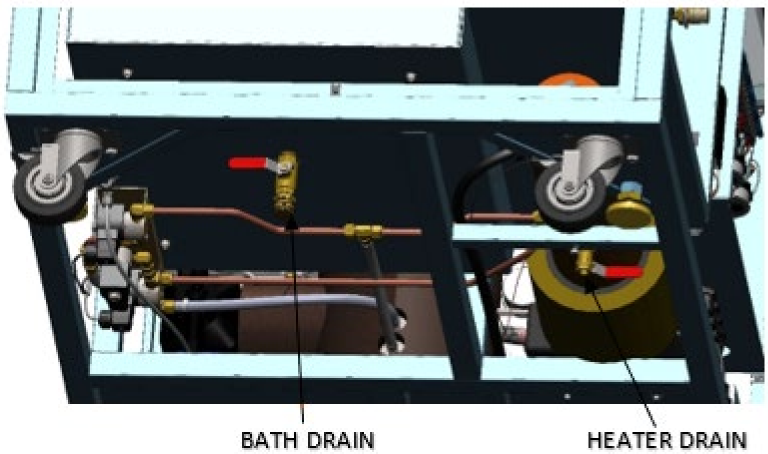
IMPORTANT!

THIS PROCEDURE MUST BE PERFORMED UPON INSTALLATION TO ENSURE THE BATH FLUID PUMP ROTATES IN THE PROPER DIRECTION. DO NOT OPERATE THE SYSTEM UNTIL THIS PROCEDURE HAS BEEN PERFORMED.

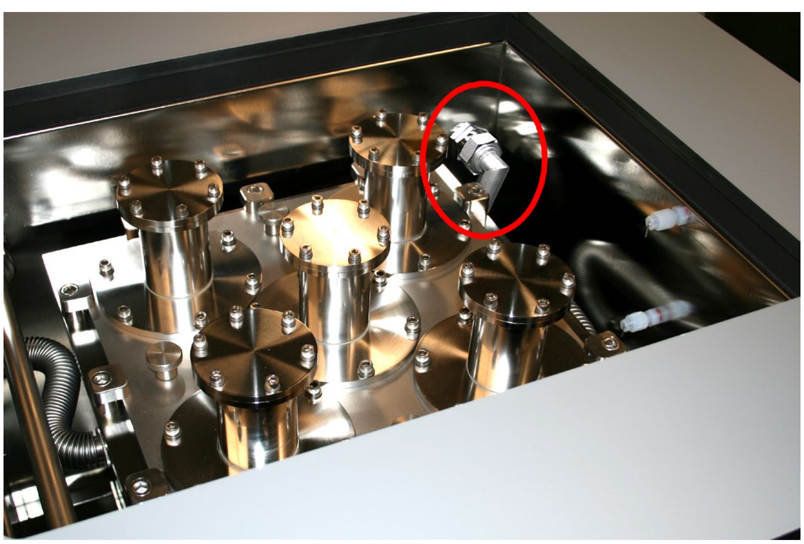
2.12.5 Temperature Bath Filling Procedure

The Model 9500 humidity generator temperature bath requires approximately 20 gallons of distilled water (do not use deionized water) as a heat transfer fluid for normal operating temperatures between 5 °C and 70 °C. For temperatures below 5 °C, the appropriate amount of propylene glycol must be added.

1. Be sure the chamber lid is in place and secure.
2. Remove rear and right-side access panels. Check drain valve (located under-insulated heater housing), ensuring valve handle is in the closed (horizontal) position. Check that the drain valve under the bath is in the closed (horizontal) position.



3. Remove the right bath inlet tube (short elbow located in the upper right rear of the bath) using the wrench provided (Note: O-rings are glued to the inlet tube connection glands).



4. Fill the bath until the water level reaches approximately 1/4” above the right bath inlet tube connection gland.

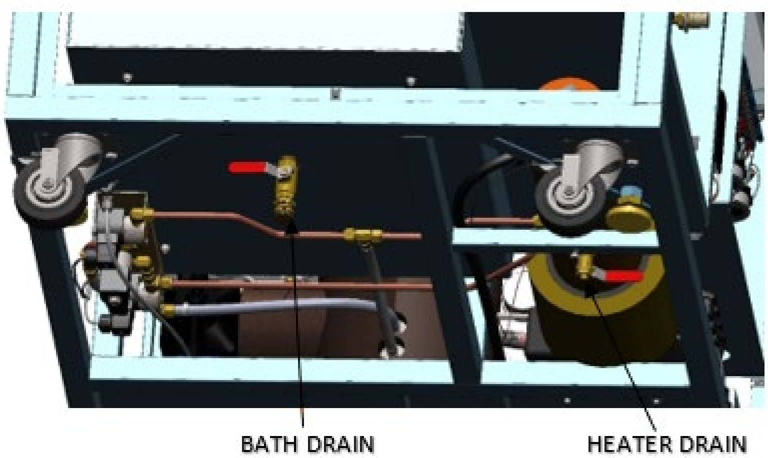
5. Once bubbles are not observed from the right bath inlet tube connection gland, replace the right bath inlet tube using the provided wrench. **Be sure the bath inlet tube is in place before performing step 8.**
6. With main electric service applied, press main system “POWER” switch to ON.
7. Allow the touch panel PC to boot and ControLog to connect to the generator.
8. Perform a Pump Rotation Test (**ensure the bath inlet tube is in place**). The pump rotation test activates the circulation pump and purges air from the pumping system. This step must be done three or four times until the air is purged.

   Refer to section 5.5 Pump Rotation Test, for detailed instructions on how to perform the pump rotation test.

9. Add distilled water until the level again reaches approximately 1/4” below the chamber lid flange.
10. Turn off the system from the File menu, and switch the main system “POWER” to OFF.

2.12.6 Temperature Bath Draining Procedure

1. Locate the bath water drain valve under the bath and connect a drain hose.
2. Open the valve and drain into a wastewater drain.
3. Close the valve and disconnect the drain hose.
4. Locate bath heater housing drain valve and connect a drain hose.
5. Open the valve and drain heater housing.
6. Close the valve and disconnect the drain hose.



Note – *If propylene glycol has been added to the bath water, then the bath water can be saved into an appropriate container.*

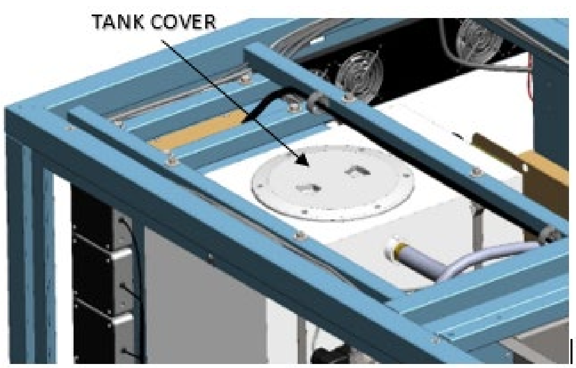
2.12.7 Holding Tank Initial Filling Procedure

The bath holding tank requires an initial filling prior to first use, then periodic filling after that.

Refer to section 5.3.1 Fill Holding Tank for detailed instructions on filling the bath holding tank.

2.12.8 Holding Tank Draining Procedure

1. Remove all console panels.
2. Remove countertop.
3. Remove the holding tank cover.
4. Drain by siphoning water from the tank.
5. Replace cover.



2.12.9 Reservoir Initial Filling Procedure

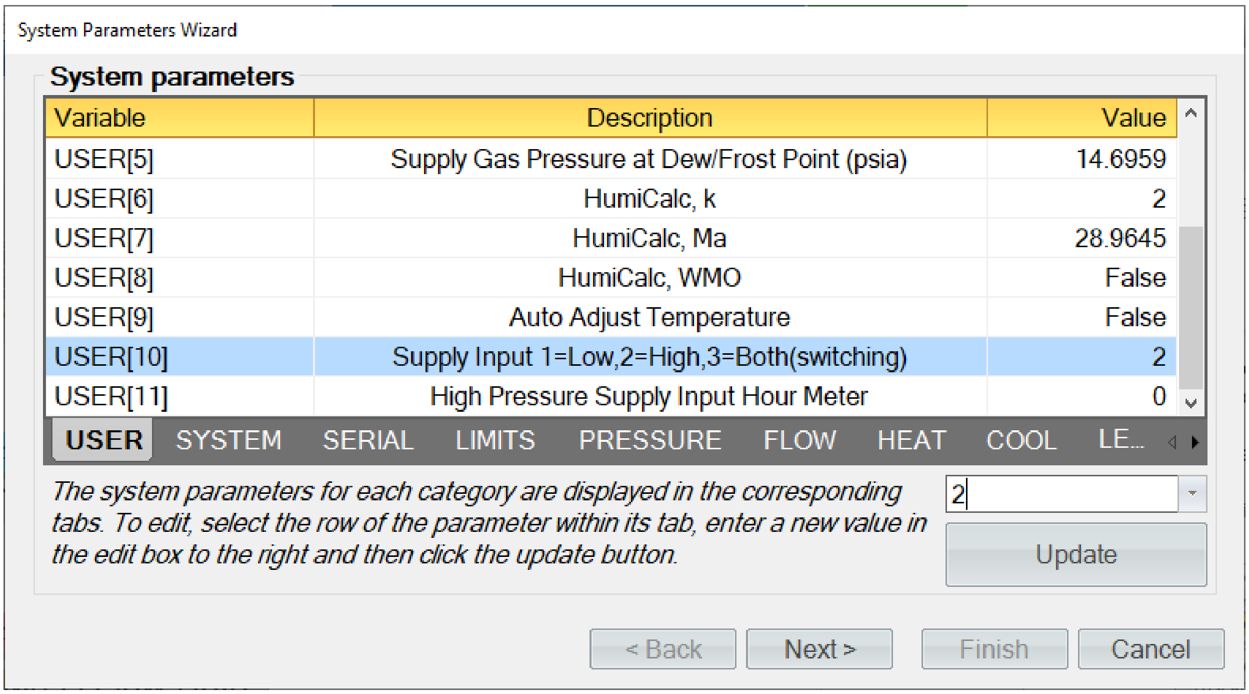
The reservoir requires an initial filling prior to first use, then periodic filling after that.

Refer to section 5.1.1 Fill Water Reservoir for detailed instructions on filling the reservoir.

2.12.10 Setting Supply Pressure Regulator

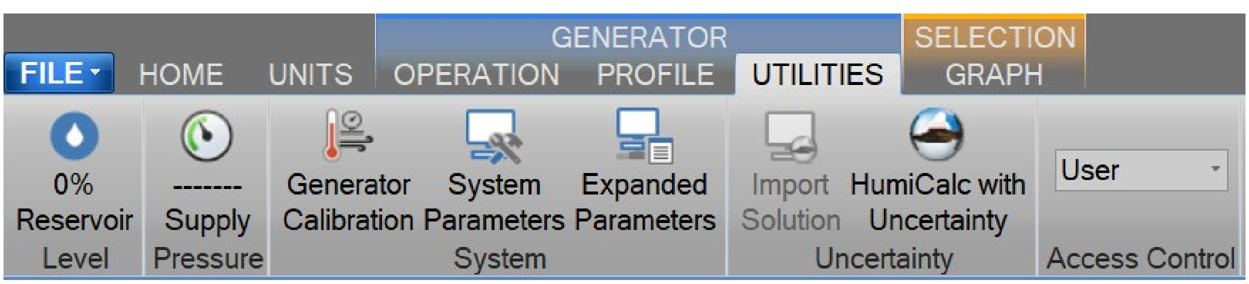
The supply pressure must be regulated to assure proper control and operation. The goal of the regulation is to remove the spikes that occur during air supply generation.

The Model 9500 humidity generator can be configured to operate on the low-pressure input, high-pressure input, or both. With the system shutdown, press System Parameters under the Utilities tab to open the system parameters wizard dialog. Select the USER tab and scroll to the bottom. Change the supply input to 1 to use only the low supply input. Change the supply input to 2 to use only the high supply input (default). Change the supply input to 3 if you want the system to switch between the low and high supply input.



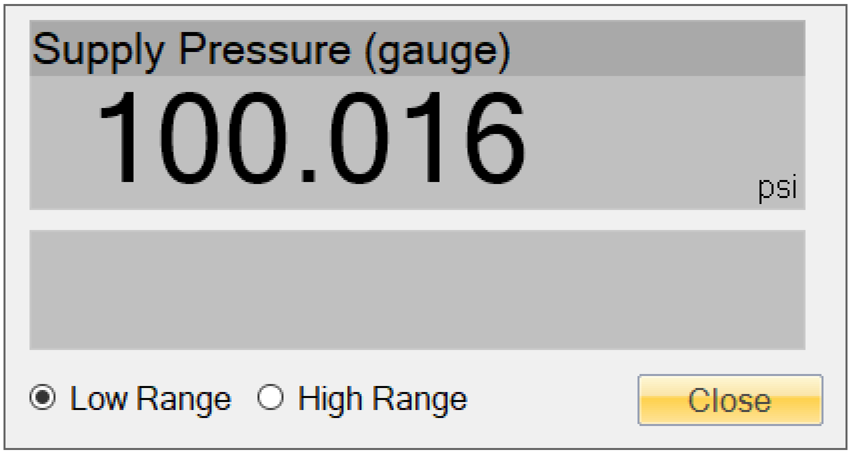
Adjust the internal regulator to 325 psiG when the system is configured to use the high supply input or both the low and high supply input. If using both supply inputs, ensure you regulate the low range using your external pressure regulator, as the internal regulator must be set for the high supply pressure input.

Low Range: With the system shutdown, press Supply Pressure under the Utilities tab to open the supply pressure dialog.

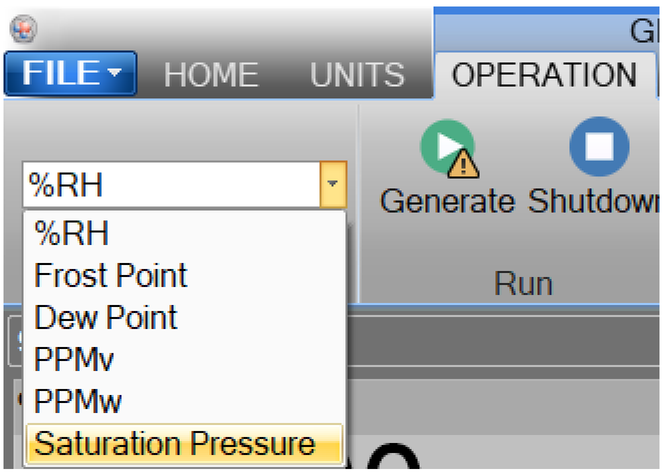


Note –*The low-range supply pressure input* ***must be externally regulated*** *before entering the 9500.*

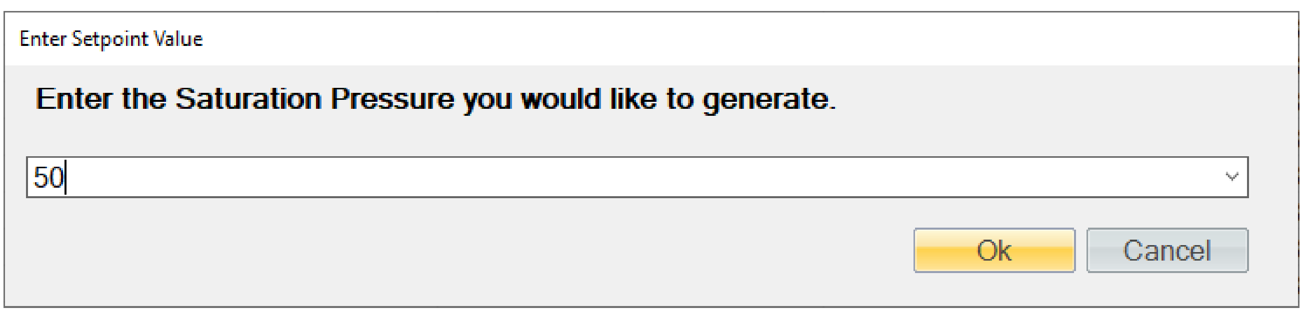
Select the Low Range option button at the bottom of the dialog to view the current low range pressure.



If a regulator adjustment is needed, select Saturation Pressure as the Mode under the Operation tab.

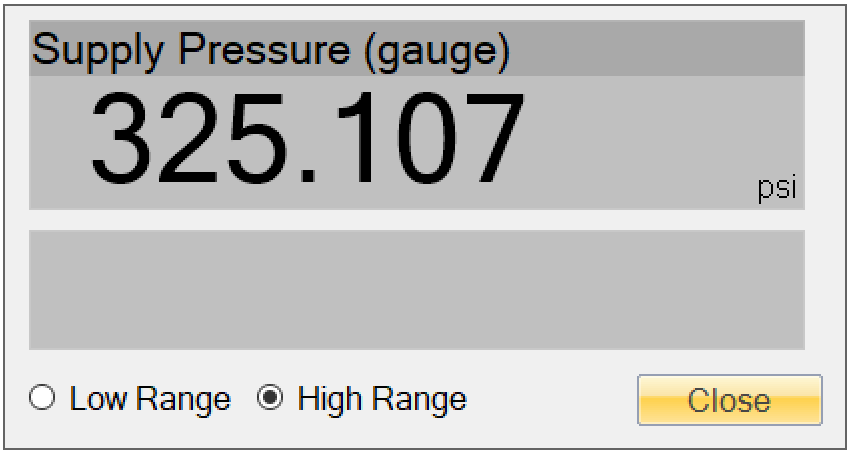


Set the Saturation Pressure setpoint to a pressure below the low supply pressure input. For example, if you have 100 psi on the low supply input, enter something below 100 psi (we use 50 in this example).

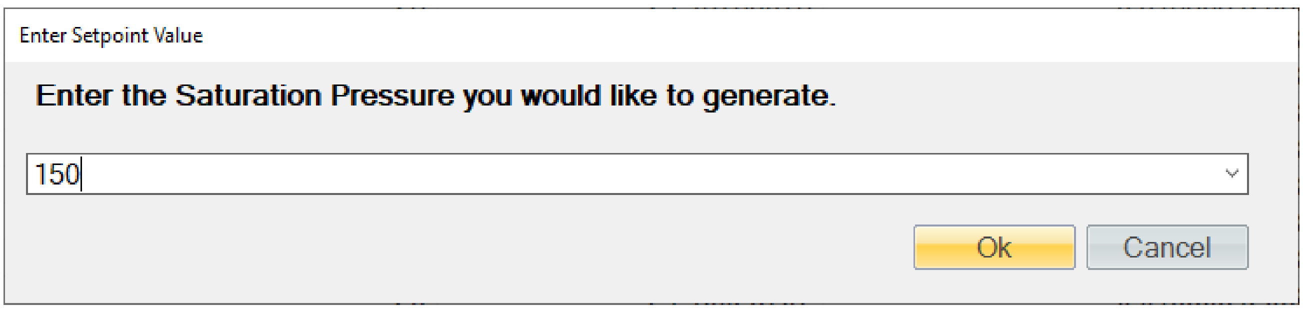


Select Generate from the Operation tab and wait for the system to start and flow and pressure to come to setpoint. While monitoring the supply pressure dialog window, adjust the external regulator. Once complete select Shutdown from the Operation tab to shutdown the system.

High Range: With the system shutdown, open the supply pressure dialog. Select the High Range option button at the bottom of the dialog to view the current high range pressure.



If a regulator adjustment is needed, remove the left-side access panel. With Saturation Pressure still set as the Mode under the Operation tab, set the Saturation Pressure setpoint to 150 psi.



Select Generate from the Operation tab and wait for the system to start and flow and pressure to come to setpoint. Once 150 psi saturation pressure is reached, rotate the regulators handle clockwise to increase pressure and counterclockwise to decrease pressure. While monitoring the supply pressure dialog window, adjust the internal regulator until the supply pressure reads 325 psiG. **Warning! Never exceed 350 psiG.** Once complete select Shutdown from the Operation tab to shutdown the system.

Refer to drawings: 9500D901-1, 9500D901-3, 9500D901-8

2.13 Quick Start

This section provides the user with a quick start on operating the generator. For detailed information on operating the generator, please refer to section 4 ControLog Interface.

CAUTION!

DO NOT OPERATE THE GENERATOR WITHOUT TEMPERATURE BATH FLUID.

2.13.1 Power-Up

To Power-Up the generator, perform the following steps:

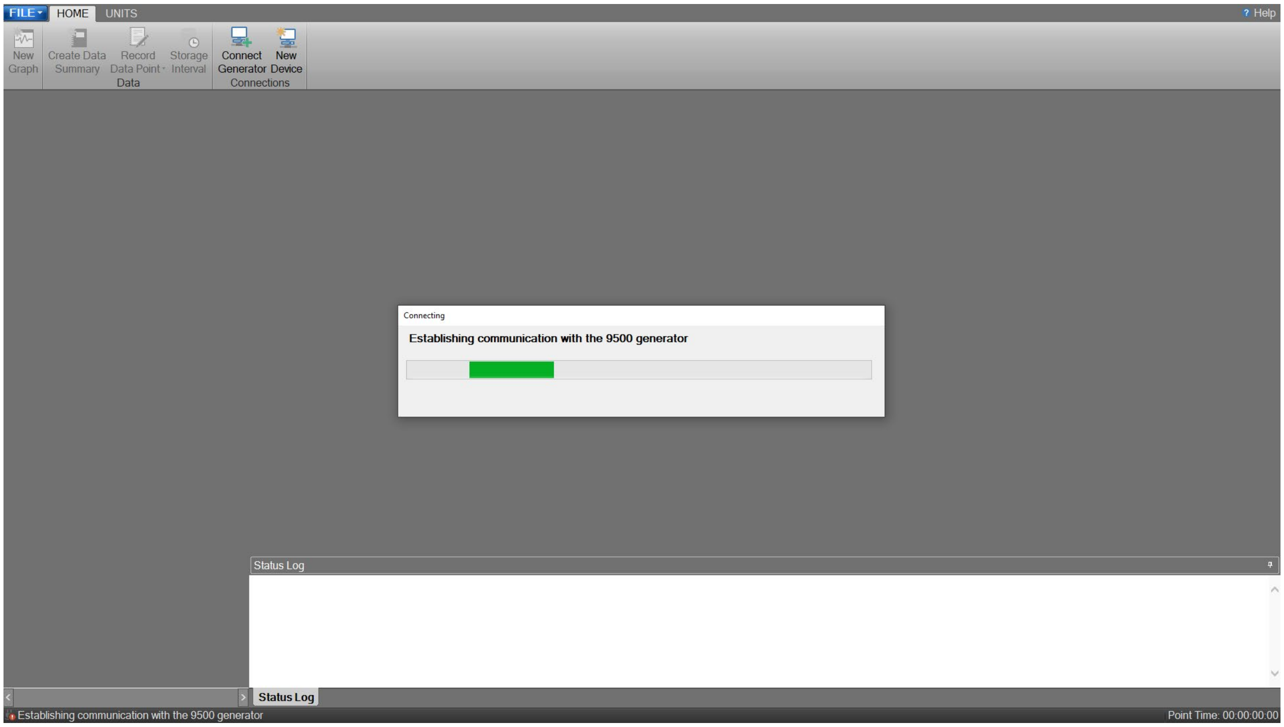
- Verify that the air supply connection has been made and the supply is on and properly regulated.
- Verify that the AC power cable is connected to the generator.
- Toggle the power switch located at the upper right rear of the generator to ON. The generator will begin to boot up.

2.13.2 Loading Screen

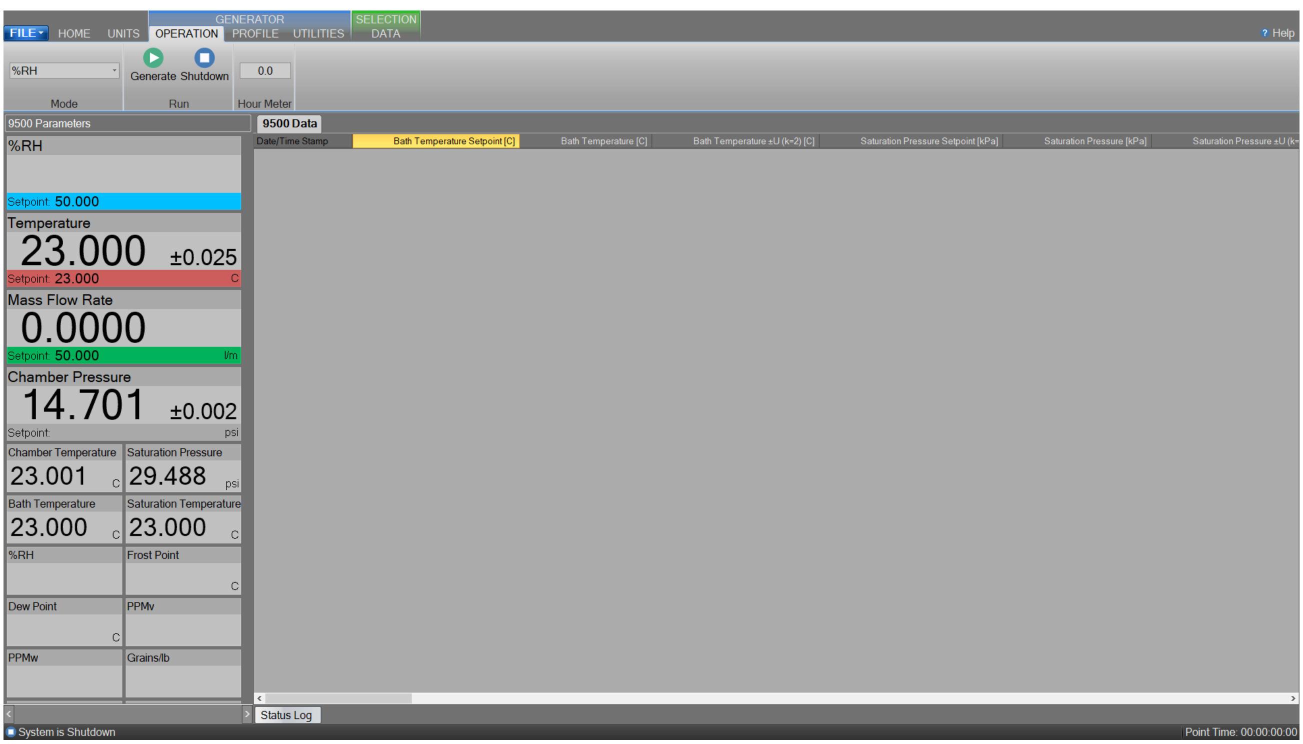
After the system boots, the generator shows a loading screen that indicates the status of the loading process and the software version of the generator.

2.13.3 ControLog Screen

Upon completion of the loading process, the generator shows the main ControLog page and a dialog showing the status of establishing communication with the generator.

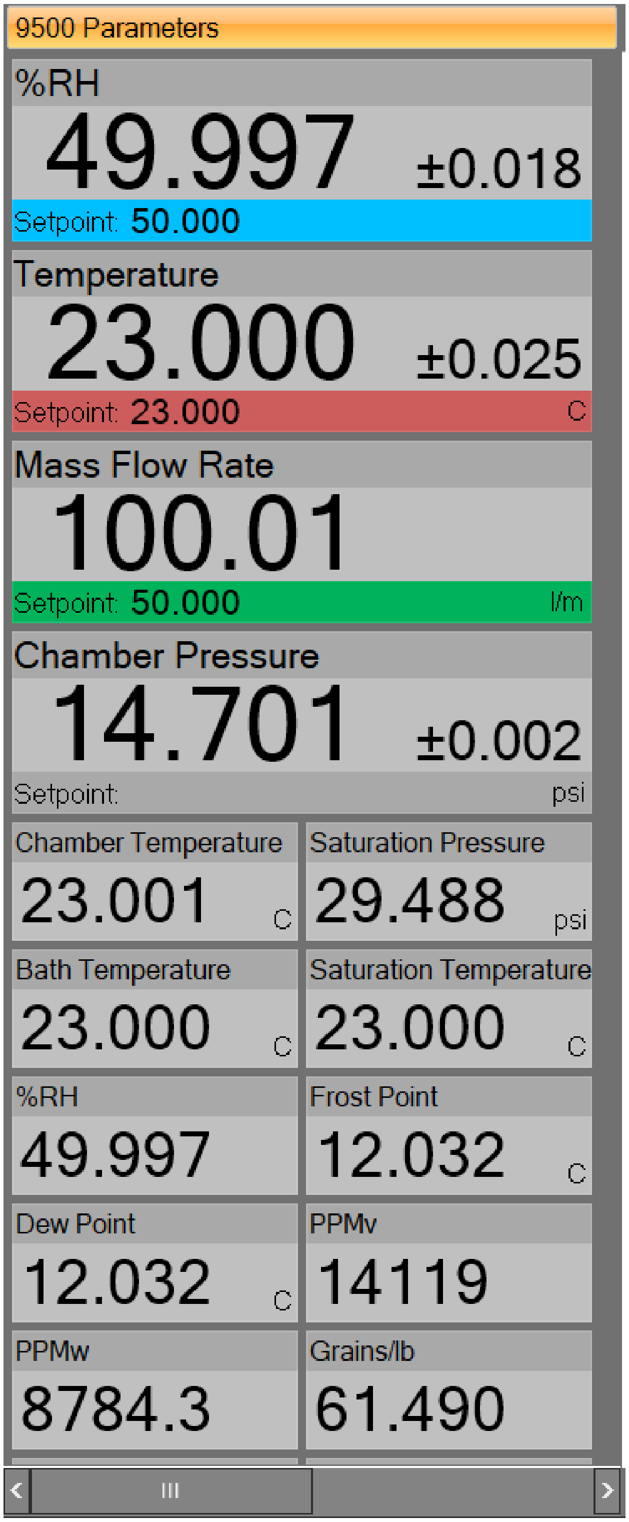


Once communication with the generator is established, the generator's parameter and data tabs are displayed.



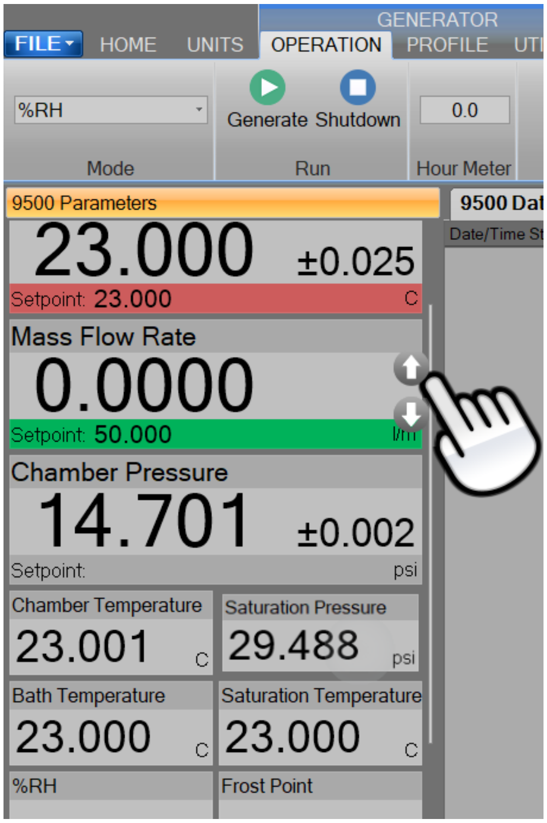
2.13.4 Control Parameters

The Parameter Tab Group is located on the left side of the application and contains a parameter tab for each connected device. The 9500 Parameters contain all the control and measurement parameters critical to the operation of the humidity generator.



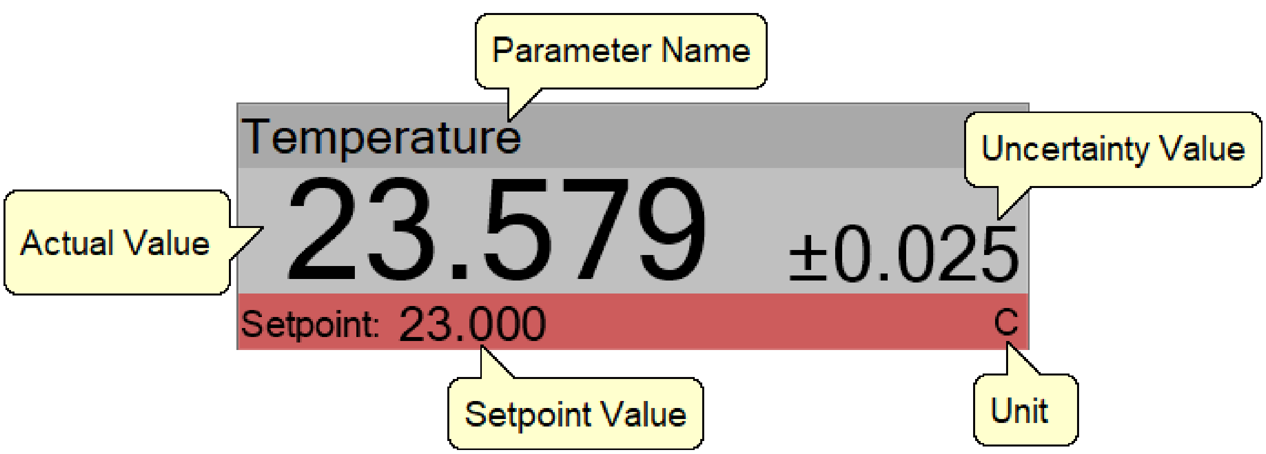
Scrolling the Parameters

Each Parameter Tab can be scrolled up and down to show additional parameters.



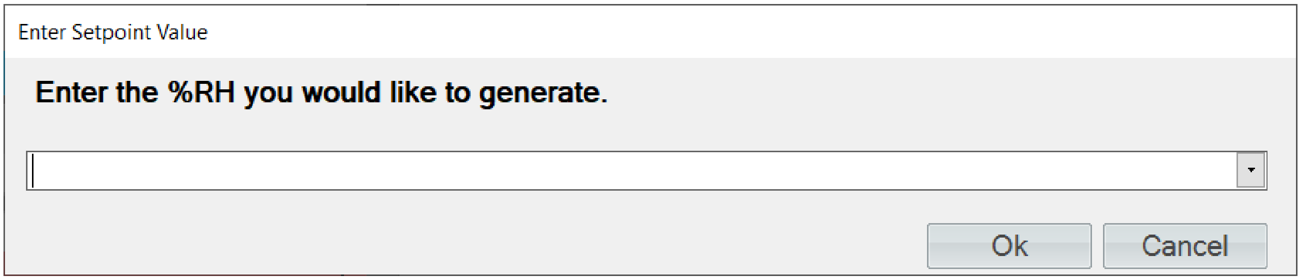
2.13.4.1 Setpoint Tile

The Setpoint Tiles allow the user to control the operation of the humidity generator by changing the desired setpoint that the generator controls. The Tiles contain 5 essential parts; a header with the Parameter Name, the Actual Value, the real-time Uncertainty Value, the Setpoint Value, and the Unit of the displayed values. Each setpoint tile has a colored bar to quickly indicate what the tile is displaying and, in turn, what the system is controlling. Blue is for the humidity being generated, red is for the temperature the system is controlling at, and green is for the flow rate at which the system generates the humidity.



2.13.4.1.1 Changing Setpoints

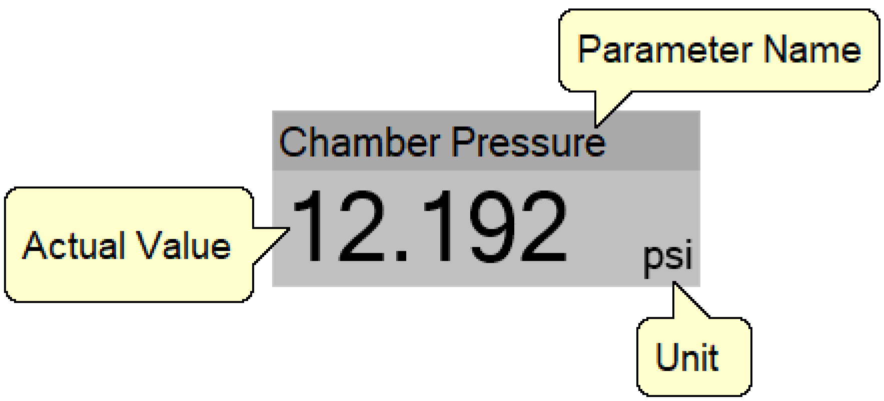
To change a setpoint, click on the setpoint tile that you would like to change. A setpoint entry box will appear. For example, to change the Percent Relative Humidity setpoint, click on the %RH setpoint tile.



Enter the new value into the Setpoint Entry box and select Ok. Notice that the Percent Relative Humidity setpoint value updates to the new value, and the actual values begin moving toward the new setpoint.

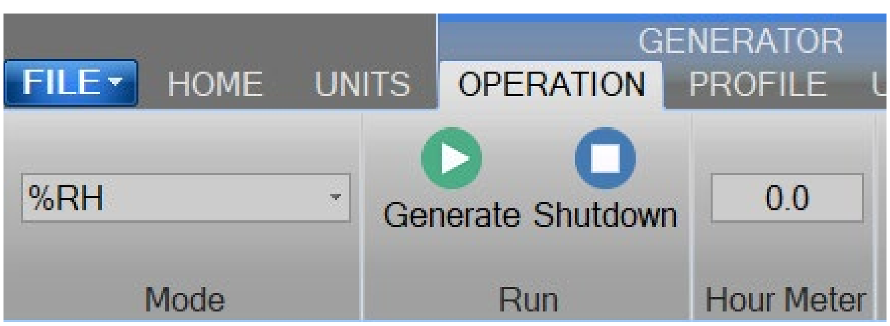
2.13.4.2 Value Tile

The Value Tiles display an actual value of a given parameter to the user. The Tiles contain 3 essential parts; a header with the Parameter Name, the Actual Value, and the Unit of the displayed value.

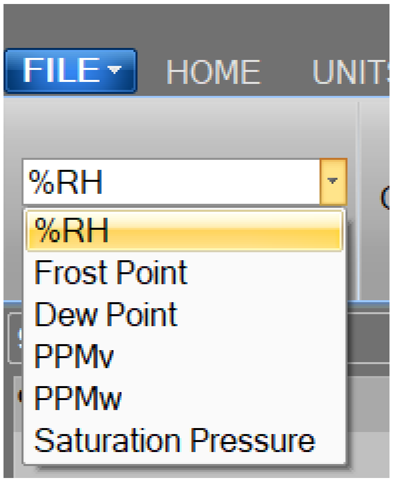


2.13.5 Control Modes

The user can change the operating mode of the 9500 by selecting from the drop-down menu within the Mode group on the Generator's Operation menu tab.

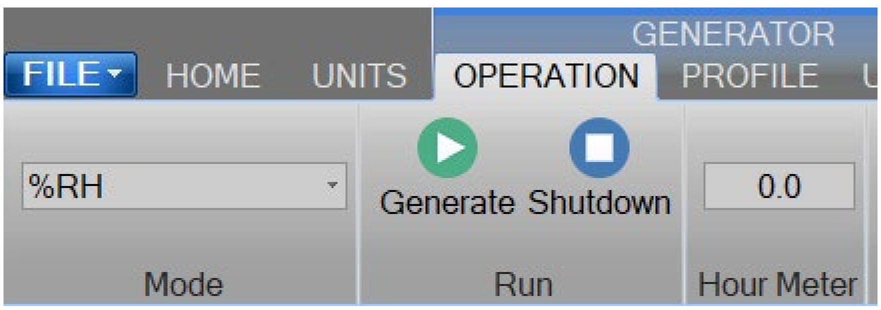


The drop-down allows the user to select %RH, Frost Point, Dew Point, PPMv, PPMw, or Saturation Pressure.



2.13.6 Generating and Shutting down

The Run menu allows the user to run the 9500 manually.



The user can select Generate or Shutdown.

2.13.6.1 Generate Mode

Selecting Generate from the run menu commands the 9500 into generate mode. When in the Generate mode of operation, the system controls the currently entered setpoints. Anytime a setpoint is changed, the system begins adjusting to that new value. The Generate mode also allows you to change the humidity control mode anytime. For instance, the system may be controlling %RH, and you can immediately switch to Dew Point control mode.

2.13.6.2 Shutdown

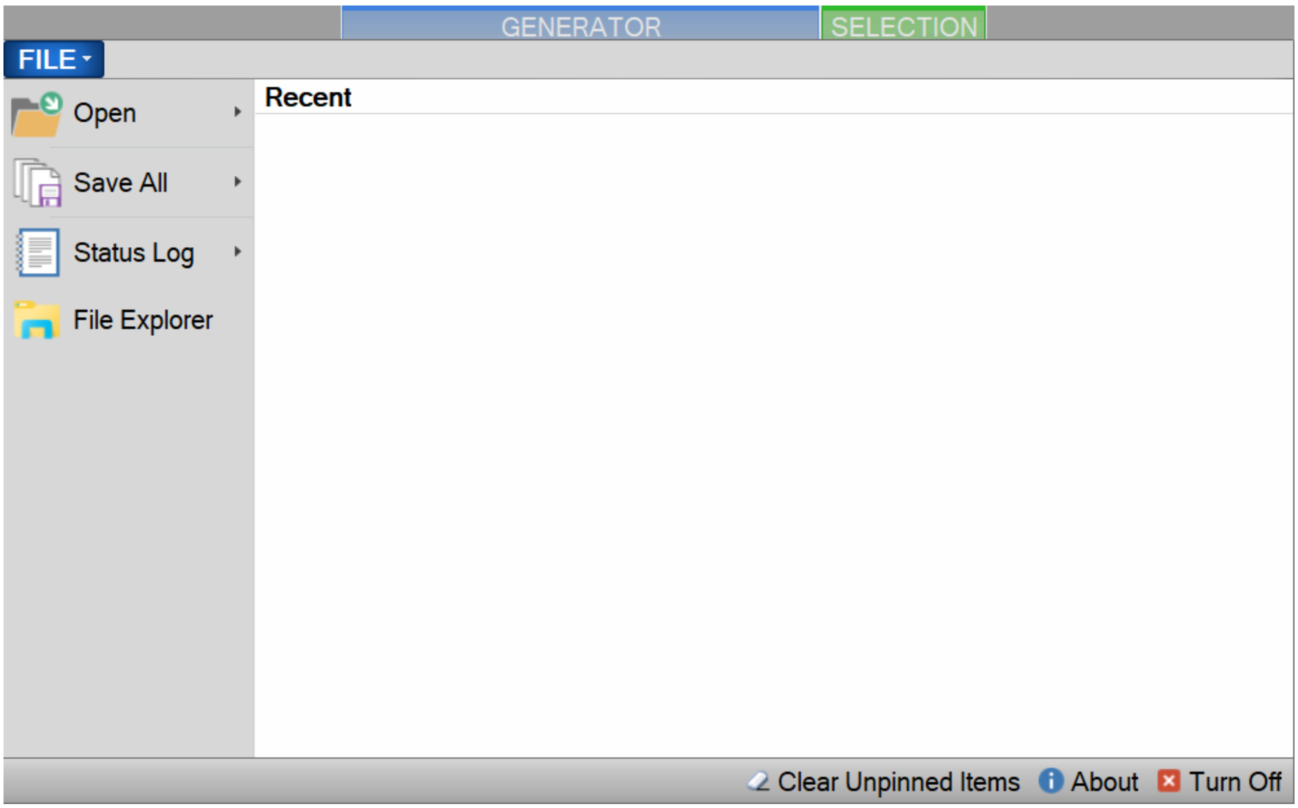
Selecting Shutdown from the run menu commands the 9500 to shutdown. The 9500 may be shutdown whenever it is generating. When stopped, all system functions shutdown, pressure is vented, and the idle

Control/Display screen is shown. During this idle time, when the 9500 is stopped, gas is not flowing through the generator.

2.13.7 Power-Off

To turn the system off, select the “Turn Off” command.

The “Turn Off” command is located under the “File” menu.



The Turn Off command properly exits the software and shuts down the computers so that the main power switch can be switched off.

> **Note** – *Always perform a Shutdown from the Operation Menu Tab before turning off the System.*

If there is current data that has yet to be saved, the user is asked to save the data before the system shuts down.

The user is safe to switch the main system “POWER” to OFF once the PC has shut down completely (display goes blank).

CAUTION!

TURNING OFF POWER WITHOUT SHUTTING DOWN THE SYSTEM FIRST CAN CORRUPT THE EMBEDDED OPERATING SYSTEM.

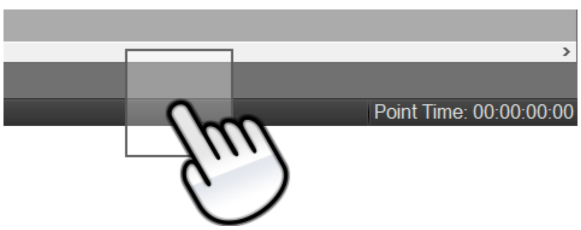
2.13.8 Set Date and Time

The user can change the current system date and time through the status bar context menu.

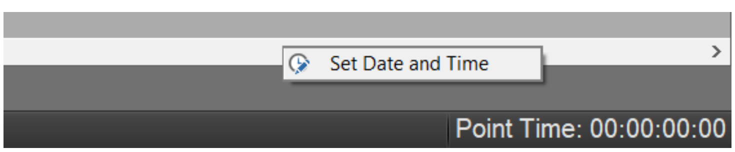
> **Note** – *To avoid time stamp confusion, only change the system date and time when the generator is shutdown and not recording data.*

Start by long pressing or right-clicking anywhere within the status bar. A long press is when you touch and hold the screen.

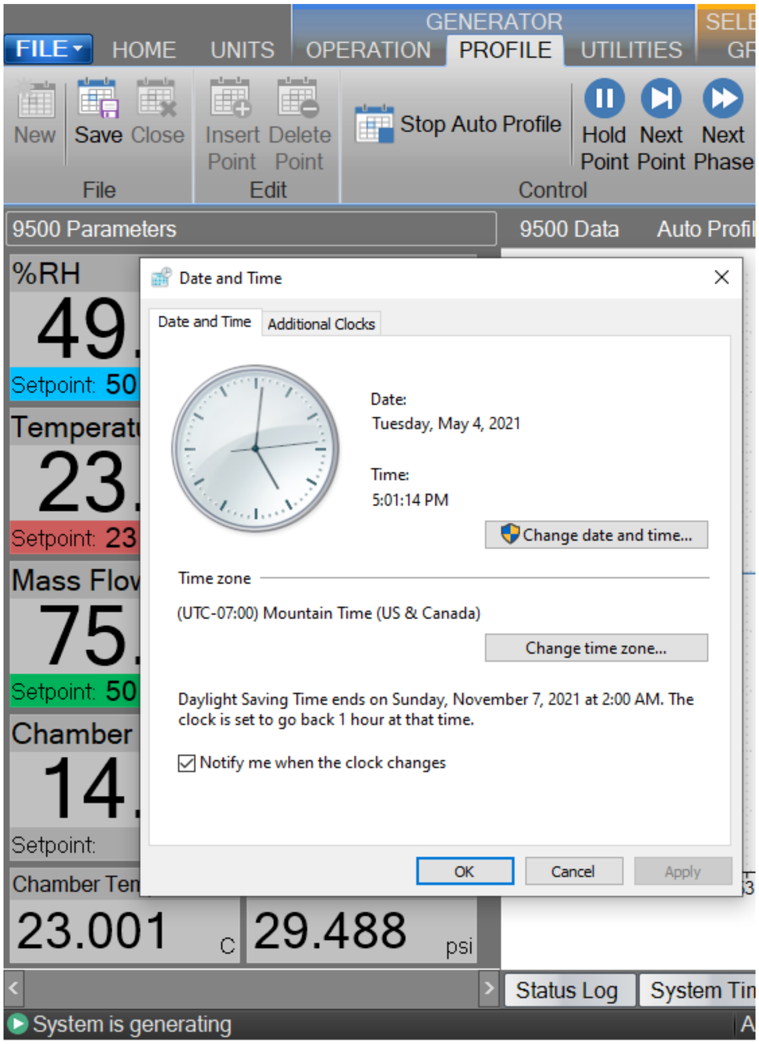
Touch and hold long enough for a square selection box to appear.



Releasing opens the status bar context menu.

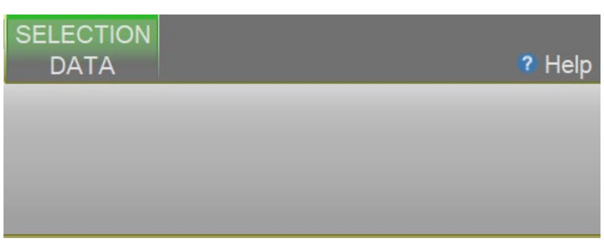


Select "Set Date and Time" from the context menu to open the system Date and Time dialog.



2.13.9 Help

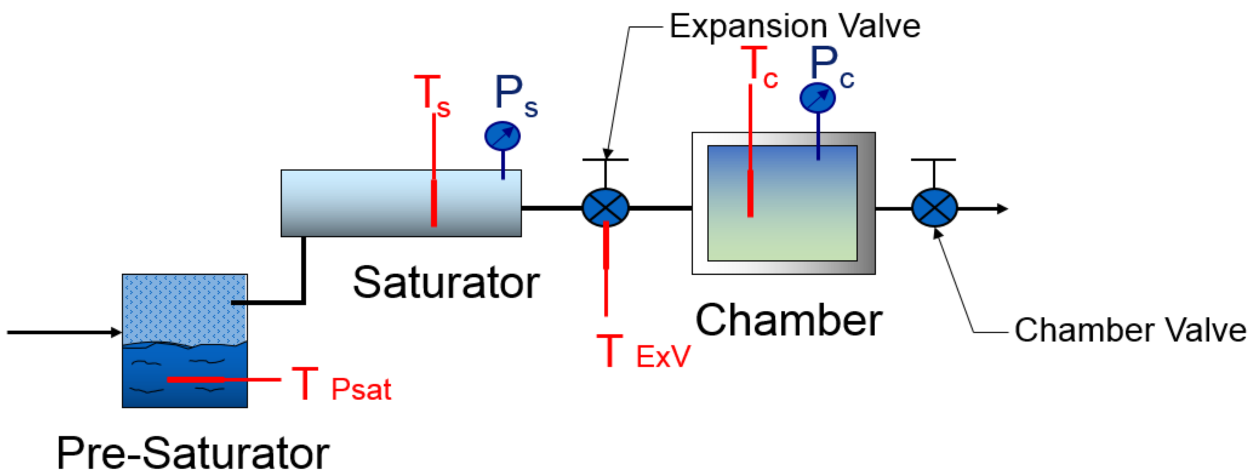
The Help Menu, located on the upper right side of the screen, allows the user to open the 9500 System Manual (this document).



Note – *Refer to the Thunder Scientific website (www.thunderscientific.com) for the latest manual edition and other information on your Model 9500 Humidity System.*

3 PRINCIPLE OF OPERATION

The Model 9500 humidity generation system is based on the two-pressure principle. This process (shown below in an elemental schematic form) involves saturating air or nitrogen with water vapor at a given temperature and pressure. The saturated high-pressure gas flows through an expansion valve where it is isothermally reduced to test pressure. The indications of saturation temperature, saturation pressure, chamber temperature, and chamber pressure are then used to determine all hygrometric parameters such as %RH, Dew Point, PPM, etc. Humidity generation by this system does not depend upon measuring the amount of water vapor but rather is dependent on the measurements of temperature and pressure alone. The system's precision is determined by the accuracy of the temperature and pressure measurements and their constancy throughout.



3.1 PRE-SATURATION (T_{PSAT})

The air stream of a two-pressure generator must be 100% saturated with water vapor at saturation temperature on the high-pressure (saturator) side of the expansion valve. This is accomplished by first passing the air stream through a Pre-Saturator (PSAT). The pre-saturator is a vertical pressure vessel presenting a water surface to the incoming air stream and is maintained at a temperature warmer than saturation temperature conditions. The pre-saturator temperature probe is used to control the pre-saturator heaters, which, when activated, are used to control this temperature offset.

3.2 EXPANSION VALVE (T_{ExV})

The expansion valve temperature probe is used to control the expansion valve heater, which, when activated, is used to warm the expansion valve body, offsetting the cooling effects due to gas expansion. This expansion valve temperature is always maintained above the saturation temperature.

3.3 Saturation Temperature (T_S)

The saturation temperature probe measures the air temperature at which the airstream is fully saturated with water vapor. This is a fundamental measurement for a Two-Pressure humidity generator. The saturation temperature is controlled indirectly through the temperature setpoint (bath fluid temperature).

Refer to section 2.9 Specifications for range.

3.4 Chamber Temperature (T_C)

The chamber temperature probe measures the temperature within the test chamber. This is a fundamental measurement for a Two-Pressure humidity generator. Chamber temperature is controlled indirectly through the temperature setpoint (bath fluid temperature).

Refer to section 2.9 Specifications for range.

3.5 Saturation Pressure (P_S)

The Saturation Pressure transducer measures and controls the absolute pressure at which the airstream is fully saturated with water vapor at saturation temperature conditions. This is a fundamental measurement for a Two-Pressure humidity generator. Saturation pressure can be controlled directly using the Saturation Pressure setpoint or indirectly through the humidity mode setpoint.

Refer to section 2.9 Specifications for range.

3.6 Chamber Pressure (P_C)

The chamber pressure transducer measures the pressure within the test chamber. This is a fundamental measurement for a Two-Pressure humidity generator. Chamber pressure can be controlled directly using the Chamber Pressure setpoint.

Refer to section 2.9 Specifications for range.

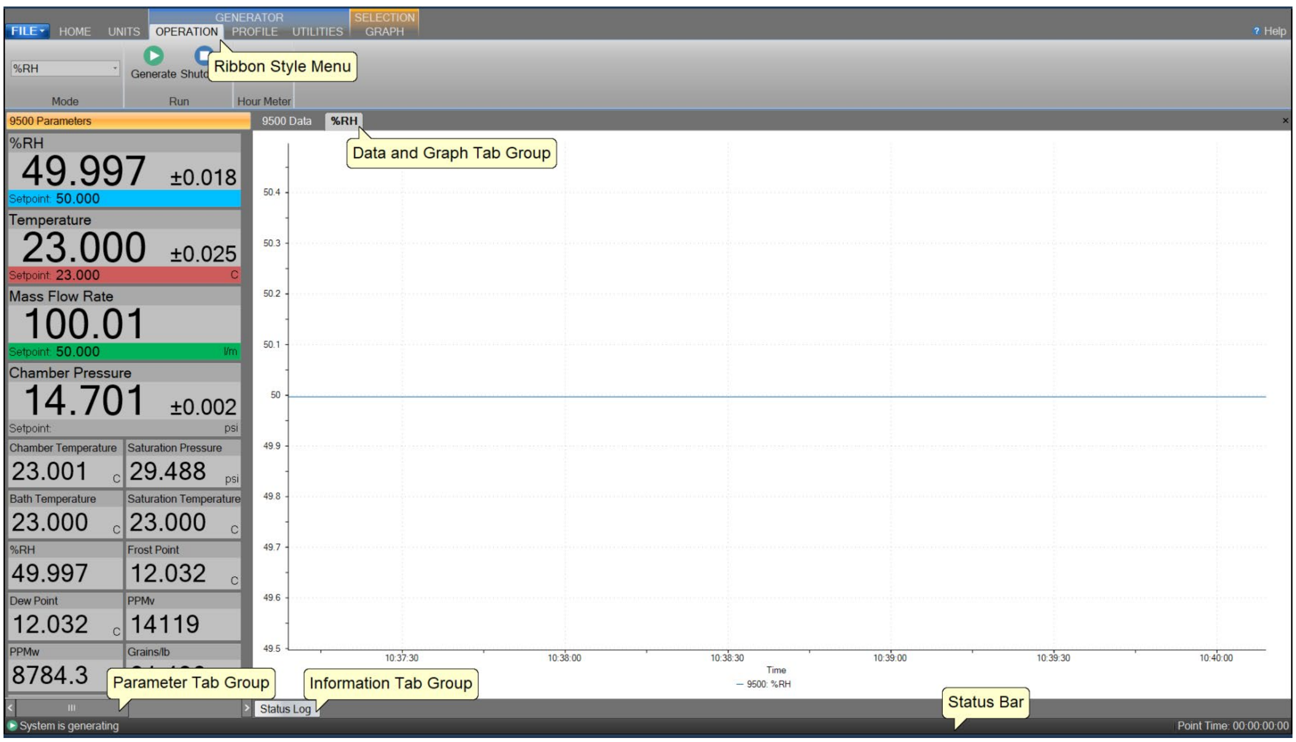
3.7 Humidity Formulas

The humidity (or water vapor content) of a gas may be expressed in various ways. While some basic understanding of humidity is helpful, thorough knowledge of the formulas and their relationships to the 9500 is not a requirement for the successful operation of the generator. Refer to the HumiCalc with Uncertainty Reference Manual for a complete description of the equations used by the 9500 to generate a known humidity value and corresponding uncertainty.

4 CONTROLOG INTERFACE

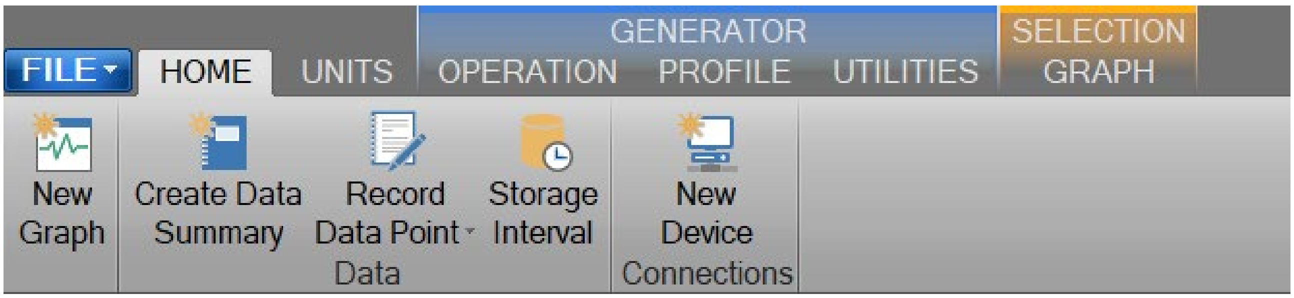
This section provides the user with a detailed overview of ControLog's layout and design. It is intended to allow the user to gain familiarity with ControLog's user interface. The sections following provide a deeper operational view of the functionality that ControLog offers.

The ControLog application is composed of five basic features: Ribbon Style Menu Bar, Parameter Tab Group, Data, and Graph Tab Group, Information Tab Group, and the Status Bar. Each feature is designed to be intuitive to use and to provide the user with detailed information on the operation of the generator and connected device(s).



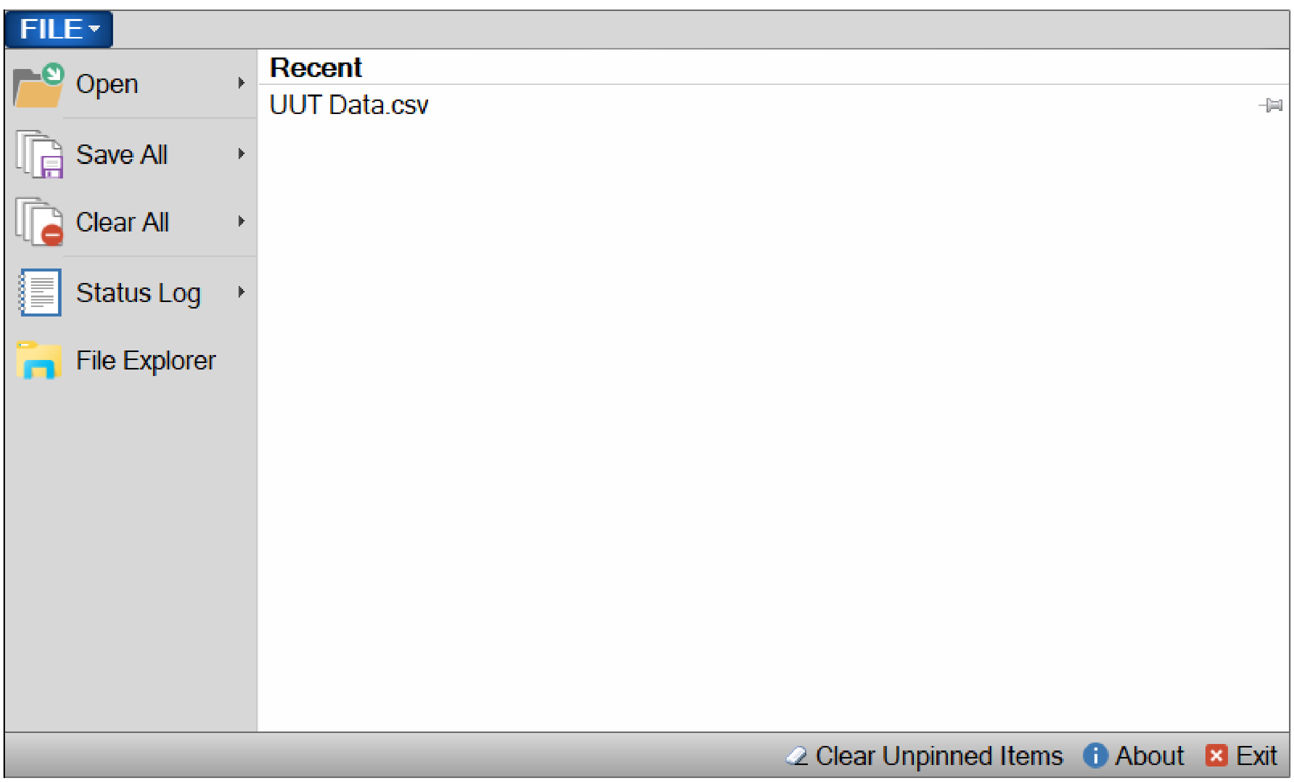
4.1 Menu Bar

The Ribbon Style Menu Bar is located at the top of the application and contains various selectable menu groups, which provide access to the different ControLog functions and controls. The Generator group provides commands directly related to the operation of the generator, such as Operation, Profile, and Utilities. The Selection group is dynamic and provides commands based on the Data or Graph Tab that is currently selected. For example, if a graph tab is selected, commands related to its graph are available. If a data tab is selected, then commands related to its data are available.



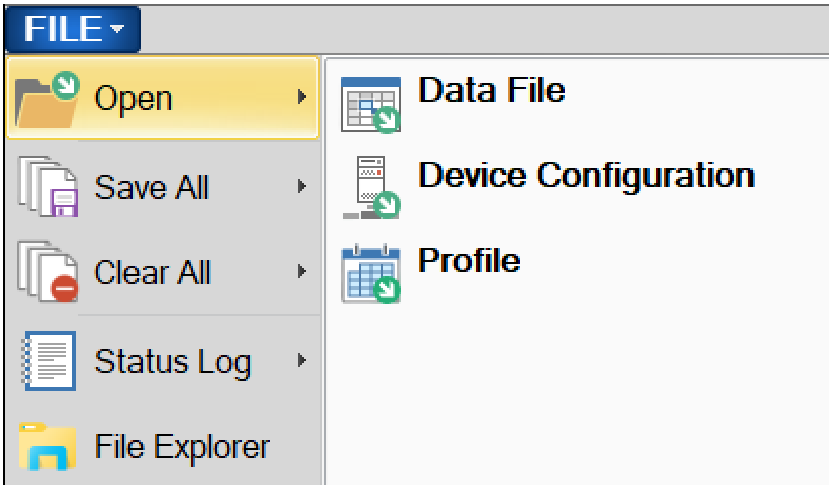
4.1.1 File Menu Tab

The File Menu allows users to perform file-specific commands to open previous data files, profiles, and device configurations. It also allows the user to save all open data or graphs, clear data, clear the status log, save the status log, get information about the application, and exit (power down) the Human Machine Interface (HMI) Computer.



4.1.1.1 *Open Data File*

The Open file menu command allows the user to open previous data files for further review and analysis, device configurations for device data logging, and profiles for generator automation.



Selecting one of these commands opens a file dialog that allows the user to browse to the desired location for the file to open.

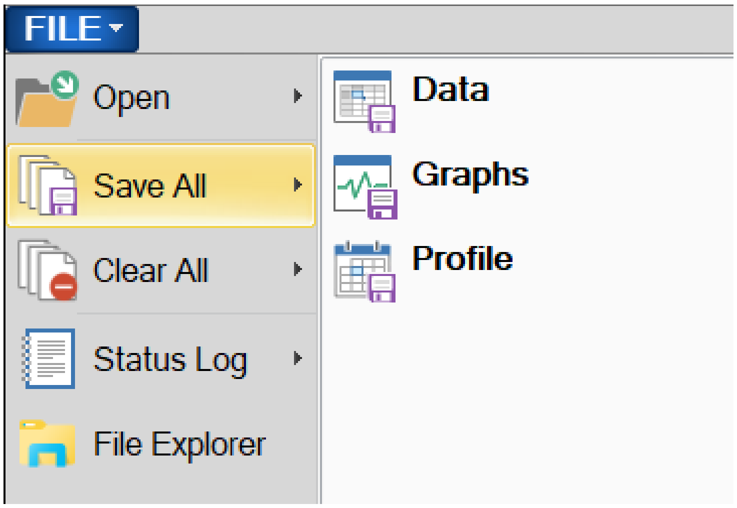
ControLog can open data saved in the follow type and format:

- Text File (Comma Delimited) (*.csv;*.txt)
- Text File (Tab Delimited) (*.dat;*.txt)
- Excel Workbook (*.xlsx;*.xls)
- Backup ControLog File (*.backup)

The user can also view and select to open recent files and has the option to "Pin" the file for quicker access later on. This can be very useful if you have a device configuration that is often used or a commonly used profile, as it removes the process of navigating and selecting the file each time.

4.1.1.2 Save All Data

The Save All file menu command allows the user to save all current open data tabs to individual files using a common name. This feature allows the user to save multiple data tabs in a single operation quickly. Selecting this command opens a save file dialog that allows the user to specify the name and browse to the desired location to save the file.



ControLog can save data in the following type and format:

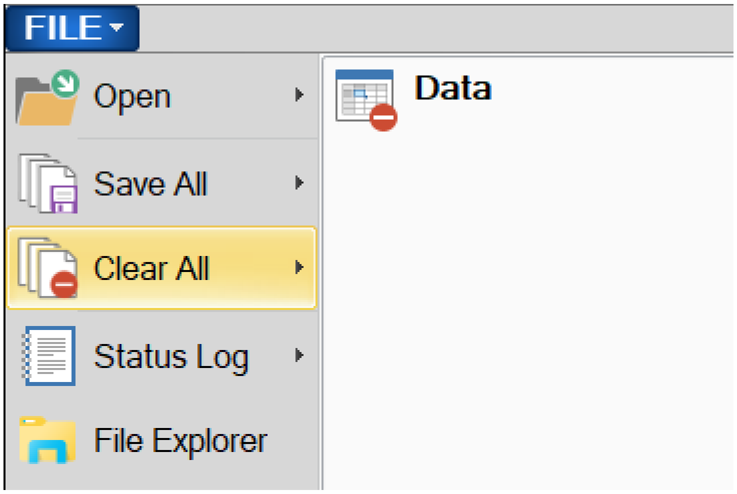
- Comma-Separated Values (*.csv)
- Text File (Comma Delimited) (*.txt)
- Text File (Tab Delimited) (*.txt)
- Excel Workbook (*.xlsx)
- Excel 97-2003 Workbook (*.xls)

Example: If the user had two data tabs open, one called “9500 Data” and the other called “UUT Data,” and the user wanted to save the files as Excel Workbooks using the name “Test Data 15Oct20”. ControLog would save two files to the user-specified location with the following names:

- Test Data 15Oct20 (9500).csv
- Test Data 15Oct20 (UUT).csv

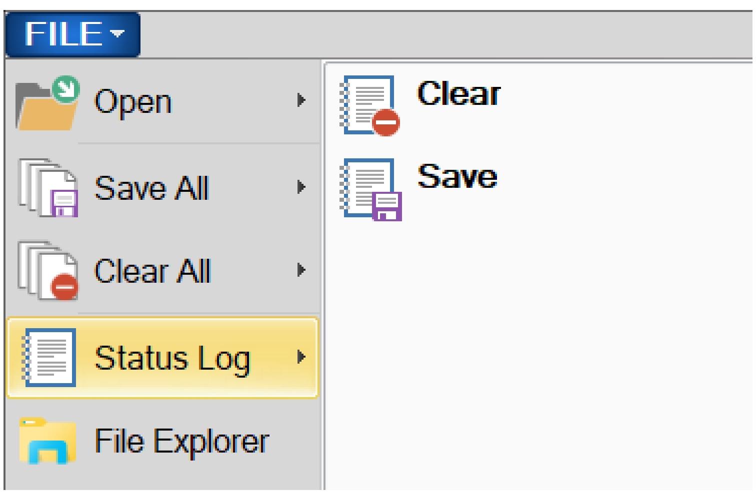
4.1.1.3 Clear All

The Clear All menu command lets the user clear all data tabs simultaneously. ControLog asks the user to save any unsaved data tab before each tab is cleared. This operation is available only when at least two data points have been recorded in any data tab.



4.1.1.4 Status Log

The Status Log file menu command allows the user to Clear or Save the status log.

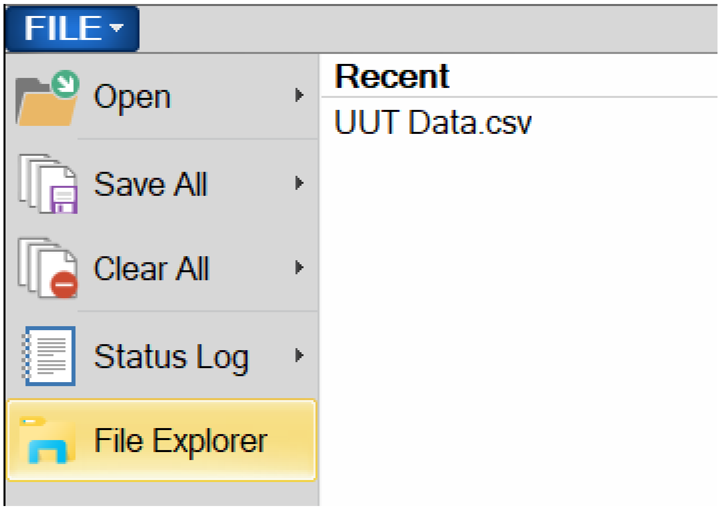


The Clear command allows the user to clear all current entries in the status log. The user is asked to save the status log data before the log is cleared.

The Save command allows the user to save the current entries in the status log. Selecting this command opens a save file dialog that allows the user to specify the name and browse to the desired location to save the file. All status log files are saved in HTML format (*.html).

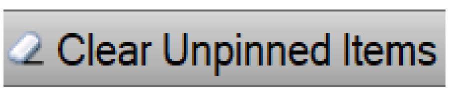
4.1.1.5 *File Explorer*

Opens a Windows file explore to allow the user to manage files. This can be used to quickly copy data and report files from the 9500 to an external USB drive.



4.1.1.6 *Clear Unpinned Items*

Clears all unpinned items in the list of recent files.



4.1.1.7 *About ControLog*

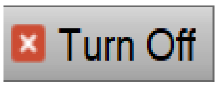
The About ControLog help menu command opens a dialog giving information on the ControLog application, including software version numbers and build dates.

4.1.1.8 Turn Off

The Turn Off command allows the user to properly exit the software and shutdown the computers so that the main power switch can be switched off. If there is current data that has yet to be saved, the user is asked to save the data before the system shuts down.

Note – *Always perform a Shutdown from the Operation Menu Tab before turning off the System.*

The user is safe to switch the main system "POWER" to OFF once the PC has shut down completely (display goes blank).

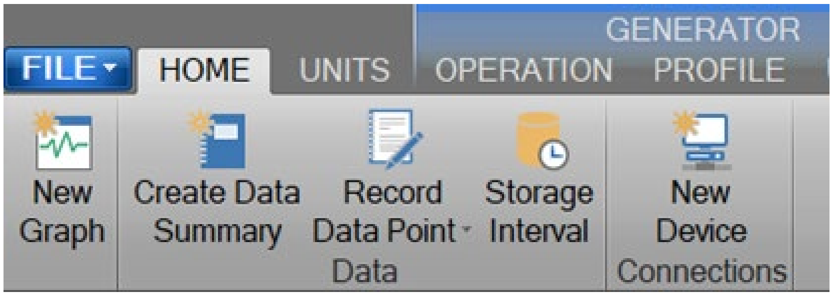


CAUTION!

TURNING OFF POWER WITHOUT SHUTTING DOWN THE SYSTEM FIRST CAN CORRUPT THE EMBEDDED OPERATING SYSTEM.

4.1.2 Home Menu Tab

The Home Menu Tab allows the user to create new graphs, create a data summary, record data points, change the storage interval and create new device connections.



4.1.2.1 New Graph

The New Graph menu command allows the user to create a new graph. Selecting this command opens a New Graph Wizard dialog that walks the user through the selection process of what data the user would like to include in the new graph. This operation is always available.

4.1.2.2 Create Data Summary

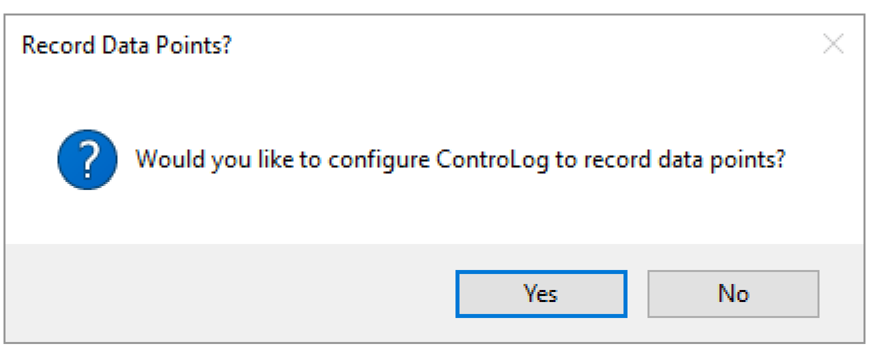
The Create Data Summary data command allows the user to create a summary of any currently opened data. It lets the user specify what items, from which device, and at what intervals to include in the data summary. The data summary can also calculate the error between the specified standard and the device under test. This operation is available whenever an open Data tab contains data.

For more information, refer to section 8 Data and Data Summary

4.1.2.3 Record Data Point

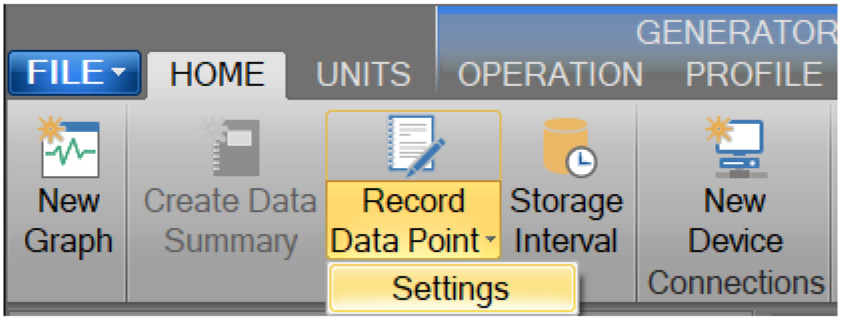
The Record Data Point data command allows the user to record certain data items from any currently connected device either manually, with each manual device entry or at the completion of each soak phase in an auto profile. The user can specify the number of prior data points to include and has the option to automatically calculate the average and or standard deviation of the prior data points. There are two submenus for this menu command; Settings and Take Point. This operation is available whenever device or generator data is being logged. The user can manually take a point using the button or the keyboard shortcut "Ctrl-P".

If the user has not configured the system to record data points, then ControLog asks the user if they would like to define the settings before taking a point.



4.1.2.3.1 Settings

The Settings submenu allows the user to define which data items and from which connected device they would like to record when a point is taken. They can also define the number of points to include and whether to calculate the average and/or standard deviation. The user can also configure when to take points manually, at the end of a profile soak phase or when a manual device entry is taken.



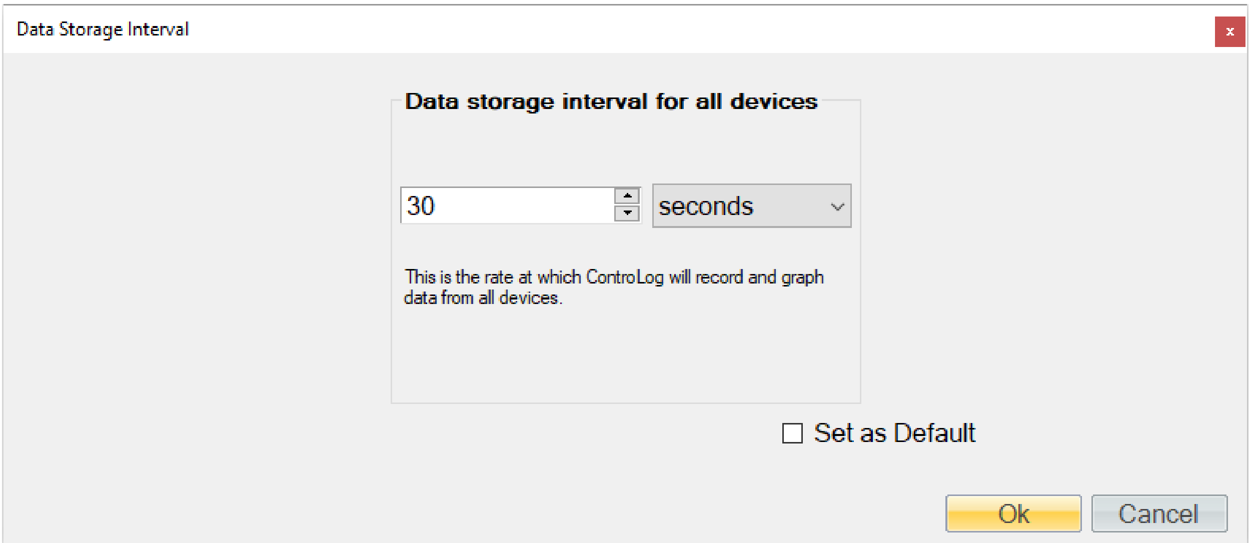
For more information, refer to section 8 Data and Data Summary

4.1.2.4 Data Storage Interval

The Storage Interval command allows the user to change the storage interval at which data is recorded. The storage interval is the rate at which data is recorded to the data tabs for all connected devices. Selecting this command opens the “Data Storage Interval” dialog, allowing the user to change the data storage interval during the generate operation. The new value becomes the default start-up interval if the “Set as Default” is checked. If not checked, the new value only affects the current session.

IMPORTANT!

STORING AND MAINTAINING DATA CAN BECOME A TIME-CONSUMING PROCESS. THE MORE DATA THAT IS STORED IN THE DATA TAB, THE SLOWER AND LESS RESPONSIVE THE COMPUTER MAY SEEM. FOR THIS REASON, SOME CONSIDERATION SHOULD BE GIVEN TO THE AMOUNT OF DATA DESIRED, THE OVERALL TIME SPAN OF THE DATA (I.E., HOURS, POSSIBLY DAYS), AND ULTIMATELY THE DATA INTERVAL.



Note - *Data is only recorded while the 9500 is in generate mode.*

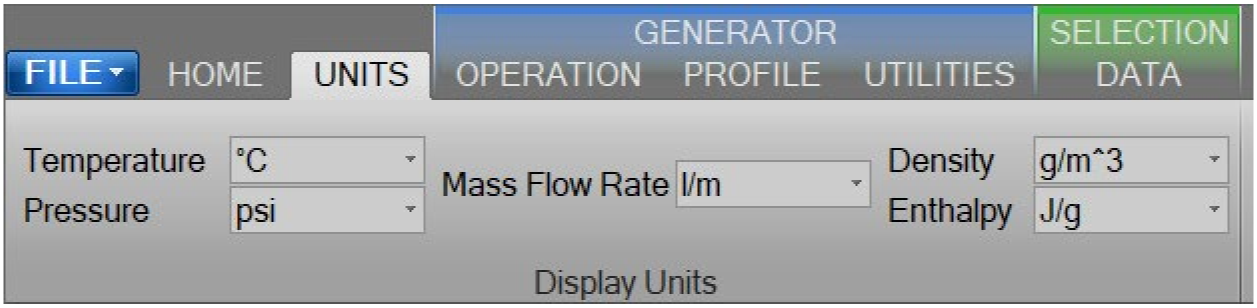
4.1.2.5 New Device

The New Device connection command allows the user to create a new device connection. Selecting this command opens a Connection Wizard dialog that steps the user through the process of creating a new connection to a device.

For more information, refer to section 10 Connections

4.1.3 Units Menu Tab

The Units Menu Tab allows the user to change ControLog's displayed units. The Temperature, Pressure, Flow Rate, Density, and Enthalpy units can be changed.



Note - *All parameter tabs and graph tabs are updated with the selected unit, but the data tabs are not changed. Data tab values remain in SI units, providing a consistent unit base for saved data.*

4.1.3.1.1 Temperature Unit

The Temperature Unit allows the user to change the displayed units for temperatures.

Available temperature units:

- °F
- °C
- K

4.1.3.1.2 Pressure Unit

The Pressure Unit allows the user to change the displayed units for pressure.

Available pressure units:

- psi
- atm
- Pa
- hPa
- kPa
- MPa
- bar
- mbar
- inHg

4.1.3.1.3 Flow Unit

The Flow Unit allows the user to change the displayed units for flow.

Available flow units:

- l/m
- l/h
- cfm
- cfh

4.1.3.1.4 Density Unit

The Density Unit allows the user to change the displayed units for density.

Available density units:

- g/L
- g/m^3
- lb/ft^3

4.1.3.1.5 Enthalpy Unit

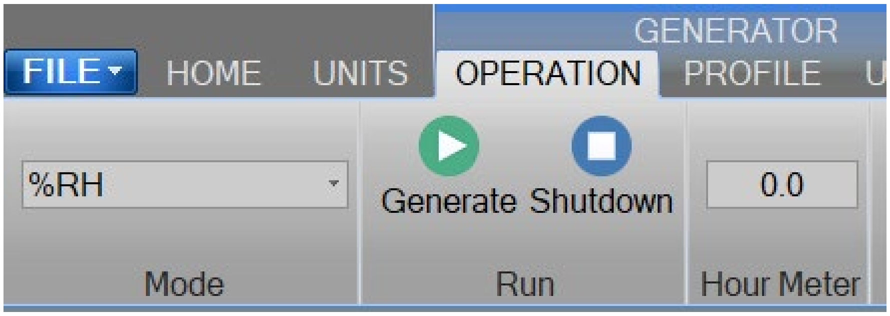
The Enthalpy Unit allows the user to change the displayed units for enthalpy.

Available enthalpy units:

- btu/lb
- J/g

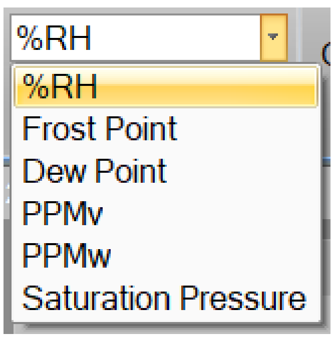
4.1.4 Operation Menu Tab

The Operation Menu Tab allows the user to control the generator's operation, from the humidity operating mode to the startup and shutdown of the generator.



4.1.4.1 Mode

The Mode Menu allows the user to change the operating mode of the 9500. It allows the user to select %RH, Frost Point, Dew Point, PPMv, PPMw, or Saturation Pressure.



4.1.4.1.1 %RH Control Mode

In the %RH Control mode, the percent relative humidity is controlled at a constant value by varying saturation pressure (Ps) to compensate for any changes in saturation temperature (Ts), chamber temperature (Tc), or chamber pressure (Pc). While %RH is held constant, all other humidity parameters may vary.

4.1.4.1.2 Frost Point Control Mode

In the Frost Point Control Mode, the frost point temperature (Tf) is controlled at a constant value by varying the saturation pressure (Ps) to compensate for changes in either saturation temperature (Ts) or chamber pressure (Pc). While Frost Point is held constant other humidity parameters may vary. Frost Point is independent of chamber temperature.

4.1.4.1.3 Dew Point Control Mode

In the Dew Point Control Mode, the dew point temperature (Td) is controlled at a constant value by varying saturation pressure (Ps) to compensate for any changes in either saturation temperature (Ts) or chamber pressure (Pc). While Dew Point is held constant, other humidity parameters may vary. Dew Point control mode is valid above and below 0 °C, and Dew Point is independent of chamber temperature.

4.1.4.1.4 PPMv Control Mode

In the PPMv Control Mode, the parts per million by volume is controlled at a constant value by varying saturation pressure (Ps) to compensate for any changes in saturation temperature (Ts). While PPMv is held constant, other humidity parameters may vary. PPMv is independent of chamber pressure and chamber temperature.

4.1.4.1.5 PPMw Control Mode

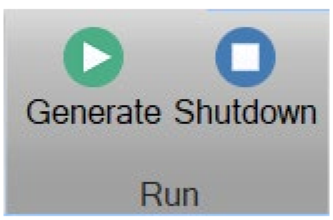
In the PPMw Control Mode, the parts per million by weight is controlled at a constant value by varying saturation pressure (Ps) to compensate for any changes in saturation temperature (Ts). While PPMw is held constant, other humidity parameters may vary. PPMw is independent of chamber pressure and chamber temperature.

4.1.4.1.6 Saturation Pressure Control Mode

In the Saturation Pressure Control Mode, the saturation pressure (Ps) is controlled at a constant value independent of any other pressure, temperature, or humidity value. While saturation pressure is held constant, all humidity parameters may vary.

4.1.4.2 Run Menu

The Run Menu allows the user to run the 9500 manually in generate mode. The Run menu also allows the user to manually shutdown the 9500.



4.1.4.2.1 Generate Mode

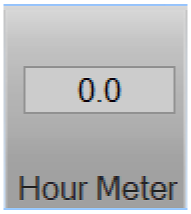
Selecting Generate from the run menu commands the 9500 into generate mode. Generate mode is used to operate the system when exact humidity points or associated time intervals have not been determined when data must be viewed and/or verified manually before proceeding to the next humidity point, or when more immediate control over the generated humidity is required. In the Generate mode of operation, the system indefinitely controls the currently entered setpoint. Anytime a setpoint is changed, the system begins adjusting to that new value and controls the new point indefinitely. Generate mode offers the flexibility to change the setpoint at any time and does not force you into any set sequence or for any prescribed amount of time. The Generate mode also allows you to change the humidity control mode anytime. For instance, the system may be controlling Frost Point, and you can immediately switch to PPMv control mode.

Shutdown

Selecting Shutdown from the run menu commands the 9500 to shutdown. The 9500 may be shutdown while generating. When stopped, all system functions shutdown, pressure is vented, and the idle Control/Display screen is shown. During this idle time, when the 9500 is stopped, gas is not flowing through the saturator.

4.1.4.3 Hour Meter

The Hour Meter allows the user to see the number of operational hours the generator has on it. The hour meter indicates the number of hours the generator has been operated in the generate mode.

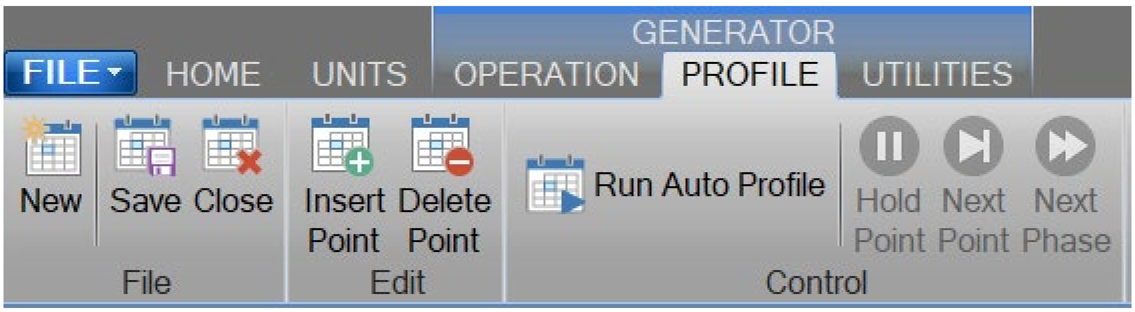


4.1.5 Profile Menu Tab

The Profile Menu Tab allows the user to manage Auto Profiles. Auto Profiles allow the user to program a set of humidity and temperature test points and dwell times that automate the 9500 generation process. The profile menu is dynamic and has operations that are specific to the profile tab. Specific operations are hidden when another non-profile tab is selected.

The Auto Profiling feature is very similar to the Generate mode, with the main exception that profiling relies on a predefined list of setpoints referred to as a profile. The user-configurable profile is used as ControLog's road map during Auto Profile operation. It defines which setpoint values to go to, at what rate to go from one setpoint to another, and how long to stay at a specific setpoint before moving to the next one.

For more information, refer to section 9 Profiling.



4.1.5.1 New Profile

The New profile command allows the user to create a new Auto Profile.

4.1.5.2 Save Profile

The Save profile command allows the user to save the currently opened Profile. Selecting this command opens a save file dialog that allows the user to specify the name and browse to the desired location to save the file. ControLog Auto Profiles are saved in XML format with a *.profile extension.

4.1.5.3 Close Profile

The Close profile command allows the user to close the Profile tab. Selecting this command closes the Profile tab, but if the profile has not been saved, ControLog asks the user to save the profile before closing the Profile tab.

4.1.5.4 Insert Point

The Insert Point command allows the user to insert new profile points between existing points. ControLog inserts a new point at the selected location and automatically predicts the values.

4.1.5.5 Delete Point

The Delete Point command allows the user to delete the selected profile point.

4.1.5.6 Run Auto Profile

The Run Auto Profile command allows the user to start an Auto Profile. Selecting this command opens the Profile Starting Point dialog, allowing the user to select the point from which to start the profile.

4.1.5.7 Hold Point

The Hold Point profile command allows the user to hold or pause the current Auto Profile point. Selecting Hold Point pauses the current point, allowing the system to remain indefinitely at the current point. While in a hold mode, the system is prevented from completing the ramp, assurance, or soak phases for a point. To resume the profile point, select the menu item again. This re-enables the point and allows the profile to resume regular operation.

4.1.5.8 Next Point

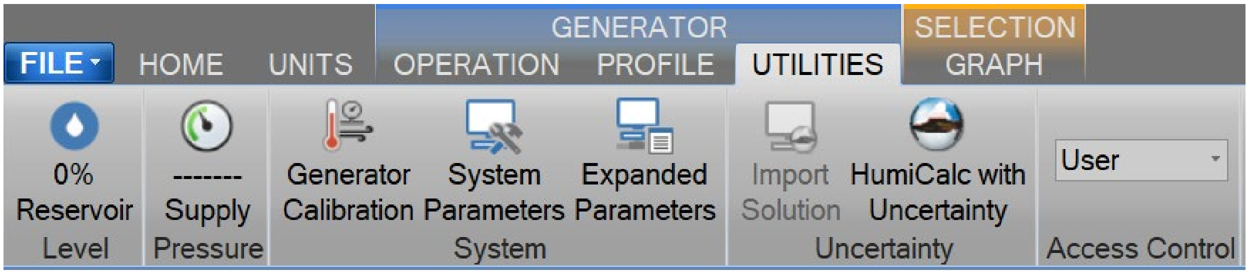
The Next Point profile command allows users to skip to the next point in the Auto Profile. Selecting Next Point manually advances to the next point, skipping any remaining ramp, assurance, or soak phase.

4.1.5.9 Next Phase

The Next Phase profile command allows the user to skip to the next phase in the Auto Profile. Selecting Next Phase manually advances to the next phase. It causes Ramp Phase to proceed to the Assurance or Soak Phase, Assurance to proceed to Soak, or Soak to proceed to Ramp of the next profile point. This allows for early manual termination of any phase within a profile point.

4.1.6 Utilities Menu Tab

The Utilities Menu Tab gives the user access to various utilities functions such as Fluid Levels, Supply Pressure, Generator Calibration, System Parameters, Expanded Parameters, generator Uncertainty, and Access Control.



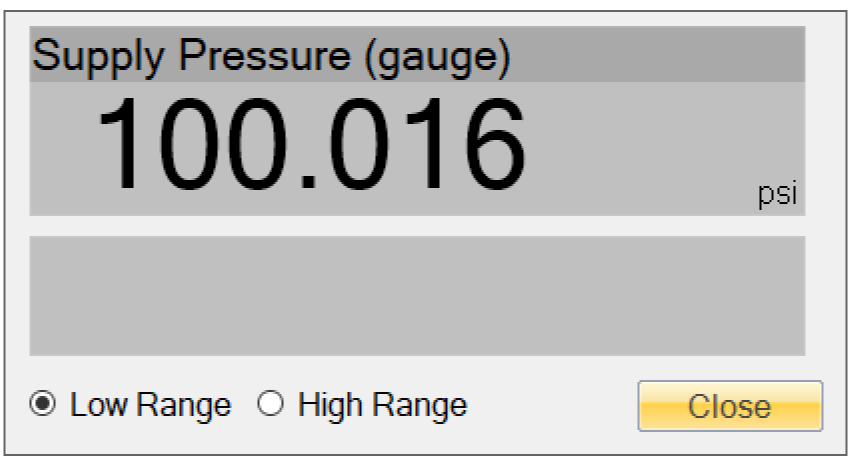
4.1.6.1 Reservoir Level

The Reservoir Level indicates the current level of the water reservoir and, when pressed, opens up the 9500 fluid level interaction dialog that allows the user to view the state of the various fluid levels and liquid level states. It also allows the user to control the filling process and bath level.

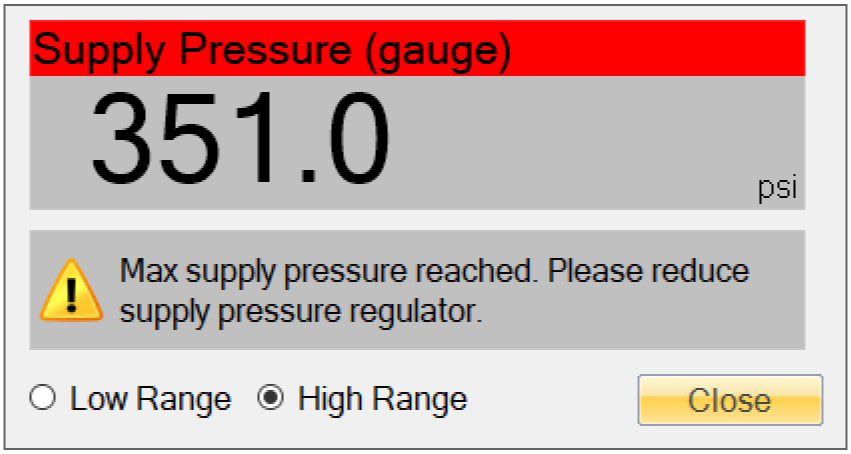
For more information, refer to section 5 Fluid Levels and Bath Level Control.

4.1.6.2 Supply Pressure

The Supply Pressure indicates the current supply pressure and, when pressed, opens a dialog box for the user to view the current supply pressure (in gauge). This command opens the selected supply pressure solenoid if the generator is shut down. The exact pressure value varies based on the air supply connected to the generator.

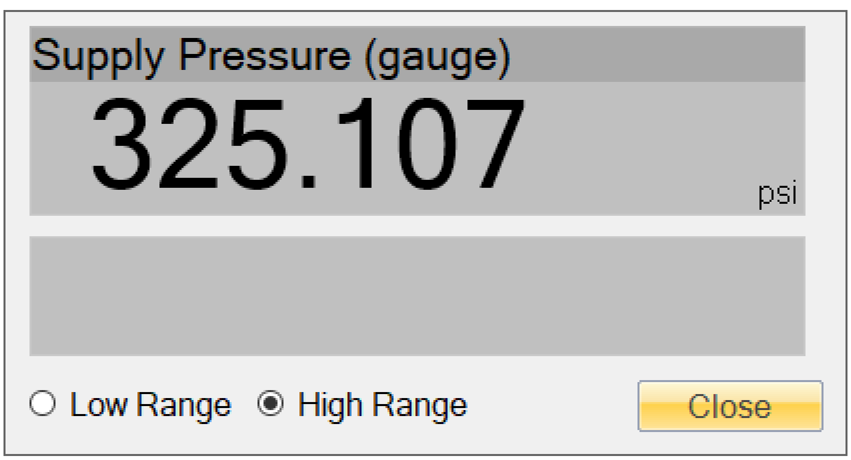


A warning message is displayed if the supply pressure is set too high. The user needs to reduce the pressure regulator until the message disappears.

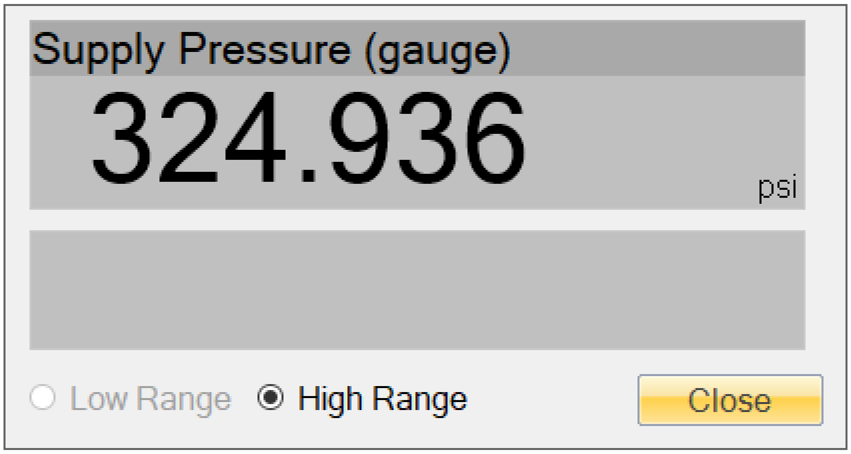


Refer to section 2.12.10 Setting Supply Pressure Regulator for detailed instructions on setting the supply pressure regulator.

The 9500 supports two supply pressure inputs for when a pressure booster is needed to achieve high pressure. The low range supply is directly connected to the facility air supply, and the high range supply is connected to a pressure booster to achieve the higher supply pressures. This two-supply input feature helps limit the operation of the air booster as the system operates on the low supply and only switches to the high supply (air booster) when required. When the system is shutdown, the user can select to view either the low range or high range pressure using the option buttons at the bottom of the dialog.



When generating, the system controls which supply to use, and the user cannot select between the two supplies but can see the current supply pressure reading.



Note – *The internal 9500 regulator should be set to regulate the high range pressure. The low range supply pressure input* *<u>must be externally regulated</u>* *to 100 psiG before entering the 9500.*

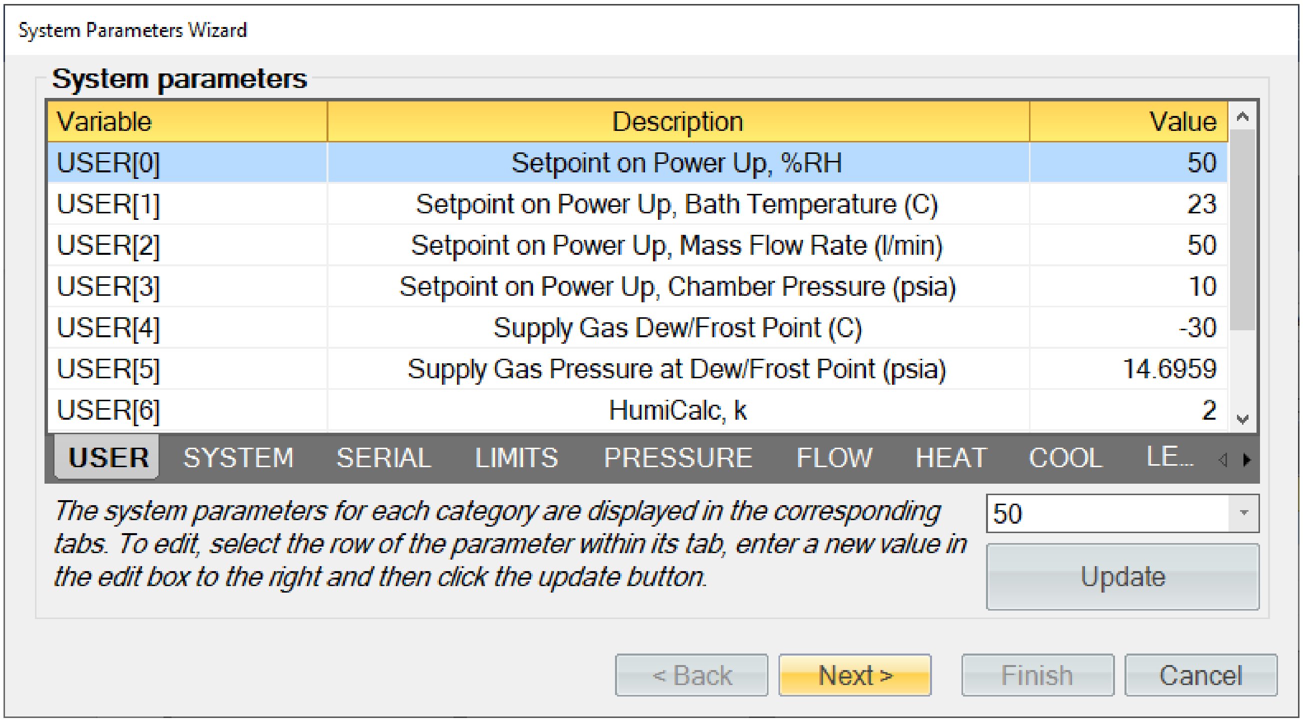
4.1.6.3 Generator Calibration

The Generator Calibration command opens the Calibration Wizard dialog to calibrate the Model 9500 Humidity Generator's temperature probes, pressure transducers, and mass flow meter. ControLog requests a password to access the calibration functionality since it affects the accuracy and possibly the operation of the generator if incorrectly performed. The passwords are on the yellow product key flyer delivered with the generator.

For more information, refer to section 6 Calibration

4.1.6.4 System Parameters

The System Parameter command opens the System Parameter Wizard dialog to allow adjustment of the generator's system parameters that pertain to the operation, control, limits, etc. The User tab is accessible with User Access Level and lets the user change things like power-up setpoints, supply gas dryness, supply input, and HumiCalc parameters such as molecular weight of the supply gas.



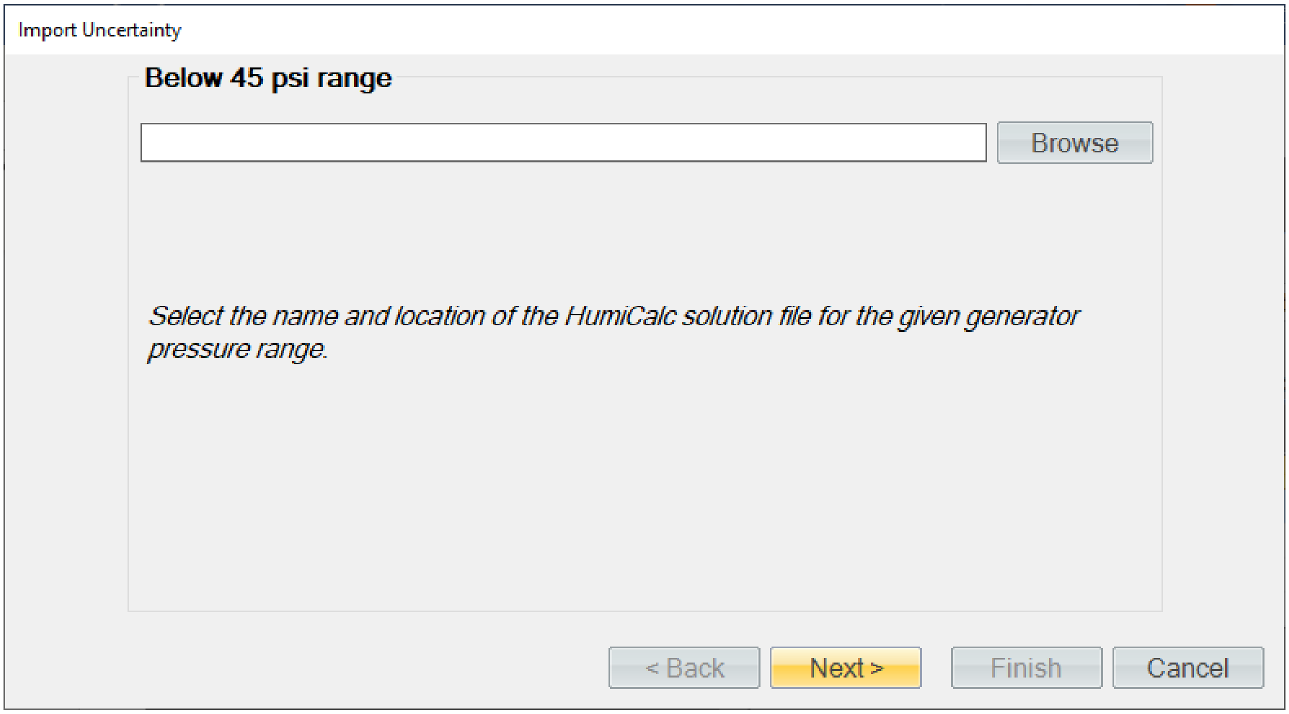
All the other tabs require Admin Access Level, and changes should only be made upon request by Thunder Scientific Technical Support.

4.1.6.5 Expanded Parameters

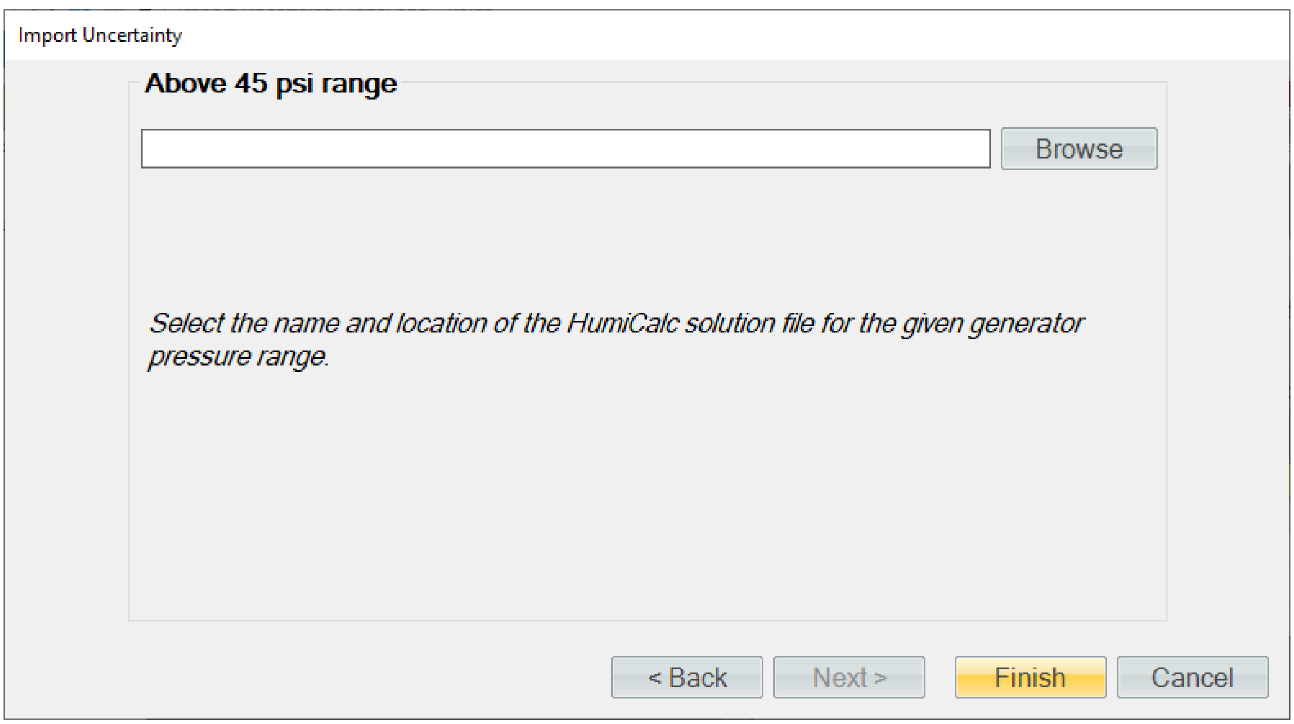
The Expanded Parameters command opens a second tab in the Parameter Tab Group with additional generator parameters used for technical support. This tab does not need to be opened during regular operation but can be used to help diagnose problems when requesting technical support. This tab is automatically displayed when operating the generator under the "Admin" access level.

4.1.6.6 Import Uncertainty Solution (Requires Manager Access Level or above)

The Import Uncertainty Solution file command allows a manager to import a HumiCalc with Uncertainty solution into ControLog to define the uncertainty for the Model 9500 humidity generator. Selecting this command opens an "Import Uncertainty" dialog that steps the user through a two-step import process. The 9500 uses two pressure ranges, one pressure transducer for saturation pressures below 45 psi and one pressure transducer for saturation pressures above 45 psi. These pressure transducers have different uncertainties and therefore require different HumiCalc solutions. Refer to your HumiCalc with Uncertainty Reference Manual for more information on creating uncertainty solutions.



The first step in the import process is selecting the uncertainty solution for the 9500 operating below 45 psi. Clicking the “Browse” button opens a file dialog that allows the user to browse to the desired location for the solution file to open. Once a file has been selected, clicking the “Next” button displays a status dialog as the first solution is imported into ControLog.



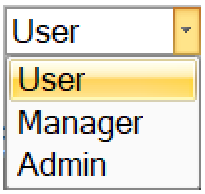
The second step in the import process is selecting the uncertainty solution for the 9500 operating above 45 psi. Clicking the “Browse” button opens a file dialog that allows the user to browse to the desired location for the solution file to open. Once a file has been selected, clicking the “Finish” button completes the import process and displays a status dialog as the second solution is imported into ControLog.

4.1.6.7 HumiCalc with Uncertainty

The HumiCalc with Uncertainty command opens the standalone HumiCalc with Uncertainty application. A USB keyboard is recommended when working with the HumiCalc with Uncertainty application.

4.1.6.8 Access Control

The Access Control Menu allows the user to change the access level. The user can select between User, Manager, and Admin



4.1.6.8.1 User Access Level

The User Access Level is the default level and allows the user to run the generator and calibrate the generator but does not give access to change system parameters, edit calibration coefficients, or open the interface console. No password is required for this level.

4.1.6.8.2 Manager Access Level

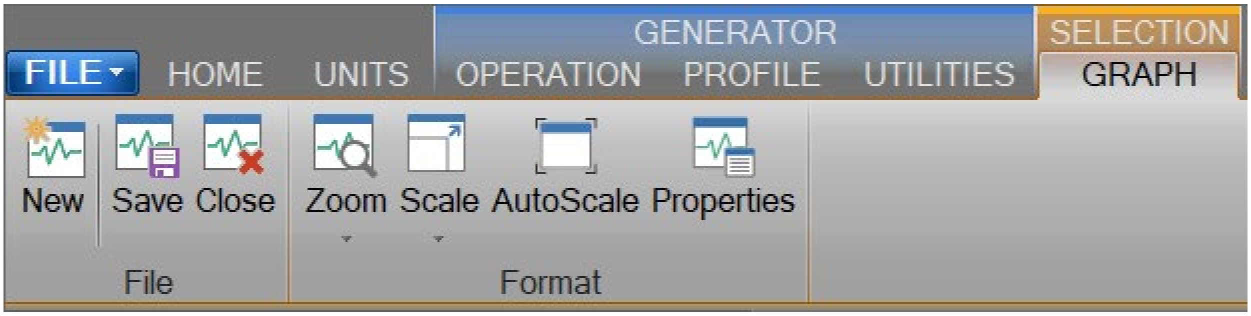
The Manager Access Level is one level above the user level and allows the user to run the generator, calibrate the generator, and edit calibration coefficients but does not give access to change system parameters or open the interface console. A password is required for this level. The passwords are on the yellow product key flyer delivered with the generator.

4.1.6.8.3 Admin Access Level

The Admin Access Level gives the user full access to run the generator, calibrate the generator, edit calibration coefficients, change system parameters, and open the interface console. This level is intended for factory support and should not be used regularly by the user of the 9500. A password is required for this level. The passwords are on the yellow product key flyer delivered with the generator.

4.1.7 Graph Menu Tab

The Graph Menu Tab allows the user to create a New graph, Save, Close, Zoom, Scale, Auto Scale, and set the Properties for the selected graph. The graph menu tab is part of the selection group, which changes based on the selected data, graph, or parameter tab. The Graph Menu Tab only operates on the currently selected graph tab.



For more information, refer to section 7 Graphing.

4.1.7.1 New Graph

The New graph command allows the user to create a new graph. Selecting this command opens a New Graph Wizard dialog that steps the user through the selection process of what data the user would like to include in the new graph. This operation is always available.

4.1.7.2 Save Graph

The Save graph command allows the user to save the selected graph. Selecting this command opens a save file dialog that allows the user to specify the name and browse to the desired location to save the file. ControLog graphs can be saved in the following graphic file types:

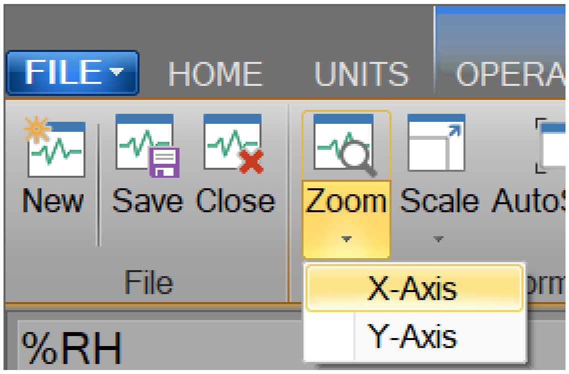
- Joint Photographic Experts Group (*.jpg)
- W3C Portable Network Graphics (*.png)
- Scalable Vector Graphics (*.svg)

4.1.7.3 Close Graph

The Close graph command allows the user to close the selected graph. Selection results in a confirmation message to assure the user wants to close the graph.

4.1.7.4 Zoom Graph

The Zoom graph command allows the user to zoom a rectangular area of the graph. Selecting this command allows the user to create a rectangular area on the graph to be zoomed in.



4.1.7.4.1 Zoom Graph’s X-Axis

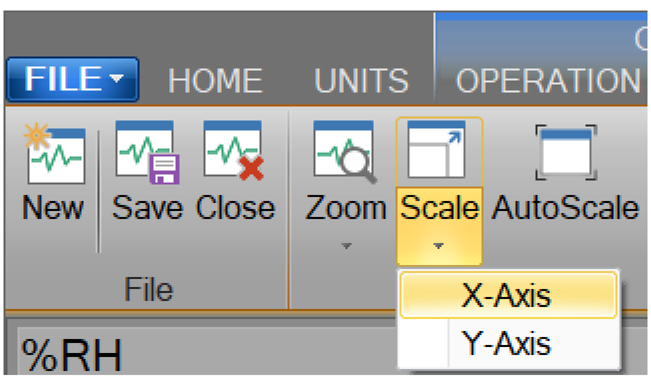
The Zoom X-Axis graph command allows the user to zoom along the graph's X-Axis. Selecting this command allows the user to create a sectioned area on the graph to be zoomed along the X-Axis.

4.1.7.4.2 Zoom Graph’s Y-Axis

The Zoom Y-Axis graph command allows the user to zoom along the graph's Y-Axis. Selecting this command allows the user to create a sectioned area on the graph to be zoomed along the Y-Axis.

4.1.7.5 Scale Graph

The Scale graph command allows the user to scale both the X and Y-axis. Selecting this command allows the user to use the scale using a touch or mouse gesture. Dragging the cursor up scales the display in (zooms in), and dragging the cursor down, scales the display out (zoom out).



4.1.7.5.1 Scale Graph X-Axis

The Scale X-Axis graph command allows the user to scale the X-axis. Selecting this command allows the user to use the scale using a touch or mouse gesture. Dragging the cursor up scales the X-Axis in (zooms X-Axis in), and dragging the cursor down scales the X-Axis out (zooms X-Axis out).

4.1.7.5.2 Scale Graph Y-Axis

The Scale Y-Axis graph command allows the user to scale the Y-axis. Selecting this command allows the user to use the scale using a touch or mouse gesture. Dragging the cursor up scales the Y-Axis in (zooms Y-Axis in), and dragging the cursor down scales the Y-Axis out (zooms Y-Axis out).

4.1.7.6 Auto Scale

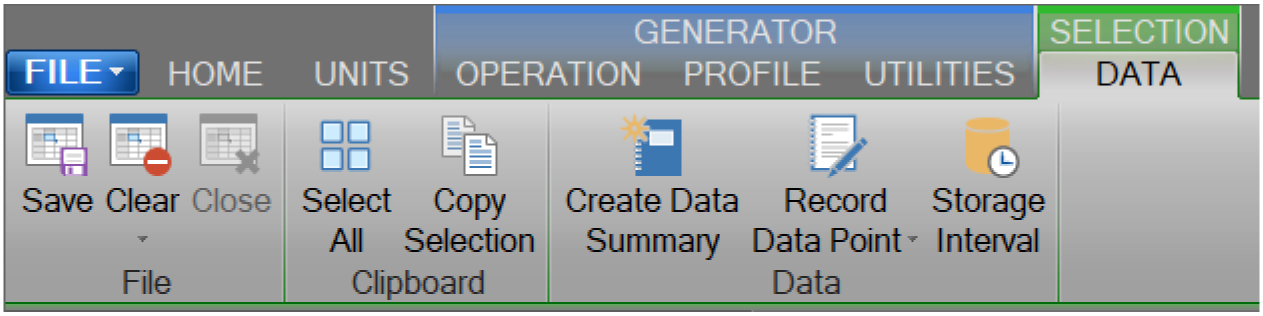
The Auto Scale graph command allows users to reset the graph view to encompass all data. Selecting this command automatically resets both axes of the graph so that the entire data set of each item is contained within the boundaries of the graph.

4.1.7.7 Graph Properties

The Graph Properties graph menu command allows the user to modify the properties of the selected graph. Selecting this command opens the Graph Properties dialog that allows the user to change what data is graphed, the display properties for each line, and the axis values.

4.1.8 Data Menu Tab

The Data Menu Tab allows users to Save, Clear, Close, Select, Copy, Create and change the Storage Interval. The data menu tab is part of the selection group, which changes based on the selected data, graph, or parameter tab. The Data Menu Tab only operates on the currently selected data tab.



For more information, refer to section 8 [Data and Data Summary]

4.1.8.1 Save Data

The Save data command allows the user to save the selected data tab. Selecting this command opens a save file dialog that allows the user to specify the name and browse to the desired location to save the file. ControLog can save data in the following type and format:

- Comma-Separated Values (*.csv)
- Text File (Comma Delimited) (*.txt)
- Text File (Tab Delimited) (*.txt)
- Excel Workbook (*.xlsx)
- Excel 97-2003 Workbook (*.xls)

4.1.8.2 Clear Data

The Clear data command allows the user to clear the selected data tab. ControLog asks the user to save any unsaved data tab before the tab is cleared. This operation is available only when at least one data point has been recorded in the selected data tab.

4.1.8.3 Close Data

The Close data command allows the user to close the selected data tab. ControLog asks the user to confirm before closing the tab. If there is any unsaved data, ControLog prompts the user to save the data before the tab is closed. This operation is available only when the device for the selected data tab is disconnected.

4.1.8.4 Select All Data

The Select All data command allows the user to select all the data within a data tab.

4.1.8.5 Copy Selection

The Copy Selection command allows the user to copy the selected data within a data tab to the clipboard. Selecting this command copies the selected data within a data tab to the clipboard in a tab-delimited format. This data may then be pasted into another program.

4.1.8.6 Create Data Summary

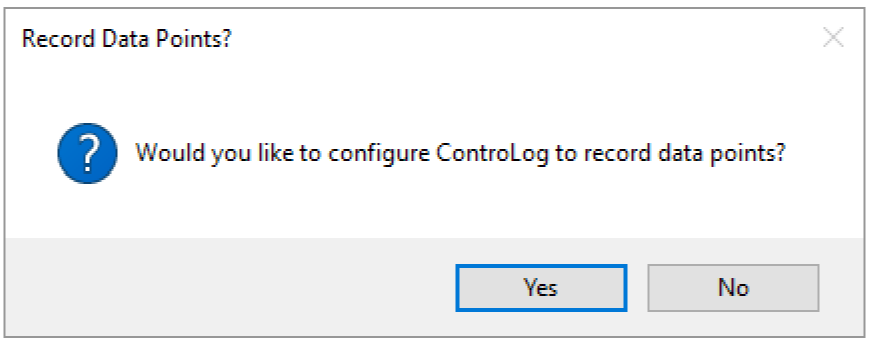
The Create Data Summary data command allows the user to create a summary of any currently opened data. The feature lets the user specify items from which device and at what intervals to include in the data summary. The data summary can also calculate the error between the specified standard and the device under test. This operation is available whenever an open Data tab contains data.

For more information, refer to section 8 [Data and Data Summary]

4.1.8.7 Record Data Point

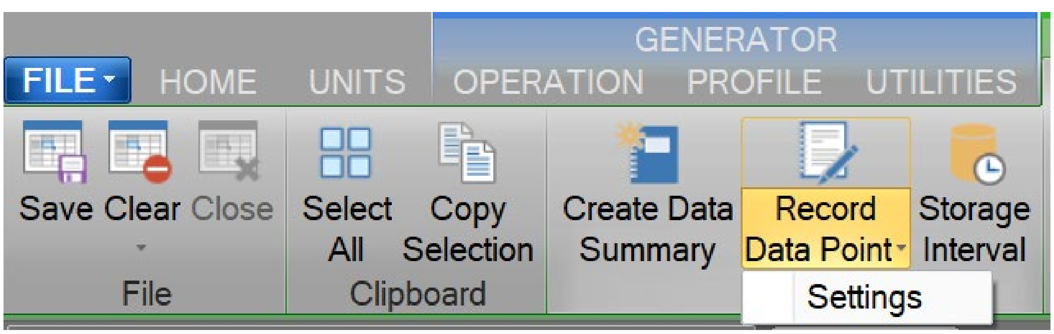
The Record Data Point data command is the same as the one on the Home tab. It allows the user to record certain data items from any currently connected device either manually, with each manual device entry, or at the completion of each soak phase in an auto profile. The user can specify the number of prior data points to include and has the option to automatically calculate the average and or standard deviation of the prior data points. There are two submenus for this menu command; Settings and Take Point. This operation is available whenever device or generator data is being logged. The user can manually take a point using the button or the keyboard shortcut "Ctrl-P".

If the user has not configured the system to record data points, then ControLog asks the user if they would like to define the settings before taking a point.



4.1.8.7.1 Settings

The Settings submenu allows the user to define which data items and from which connected device they would like to record when a point is taken. They can also define the number of points to include and whether to calculate the average and/or standard deviation. The user can also configure when to take points manually, at the end of a profile soak phase or when a manual device entry is taken.



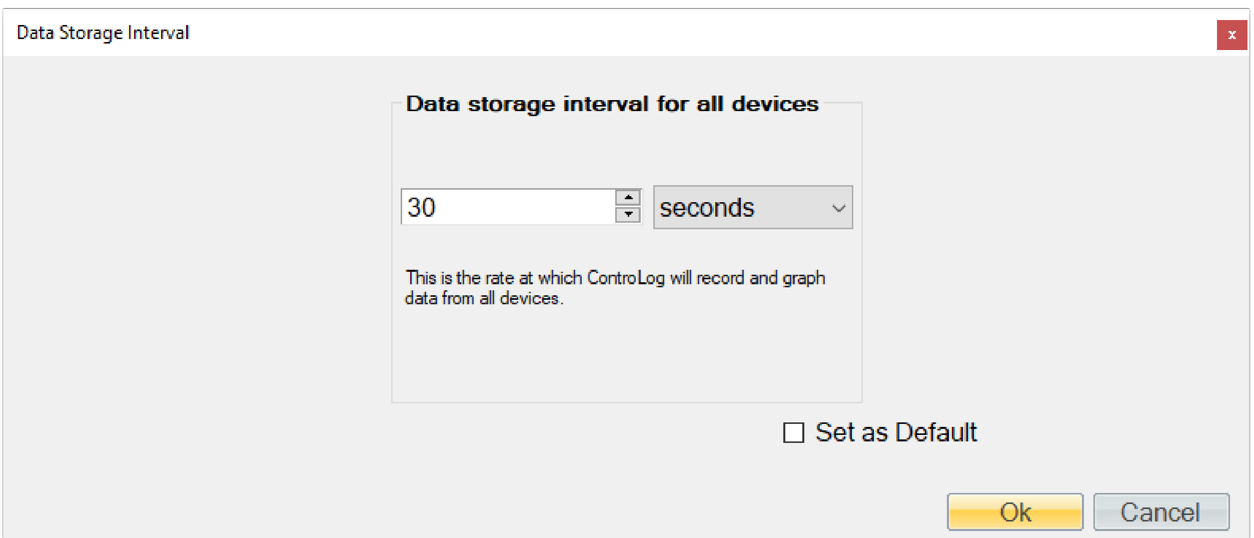
For more information, refer to section 8 [Data and Data Summary]

4.1.8.8 Data Storage Interval

The Data Storage Interval data command allows the user to change the storage interval that data is recorded. This is the rate at which data is recorded to the data tabs for all connected devices. Selecting this command opens the "Data Storage Interval" dialog, allowing the user to change the data storage interval during the generate operation. The new value becomes the default start-up interval if the "Set as Default" is checked. If not checked, the new value only affects the current session.

IMPORTANT!

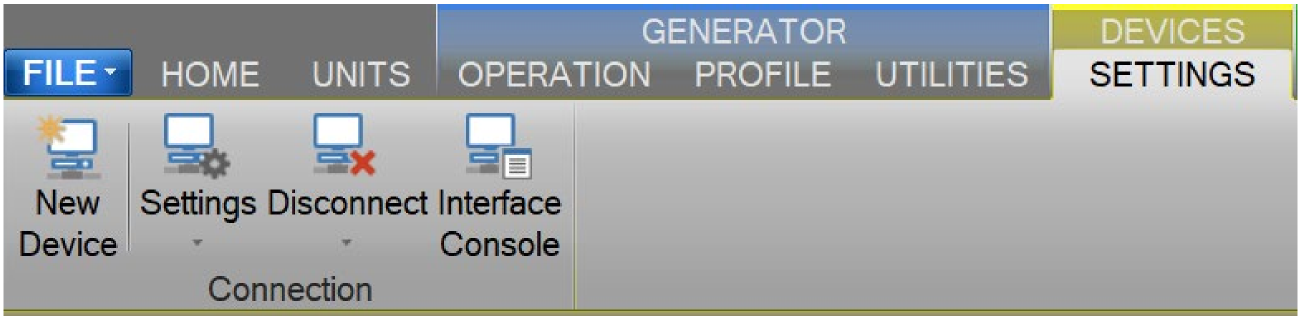
STORING AND MAINTAINING DATA CAN BECOME A TIME-CONSUMING PROCESS. THE MORE DATA THAT IS STORED IN THE DATA TAB, THE SLOWER AND LESS RESPONSIVE THE COMPUTER MAY SEEM. FOR THIS REASON, SOME CONSIDERATION SHOULD BE GIVEN TO THE AMOUNT OF DATA DESIRED, THE OVERALL TIME SPAN OF THE DATA (I.E., HOURS, DAYS, POSSIBLY WEEKS), AND ULTIMATELY THE DATA INTERVAL.



Note - *Data is only recorded while the 9500 is in generate mode.*

4.1.9 Device Settings Menu Tab

The Settings Menu Tab in the devices group allows the user to create a new device connection, change the settings of a device connection, disconnect a device connection, and open an interface console to view communication with a device.



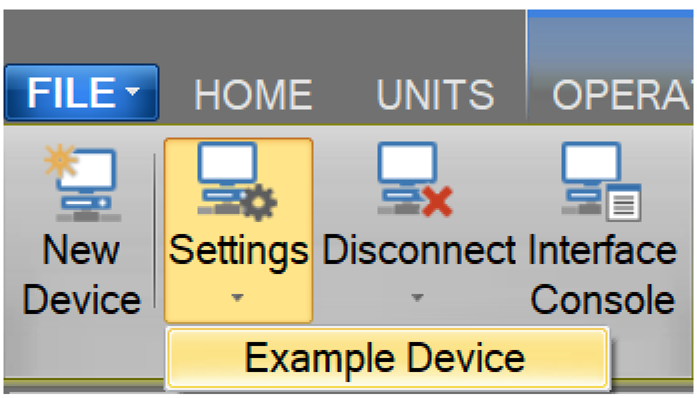
4.1.9.1 New Device

The New Device connection command allows the user to create a new device connection. Selecting this command opens a Connection Wizard dialog that steps the user through the process of creating a new connection to a device.

For more information, refer to section 10 Connections

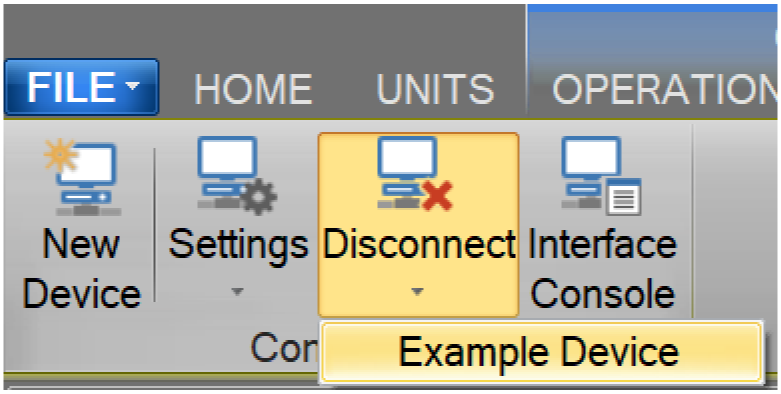
4.1.9.2 Settings

The Settings connection menu command allows the user to change the settings for a specific connection. Selecting this command opens the Connection Wizard dialog for the selected connection, allowing the user to change connection settings as desired.



4.1.9.3 Disconnect

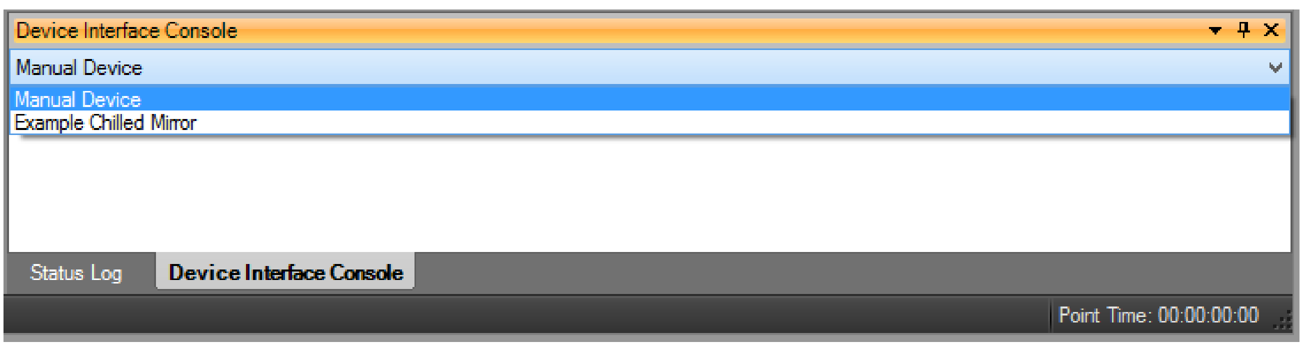
The Close connection menu command allows the user to close a specific connection. ControLog asks the user to confirm before closing the connection.



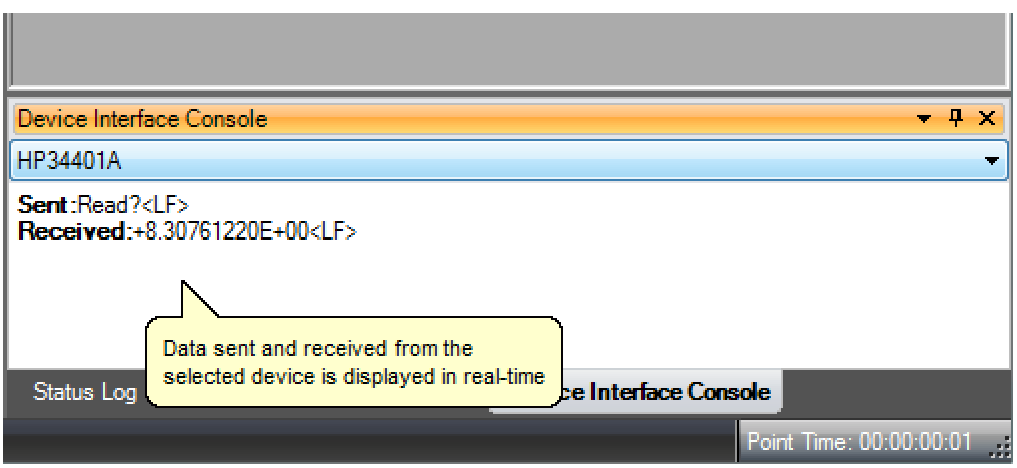
4.1.9.4 Interface Console

The Open Device Interface Console connection menu command under Settings allows the user to open a device console tab. The device console tab allows the user to view the commands sent to and received from any connected device.

The user can select which connected device to view using the drop-down selection at the top of the tab.

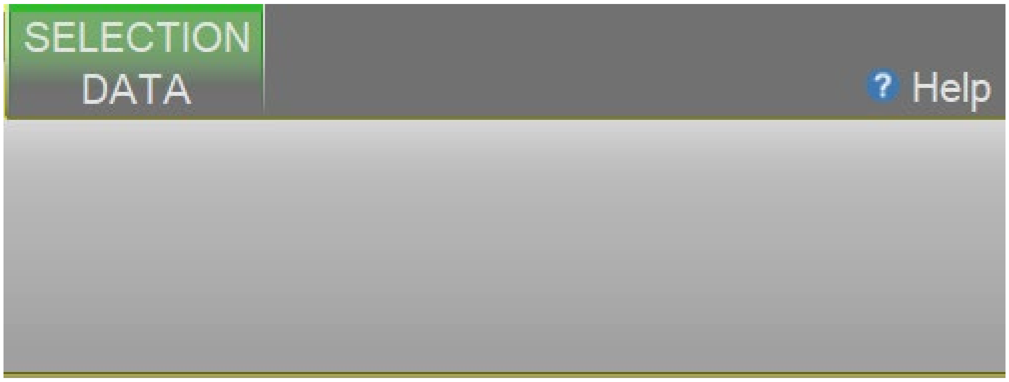


The data sent to and received from the selected device is displayed in the lower text area of the console tab.



4.1.10 Help

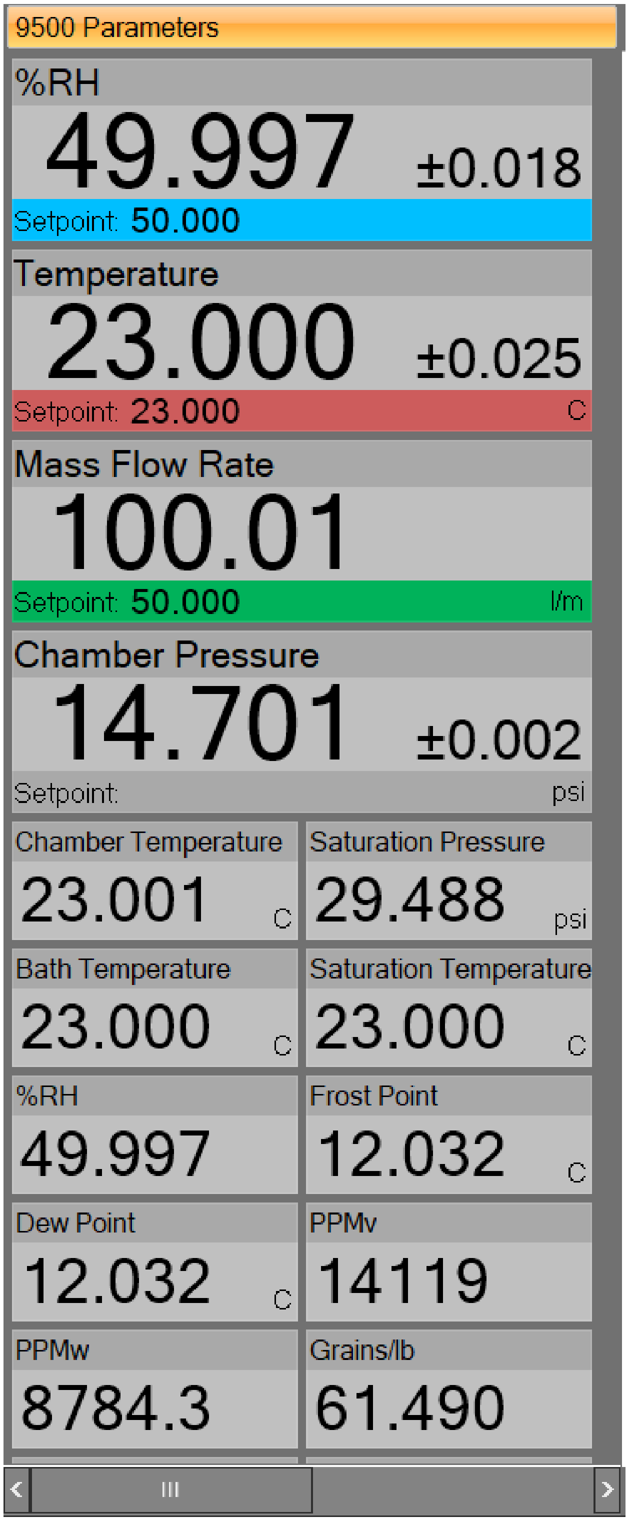
The Help Menu on the right side of the ribbon menu allows the user to open the 9500 System Manual (this document).



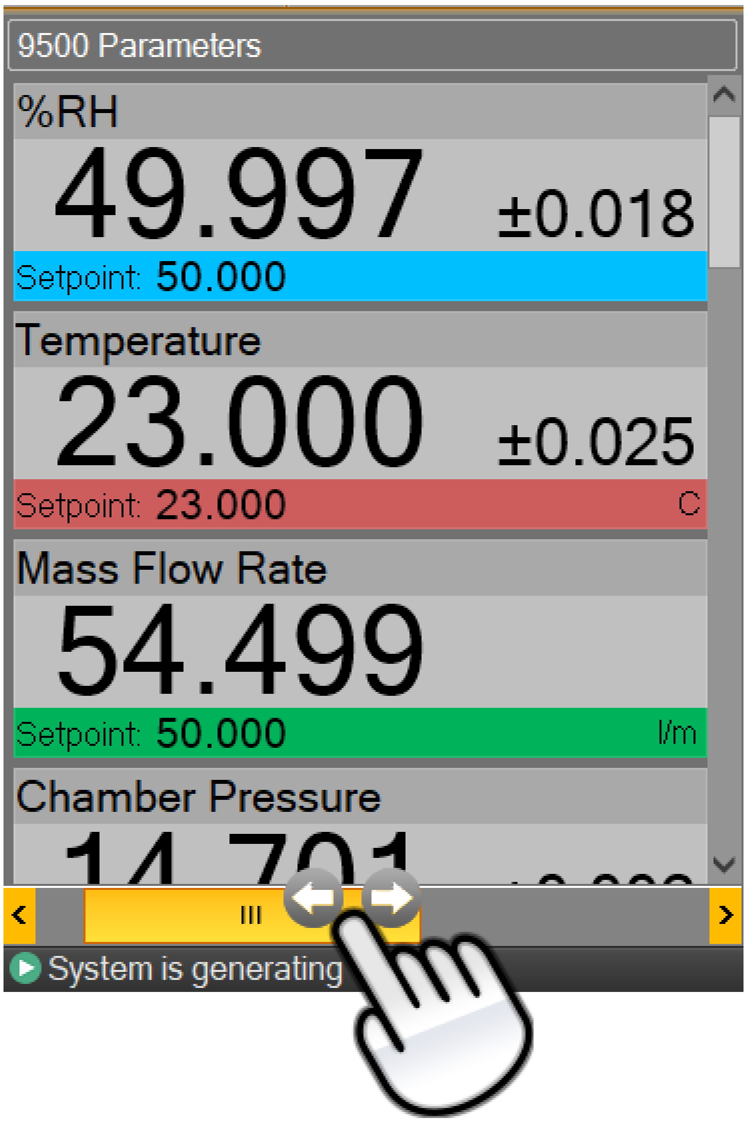
Note – *Refer to the Thunder Scientific website (www.thunderscientific.com) for the latest manual edition and other information on your Model 9500 Humidity System.*

4.2 Parameters Tab Group

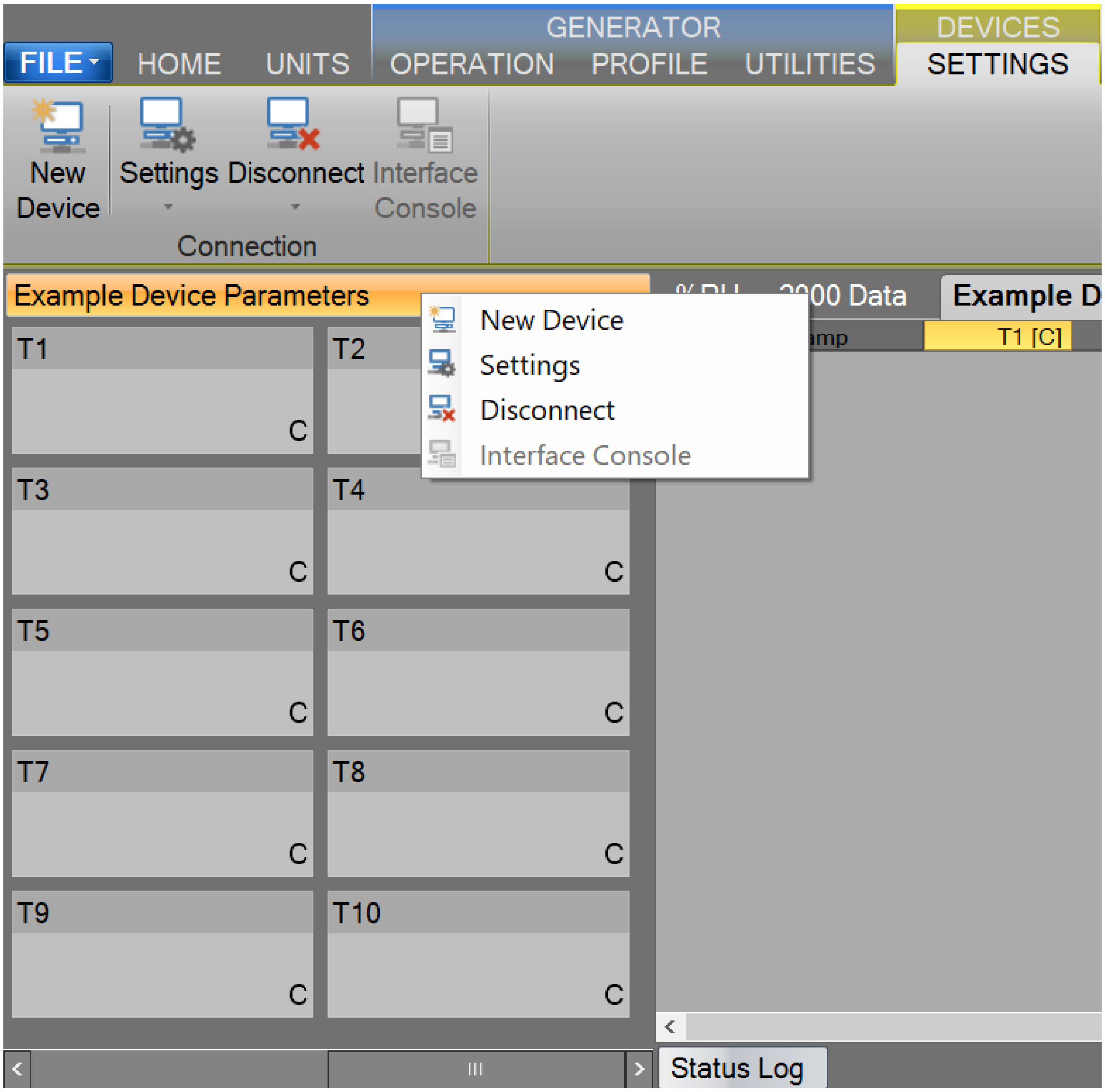
The Parameter Tab Group is located on the left side of the application and contains a parameter tab for each connected device. Each parameter tab displays the current data for its device, and a parameter tab can be selected using the scroll bar at the bottom of the group.



If multiple parameter tabs are open, the user can access other tabs using the scroll bar at the bottom of the group.

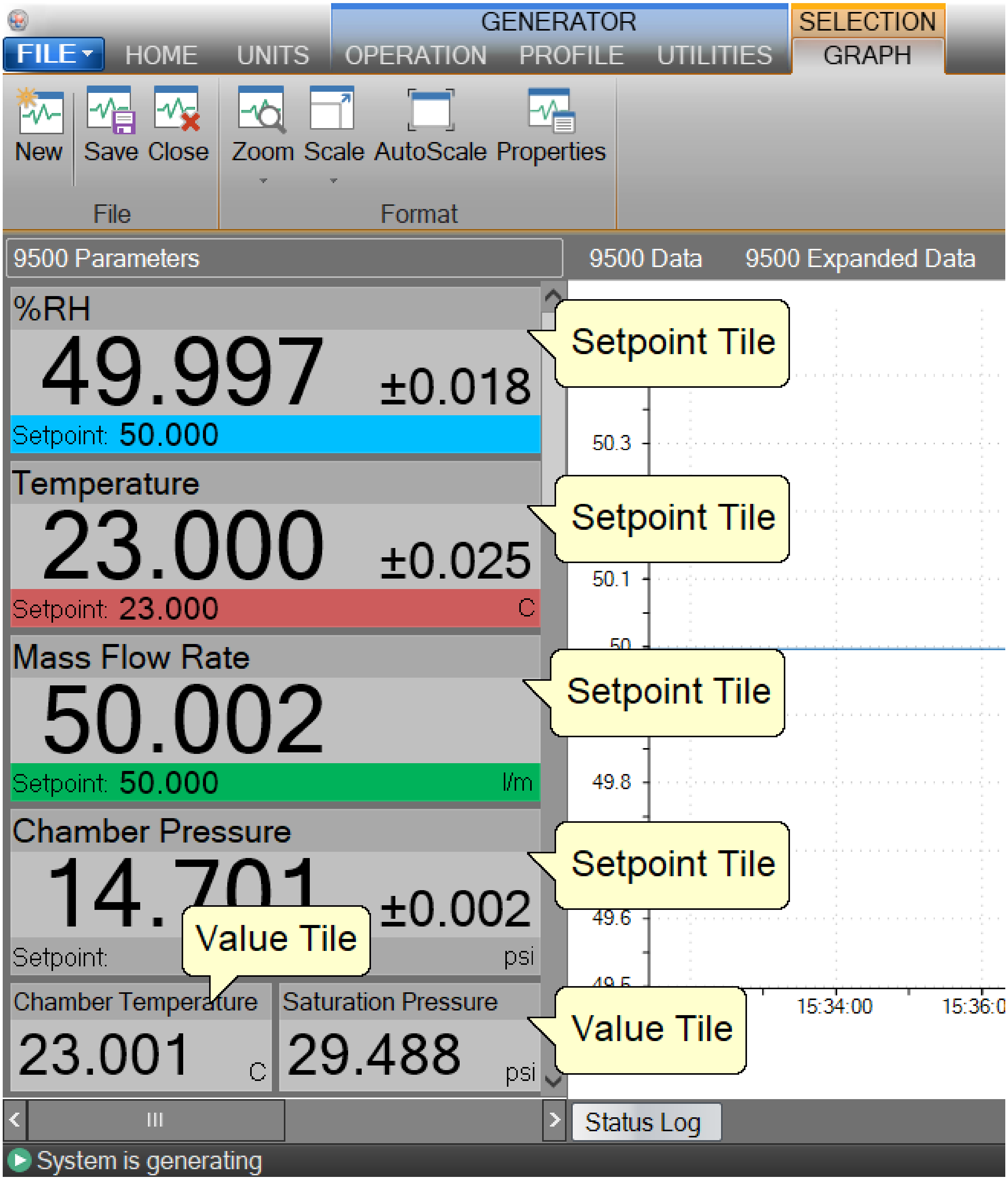


All Device Parameter Tabs have a context menu that can be displayed by long-pressing the tab title area or by right-clicking in the tab area. The context menu allows quick access to the device-related functions in the Settings Menu Tab.



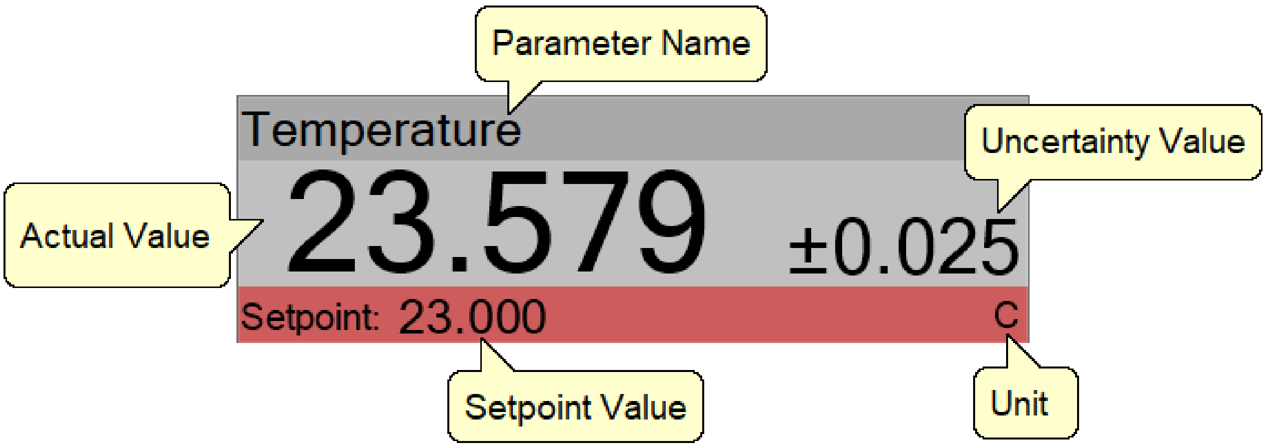
4.2.1 Tiles

Within each parameter, tab area are tiles allowing the user to setpoints, view actual values, and view real-time uncertainty values. There are two different tiles: a Setpoint Tile and a Value Tile.



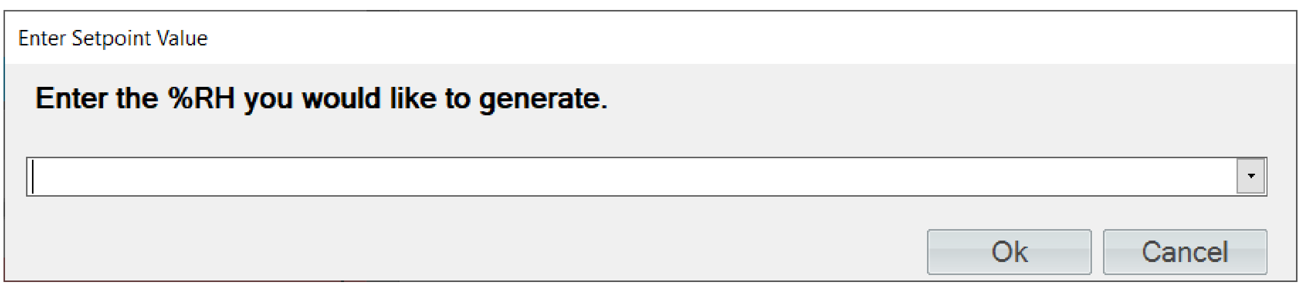
4.2.1.1.1 Setpoint Tile

The Setpoint Tiles allow the user to control the operation of the humidity generator by changing the desired setpoint that the generator controls. The Tiles contain 5 essential parts; a header with the Parameter Name, the Actual Value, the real-time Uncertainty Value, the Setpoint Value, and the Unit of the displayed values. Each setpoint tile has a colored bar to quickly indicate what the tile is displaying and, in turn, what the system is controlling. Blue is for the humidity being generated, red is for the temperature the system is controlling at, and green is for the flow rate at which the system generates the humidity.



4.2.1.1.1.1 Changing Setpoints

To change a setpoint, click on the setpoint tile that you would like to change. A setpoint entry box will appear. For example, to change the Percent Relative Humidity setpoint, click on the %RH setpoint tile.

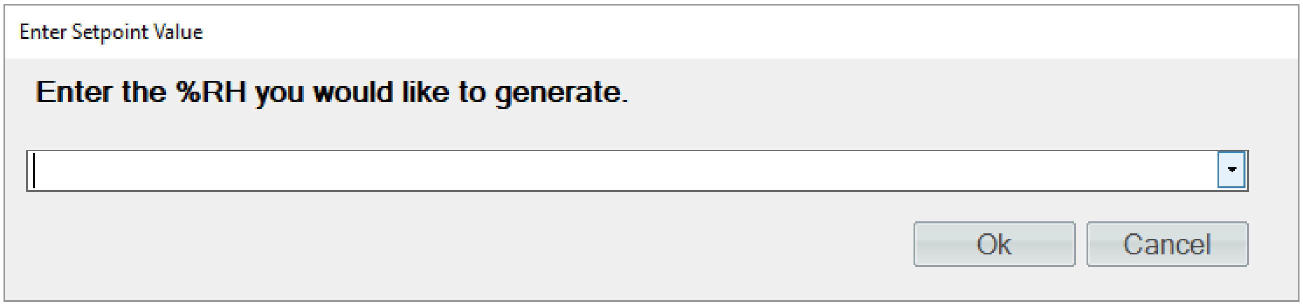


Enter the new value into the Setpoint Entry box and select Ok. Notice that the Percent Relative Humidity setpoint value updates to the new value, and the actual values begin moving toward the new setpoint.

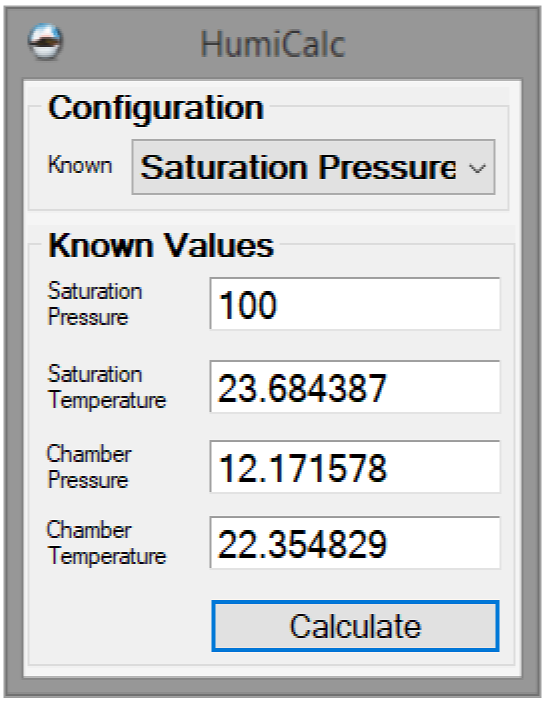
The user can also pop up a mini version of HumiCalc to help calculate the desired setpoint by clicking the drop-down arrow on the setpoint entry box.

For example, let us say the user wants to calculate the lowest %RH achievable given a limited supply pressure of only 100 psi.

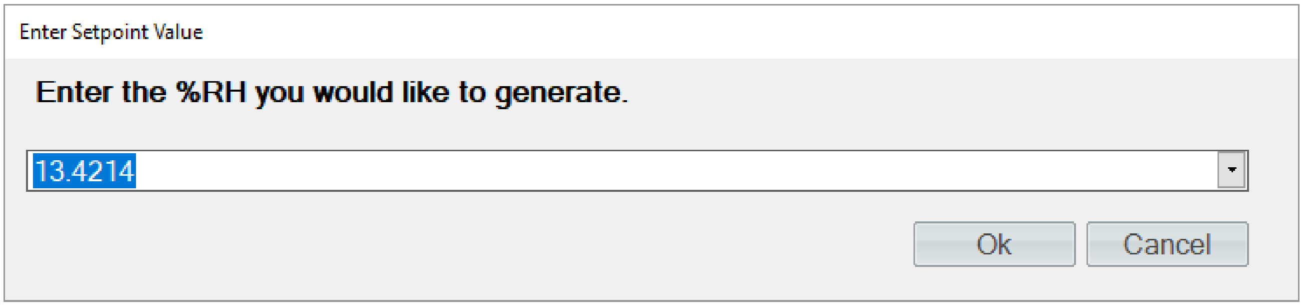
Start by opening the HumiCalc pop-up using the drop-down arrow at the right of the setpoint entry box.



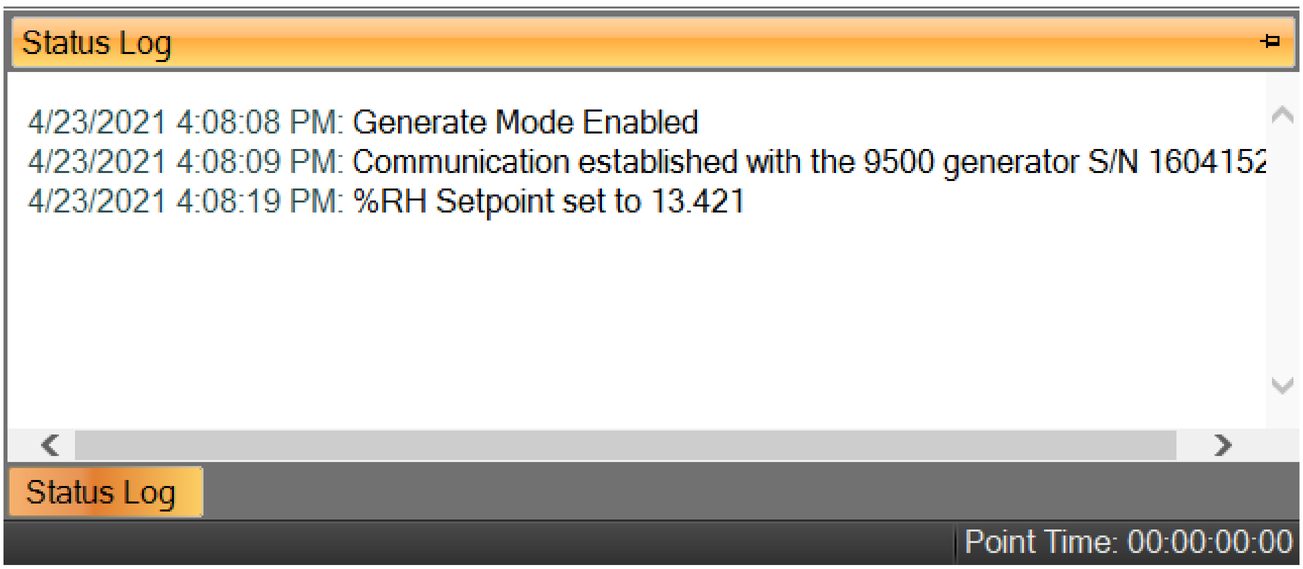
Next, select the known dropdown to be Saturation Pressure and enter the 100 psi supply pressure max.



Clicking the “Calculate” button results in the calculated %RH based on the 100 psi limit placed in the Setpoint Entry Box and closes the HumiCalc pop-up.

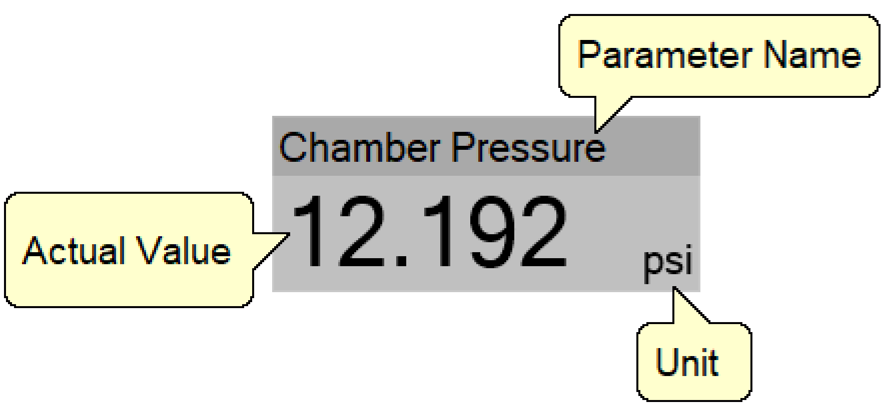


Clicking “Ok” closes the setpoint entry and sends the setpoint to the Model 9500 Humidity generator.



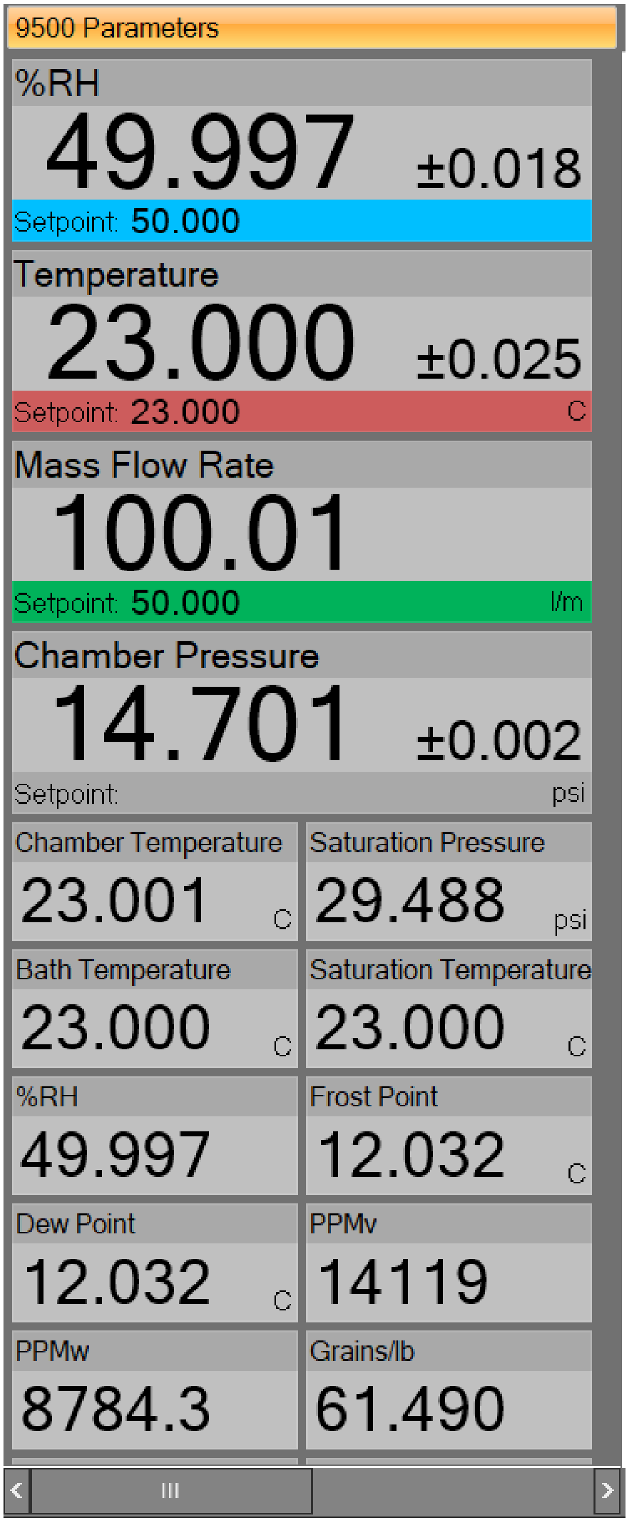
4.2.1.1.2 Value Tile

The Value Tiles display an actual value of a given parameter to the user. The Tiles contain 3 essential parts; a header with the Parameter Name, the Actual Value, and the Unit of the displayed value.

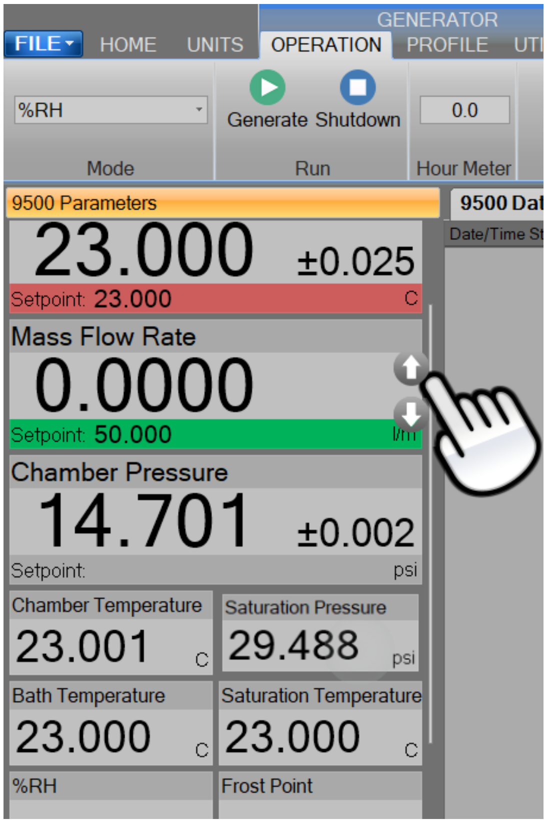


4.2.2 9500 Parameter Tab

The 9500 Parameters contain all the control and measurement parameters critical to the operation of the humidity generator.



The 9500 Parameters can be scrolled up and down to show the currently generated humidity in different humidity terms that are calculated using the HumiCalc with Uncertainty engine, along with other values that are important to the operation of the 9500 generator.



4.2.2.1 Actively Controlled Humidity

The first tile on the Control Parameters is the actively controlled humidity parameter. For instance, if ControLog were set to control the generator on dew point, Dew Point would be listed as the first parameter rather than %RH.

This setpoint controls the humidity being generated.

4.2.2.2 Temperature

Temperature is the temperature reading of the bath fluid temperature probe (RTD1), directly indicating the fluid system temperature.

The Temperature setpoint controls the fluid temperature within the system while generating and indirectly the saturation and chamber temperature.

4.2.2.3 Mass Flow Rate

Mass Flow Rate is a corrected (for water vapor) flow rate based on the flow meter (T5) reading of the air supply entering the pre-saturator. This mass flow rate indicates the total flow entering the chamber from the system once the saturation and chamber pressure have stabilized.

The Mass Flow Rate setpoint controls the mass flow rate of the system.

4.2.2.4 Chamber Pressure

Chamber Pressure (Pc) is the pressure reading of the chamber pressure transducer (T2).

For more information, refer to section 3 Principle of Operation

The Chamber Pressure setpoint controls the pressure within the chamber while generating. The 9500 has the ability to control the pressure within the chamber above ambient pressure. To enable chamber pressure control, enter a setpoint value above the current ambient pressure. Enter a setpoint value of 10.0 psi or less to disable chamber pressure control.

CAUTION!

DISABLE CHAMBER PRESSURE CONTROL OR SHUTDOWN THE GENERATOR BEFORE ATTEMPTING TO OPEN THE CHAMBER LID OR ACCESS PORT. NEVER ENABLE CHAMBER PRESSURE CONTROL WITH THE CHAMBER LID OPEN OR WITH AN OPEN ACCESS PORT.

4.2.2.5 Chamber Temperature

Chamber Temperature (Tc) is the temperature reading of the chamber temperature probe (RTD2).

For more information, refer to section 3 Principle of Operation

4.2.2.6 Saturation Pressure

Saturation Pressure (Ps) is the pressure reading of the low or high-range pressure transducer (T3/T4).

For more information, refer to section 3 Principle of Operation

4.2.2.7 Bath Temperature

Bath Temperature is the temperature reading of the bath fluid temperature probe (RTD1), which directly indicates the fluid system temperature.

4.2.2.8 Saturation Temperature

Saturation Temperature (Ts) is the temperature reading of the saturator temperature probe (RTD3).

For more information, refer to section 3 Principle of Operation

4.2.2.9 %RH

Percent Relative Humidity (%RH) is the ratio of the amount of water vapor in a given sample to the maximum amount possible at the same temperature and pressure. %RH is calculated at the chamber pressure and chamber temperature relative to the saturation pressure and saturation temperature. This is the most accurate calculation of %RH at the point near the chamber temperature probe. Placing the chamber temperature probe at the humidity sensing point of the devices under test gives the actual value of the relative humidity being imposed on the devices, as it depends on pressure and temperature.

4.2.2.10 Frost Point

Frost Point Temperature (Tf) is the temperature to which gas must be cooled in order to just begin condensing water vapor in the form of frost or ice, and therefore only exists at values below 0.01 °C. When operating the system with indicated Frost Points above 0.01 °C, the values indicated are to be interpreted as

Dew Points. However, Frost Point is not the same as Dew Point for values below freezing. Frost Point is independent of test chamber temperature.

4.2.2.11 Dew Point

Dew Point Temperature (Td) is the temperature to which gas must be cooled in order to just begin condensing water vapor in the form of dew. Generally, Dew Point exists at temperatures above freezing. In many instances, Dew Point may exist at indicated values below freezing (super-cooled dew). However, it is important to note that Dew Point is not the same as Frost Point. Dew Point is independent of test chamber temperature.

4.2.2.12 PPMv

Parts per Million by Volume is a ratio of the number of molecules of water vapor to the number of molecules of the other constituents in the gas. Once established, PPMv is pressure and temperature insensitive and is therefore independent of test chamber temperature and test chamber pressure.

4.2.2.13 PPMw

Parts per Million by Weight is a ratio of the weight of the water vapor in a sample to the weight of the remaining constituents in the gas. Once established, PPMw is pressure and temperature insensitive and is therefore independent of test chamber temperature and test chamber pressure.

4.2.2.14 Grains/lb

Grains per pound is a ratio of the weight, in grains, of water vapor to the weight, in pounds, of the other constituents in the gas. (7000 grains = 1 pound). Once established, Grains/lb is pressure and temperature insensitive and is therefore independent of test chamber temperature and test chamber pressure.

4.2.2.15 Enthalpy

Enthalpy is a measure of the amount of energy required to change gas from one temperature/humidity value to another. In application, enthalpy is not used as an absolute value, but rather it is the difference in enthalpy between two distinct points which are of interest. Therefore, the datum point that results in zero enthalpy is arbitrarily chosen at a test temperature of 0 °C and 0 %RH. Applying enthalpy is a matter of computing the difference in enthalpy between two or more distinct data points.

4.2.2.16 SVP@Tt

Saturation Vapor Pressure (SVP) is computed at the Test Temperature.

4.2.2.17 SVP@Td

Saturation Vapor Pressure (SVP) is computed at the Dew/Frost Point Temperature.

4.2.2.18 SVP@Ts

Saturation Vapor Pressure (SVP) is computed at the Saturation Temperature.

4.2.2.19 F@Tt.Pt

Enhancement Factor at Test Temperature and Pressure.

4.2.2.20 F@Td.Pt

Enhancement Factor at Dew/Frost Point Temperature and Test Pressure.

4.2.2.21 F@Ts.Ps
Enhancement Factor at Saturation Temperature and Pressure.

4.2.2.22 Specific Humidity
Specific Humidity is a ratio of the water vapor's weight to the humidified gas's total weight. Specific Humidity is independent of test chamber temperature.

4.2.2.23 Absolute Humidity
Absolute Humidity is the weight of the water vapor per unit volume of humidified gas.

4.2.2.24 Dry Air Density
Dry Air Density is the *partial* density in weight per unit volume of only the dry air portion of a moist air sample. In other words, if the water vapor were removed from a fixed volume of air, the remaining dry air would exhibit this density.

4.2.2.25 Moist Air Density
Moist Air Density is the total weight per unit volume of a moist air sample. This density includes both the weight of the air and the weight of the water vapor.

4.2.2.26 Wet Bulb Temperature
Wet Bulb temperature is used in wet bulb/dry bulb aspirated Psychrometry and is the temperature measured by a temperature probe whose tip is coated with water (typically by being covered with a wet sock). When aspirated at a constant air velocity, the wet bulb cools due to the evaporation of the water from the probe. The cool temperature, to which it equilibrates, is used in the calculation of humidity parameters.

4.2.2.27 Mixing Ratio by Volume
Mixing Ratio by Volume is a ratio of the partial pressure of the water vapor to the partial pressure of the remaining constituents in the sample. Mixing Ratio by Volume is independent of test chamber temperature.

4.2.2.28 Mixing Ratio by Weight
Mixing Ratio by Weight is a ratio of the weight of the water vapor to the weight of the remaining constituents in the sample. Mixing Ratio by Weight is independent of test chamber temperature.

4.2.2.29 Percent by Volume
Percent by Volume is a ratio (expressed as a percentage) of the partial pressure of the water vapor to the total pressure of the sample. Percent by Volume is independent of test chamber temperature.

4.2.2.30 Percent by Weight
Percent by Weight is a ratio (expressed as a percentage) of the water vapor's weight to the sample's total weight. Percent by Weight is independent of test chamber temperature.

4.2.2.31 Vapor Mole Fraction
Vapor Mole Fraction is the mole fraction of water vapor in a sample.

4.2.2.32 Dry Air Mole Fraction
Dry Air Mole Fraction is the mole fraction of the dry air portion of a sample. The dry air portion is considered to be all constituents in a gas exclusive of the water vapor.

4.2.2.33 High-Range Transducer
The High-Range Transducer is the current pressure reading of the T4 pressure transducer used to measure saturation pressures above 45 psiA.

4.2.2.34 Low-Range Transducer
The Low-Range Transducer is the current pressure reading of the T3 pressure transducer used to measure saturation pressures up to 45 psiA.

4.2.2.35 Cabinet Temperature
Cabinet Temperature is the temperature reading of the cabinet temperature probe (RTD6).

4.2.2.36 Exp-Valve Temperature
The Exp-Valve Temperature is the temperature reading of the expansion valve probe (RTD5)

For more information, refer to section 3 Principle of Operation

4.2.2.37 Pre-Saturator Temperature
The pre-saturator temperature is the temperature reading of the pre-saturator probe (RTD4).

For more information, refer to section 3 Principle of Operation

4.2.2.38 Supply Pressure
Supply pressure is the pressure reading of the gas supply pressure transducer (T1). The supply pressure value is gauge pressure.

4.2.2.39 Water Reservoir Level
Water reservoir level (LL1, LL1P) is the liquid level reading of the water within the reservoir.

Refer to section 5.1.1 Fill Water Reservoir for detailed instructions on filling the reservoir.

4.2.2.40 Holding Tank Level
Holding Tank Level (LL6) is the measured water level in the bath holding tank. The actual water level in the holding tank varies based on whether the bath is in the upper or lower position.

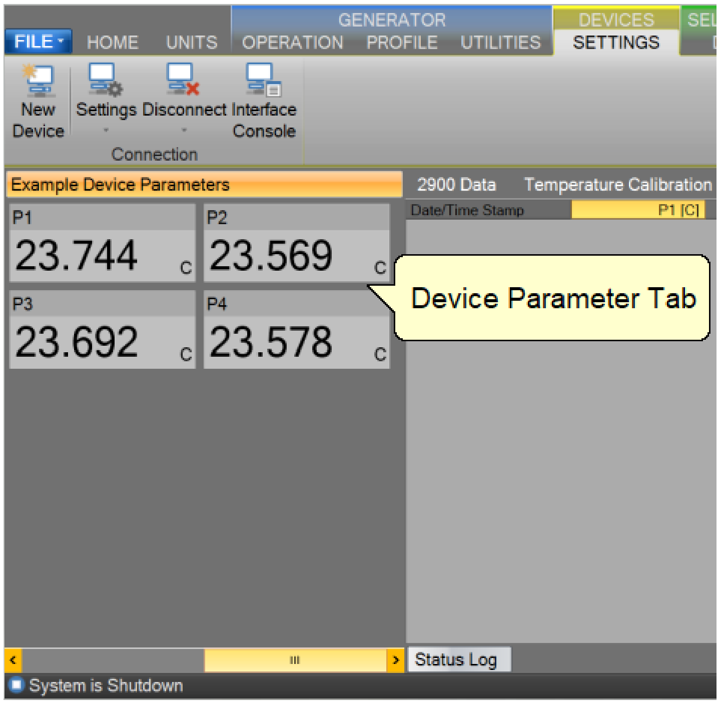
Refer to section 5.3.1 Fill Holding Tank for detailed instructions on filling the reservoir.

4.2.2.41 Bath Reserve Level
Bath Reserve Level is a calculated level value showing a 0% to 100% scale of the available water for the bath in the Holding Tank. Water is removed or added to the Holding Tank as the Bath is raised or lowered, and its level changes accordingly. The Bath Reserve level indicates only what is in reserve for the bath.

4.2.2.42 Bath Level
Bath Level shows the current state of the bath (at the upper level, at the lower level, or transitioning between the two).

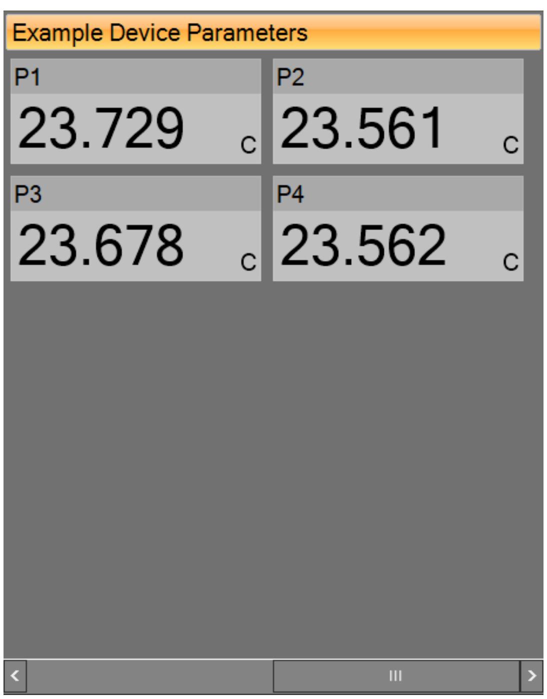
4.2.3 Device Parameter Tabs

The Device Parameter Tabs show the current actual values for the given device. The tabs are visible whenever the device is connected. The Device Parameters display a scrollbar as needed to allow for varying display sizes without data loss.



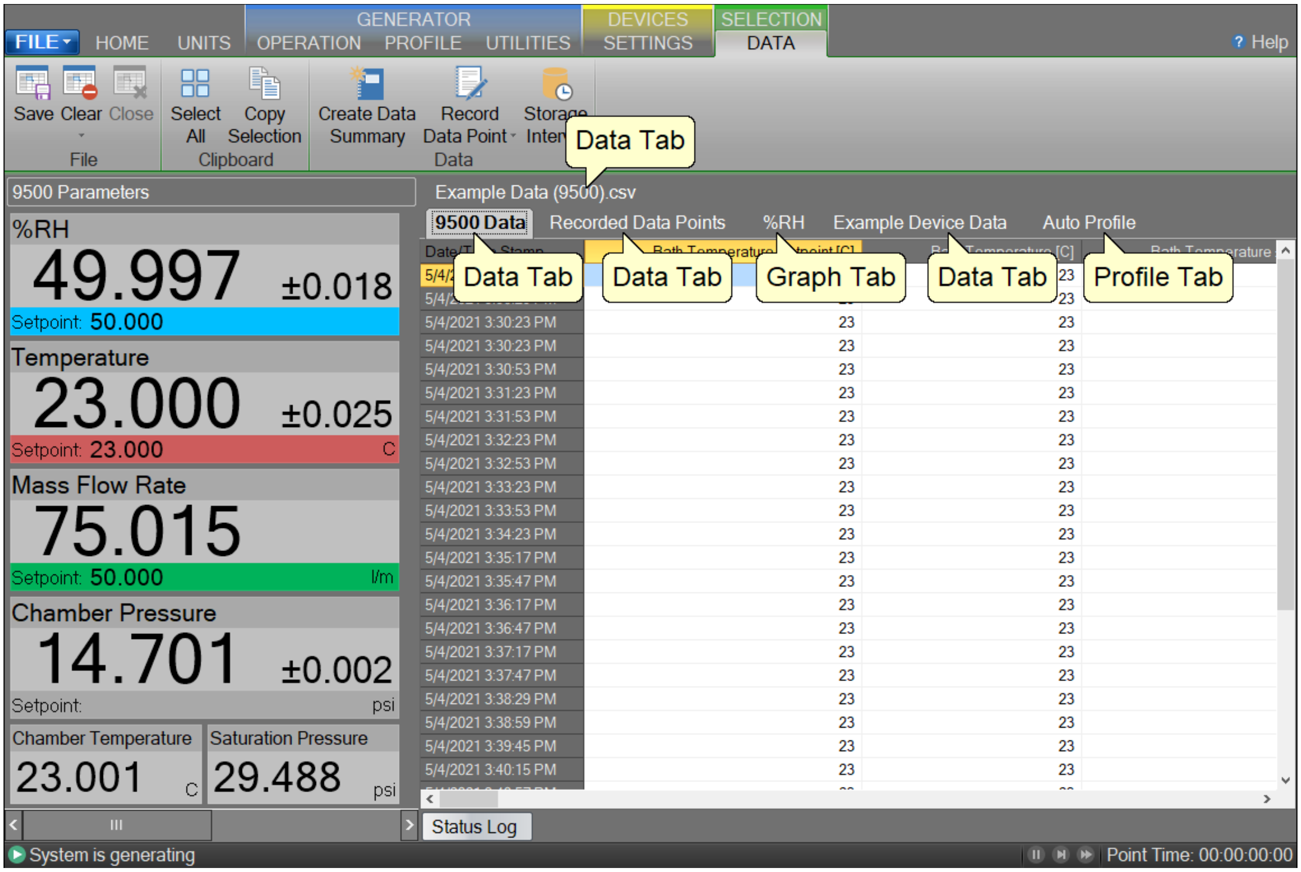
4.2.3.1 Device Parameters

Device Parameters contain all the most recent actual measurement parameters received from the device. Each parameter is displayed in a separate Value Tile.

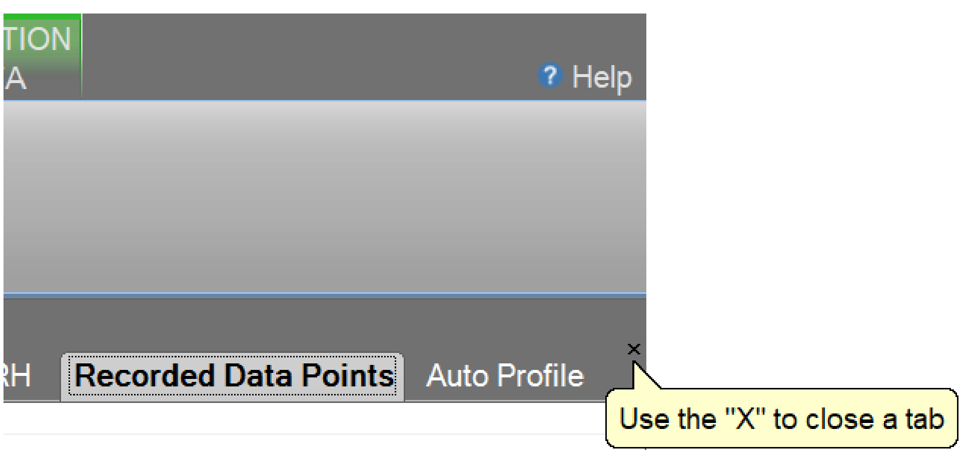


4.3 Data and Graph Tab Group

The Data and Graph Tab Group is located in the middle right of the application and can contain data, graph, and profile tabs. Data and Graph tabs are fixed tab-style windows that can be selected by clicking the desired tab labels at the top.



In addition to using the "Close Data" command from the ribbon menu, a Data and Graph Tab can be closed depending on the state of the device or generator using the "X" in the upper right-hand corner.



4.3.1 Data Tabs

Data Tabs contain a spreadsheet-type view of the logged data.

For more information, refer to section 8 Data and Data Summary

4.3.2 Graph Tabs

Graph Tabs contain a pictorial view of the logged data.

For more information, refer to section 7 Graphing

4.3.3 Profile Tab

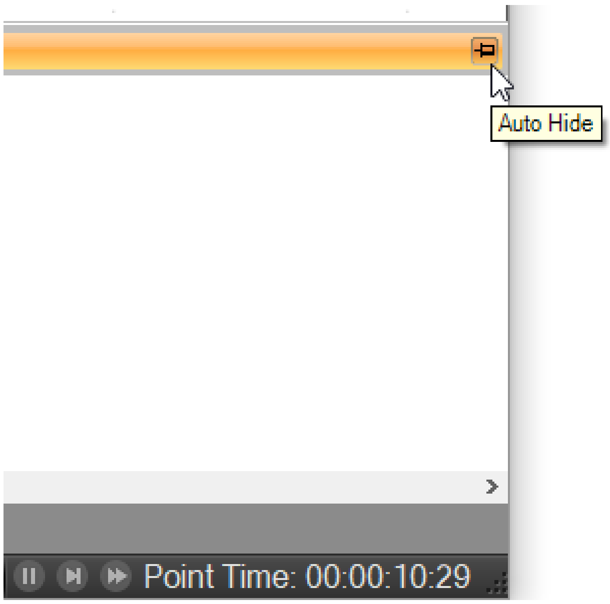
The Profile Tab contains the profile point definitions for an auto profile.

For more information, refer to section 9 Auto Profiling

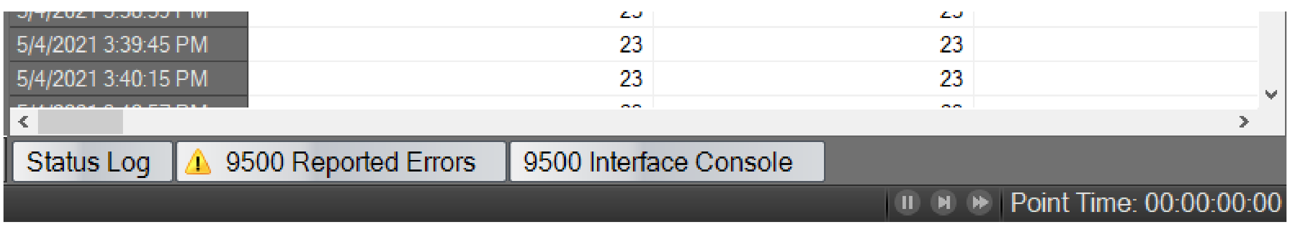
4.4 Information Tab Group

The Information Tab Group is located on the bottom right-hand side of the application. This docking-style window can be "pinned" open or allowed to close when not active. An information tab is selected by clicking its tab label at the bottom of the group. The Information Tab Group contains status information about the operation of the generator and its connected devices. The group can consist of a Status Log tab, a 9500 Warnings & Errors tab, and a 9500 Interface Console tab.

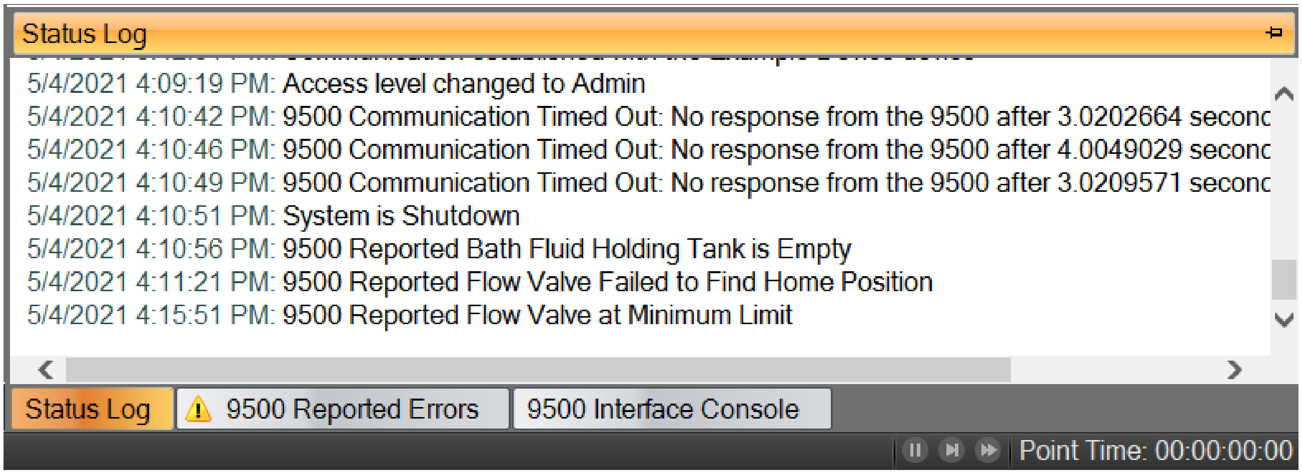
By clicking the pin icon on any information tab, the user can pin or unpin the Information tabs.



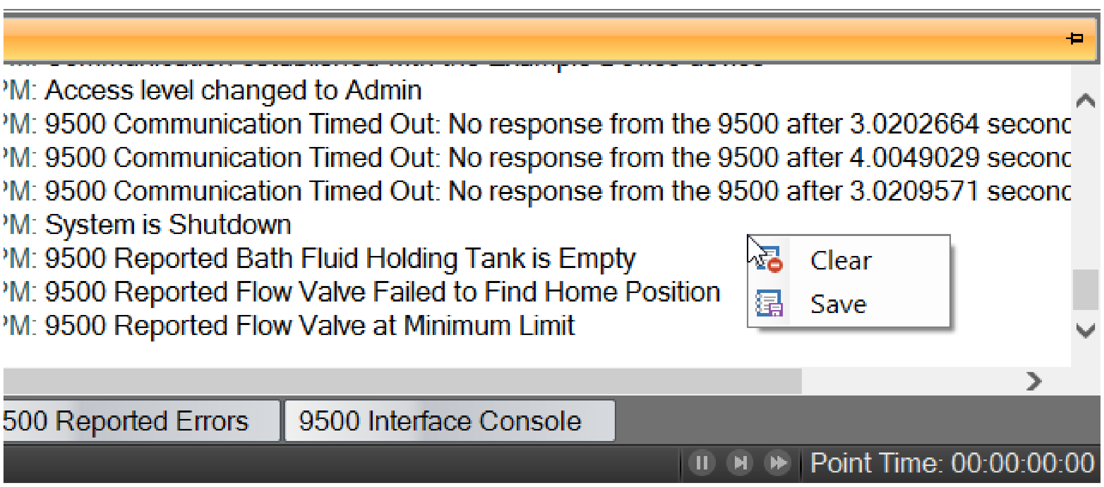
By default, the information tabs are unpinned, and they automatically hide.



The user can access the hidden tabs by clicking the desired information tab label at the bottom.

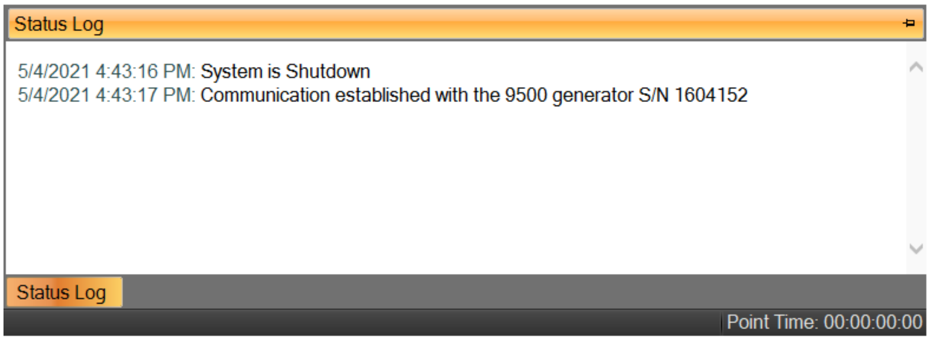


All Information Tabs have a context menu displayed by long pressing or right-clicking in the tab. The context menu allows quick access to functions that can clear and save the information.



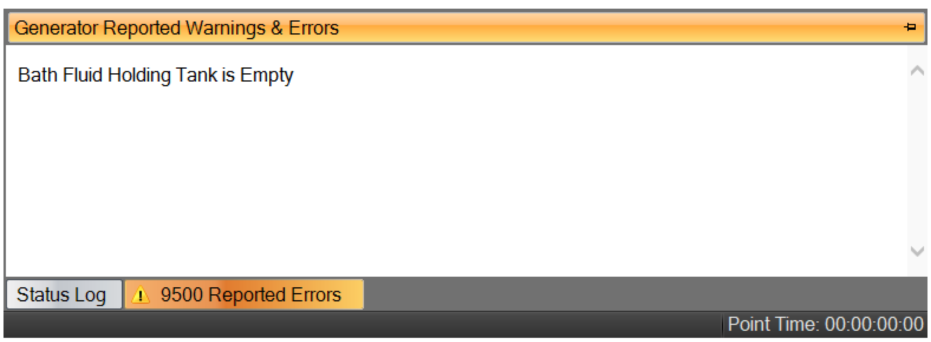
4.4.1 Status Log

The Status Log tab contains chronological information about the system status, changes in operational modes, changes in setpoints, and runtime errors due to communication or mechanical difficulties encountered by the generator.



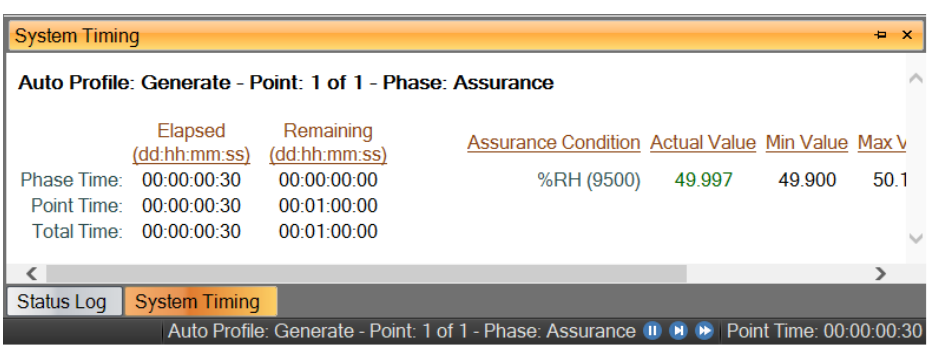
4.4.2 9500 Reported Warnings and Errors

The 9500 Warnings & Errors tab only appears when the 9500 reports a warning or error. This is a critical information tab because it reports 9500 system warnings and errors to the user. Some types of errors can cause the 9500 to shutdown and require immediate attention by the operator. The ⚠ icon is displayed to help draw the user's attention to the reported 9500 warning or error.



4.4.3 System timing

The System Timing tab shows information about the current timing associated with the current operation, such as elapsed run time at current conditions. This window may be shown at any time by clicking the "Point Time" in the status bar and is automatically shown when an Auto Profile is started. The tab gives detailed information on the Auto Profile as it runs. Elapsed and remaining Phase, Point, and Total time are listed along with the detailed assurance conditions values and tolerances.



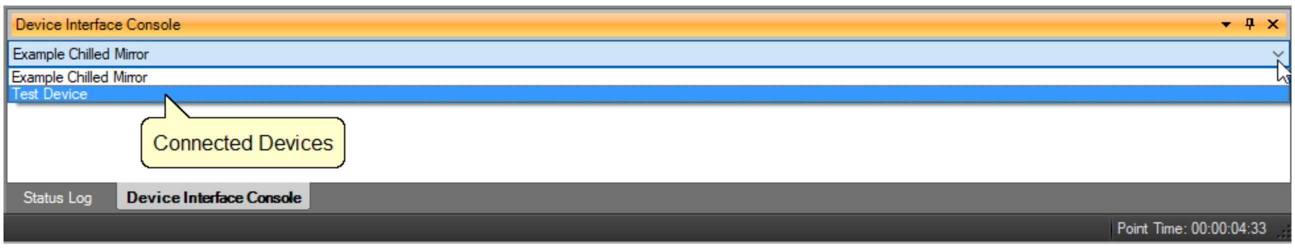
4.4.4 9500 Interface Console

The 9500 Interface Console tab allows users to send and receive commands to and from the 9500. The console tab is opened by selecting "Interface Console" from the Utilities Menu Tab. This feature is intended for factory support and should not be used regularly by the user of the 9500.

4.4.5 Device Interface Console

The Device Interface Console tab allows users to view the commands sent to and received from any connected device. The device console tab is opened by selecting "Interface Console" from the Settings Menu Tab whenever a device is connected.

The user can select which connected device to view using the drop-down selection at the top of the tab.

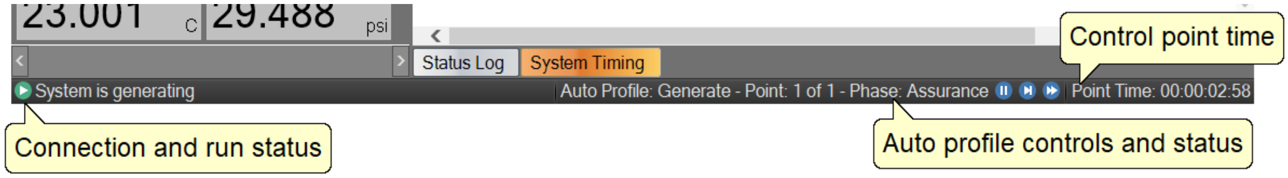


The data sent to the device is indicated by a bold "Sent:" label in the lower text area of the console tab.

The data received from the device is indicated by a bold "Received:" label in the lower text area of the console tab.

4.5 STATUS BAR

The Status Bar is located at the bottom of the application window. The Status Bar displays the generator's current Connection and Run Status, Auto Profile Controls and Status, and current Point Time.



4.5.1 Connection and Run Status

The Connection and Run Status is shown on the left-hand side of the status bar and gives the user a quick visual and textual reference to the current state of the Model 9500 Humidity generator. As new events are recorded in the Status Log, the event is displayed for a short period of time in the status bar to inform the user of the new event.

4.5.1.1 Disconnected

The status bar shows an "unplugged" icon and "Disconnected" when the 9500 is not connected to ControLog.

4.5.1.2 Generating

The status bar shows a green forward arrow icon and "System is generating" when the 9500 is generating.

If the 9500 reports an error, the green forward arrow icon also appears with a small yellow warning.

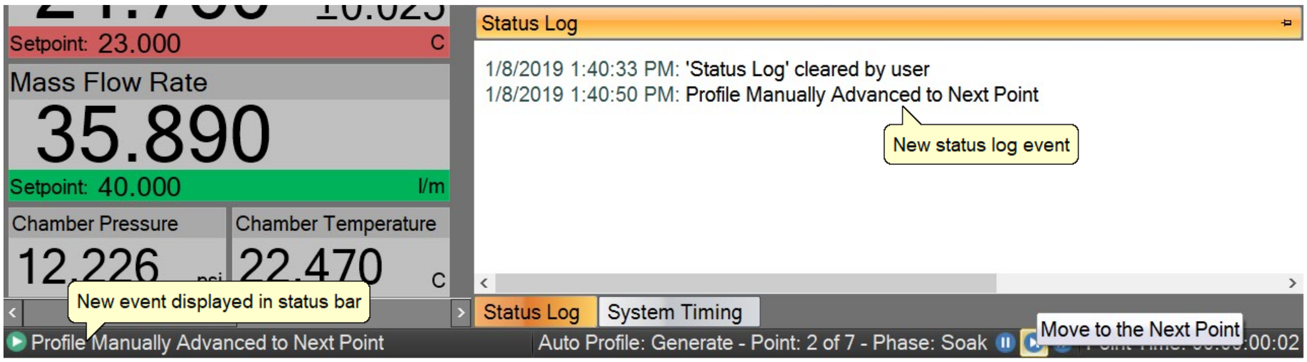
4.5.1.3 Shutdown

The status bar shows a blue stop icon and "System is shutdown" when the 9500 is shutdown.

If the 9500 reports an error, the blue stop icon also appears with a small yellow warning.

4.5.1.4 *New Event*

During any state, the most recent status log event is shown briefly in the status bar.



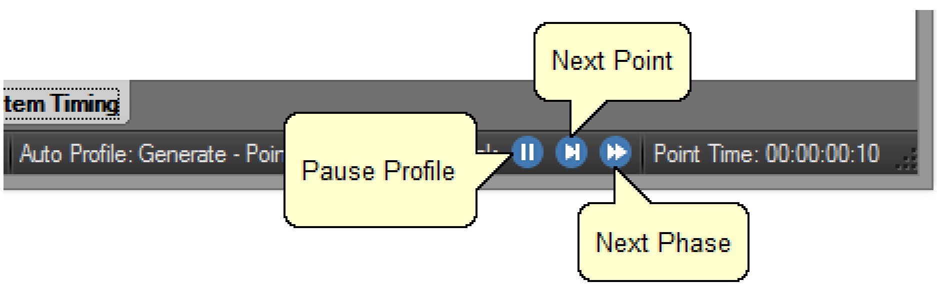
4.5.2 Auto Profile Controls and Status

The Auto Profile Controls and Status are shown on the right-hand side of the status bar and give the user quick control and status over a running profile. The Auto Profile consists of three status parts and three control parts.

For more information, refer to section 9 Auto Profiling

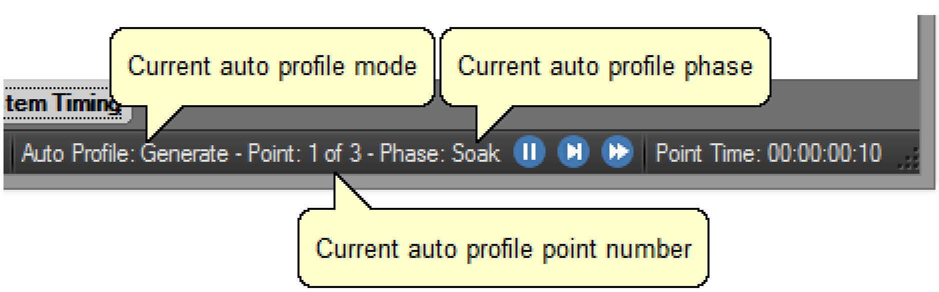
4.5.2.1 *Auto Profile Controls*

The Auto Profile controls consist of a "Pause" button, a "Next Point" button, and a "Next Phase" button.



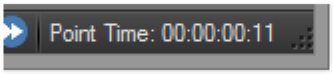
4.5.2.2 *Auto Profile Status*

The Auto Profile status consists of the generator "Run Mode" for the current profile point, the "Profile Point" the system is currently running, and the "Phase" of the current point.

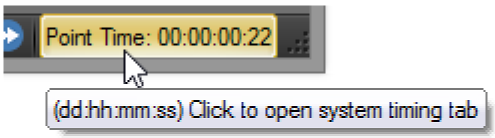


4.5.3 Current Point Time

The Current Point Time is shown on the right-hand side of the status bar and gives the user a quick display of the amount of time the system has been at a point. Point Time is not the amount of time at a setpoint but simply the amount of time since the last setpoint or mode change.



The user can click the point time to open the system timing tab.

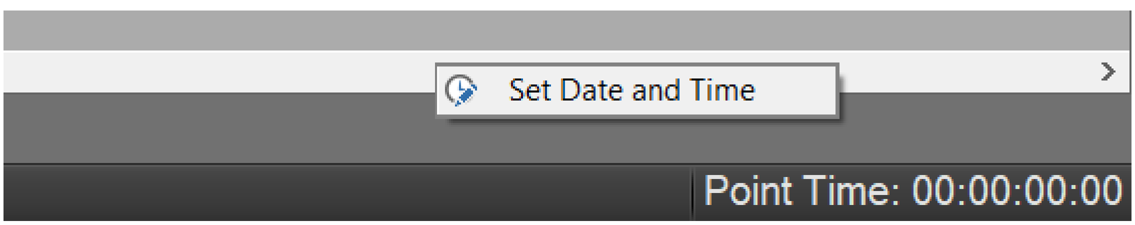


4.5.4 Set Date and Time

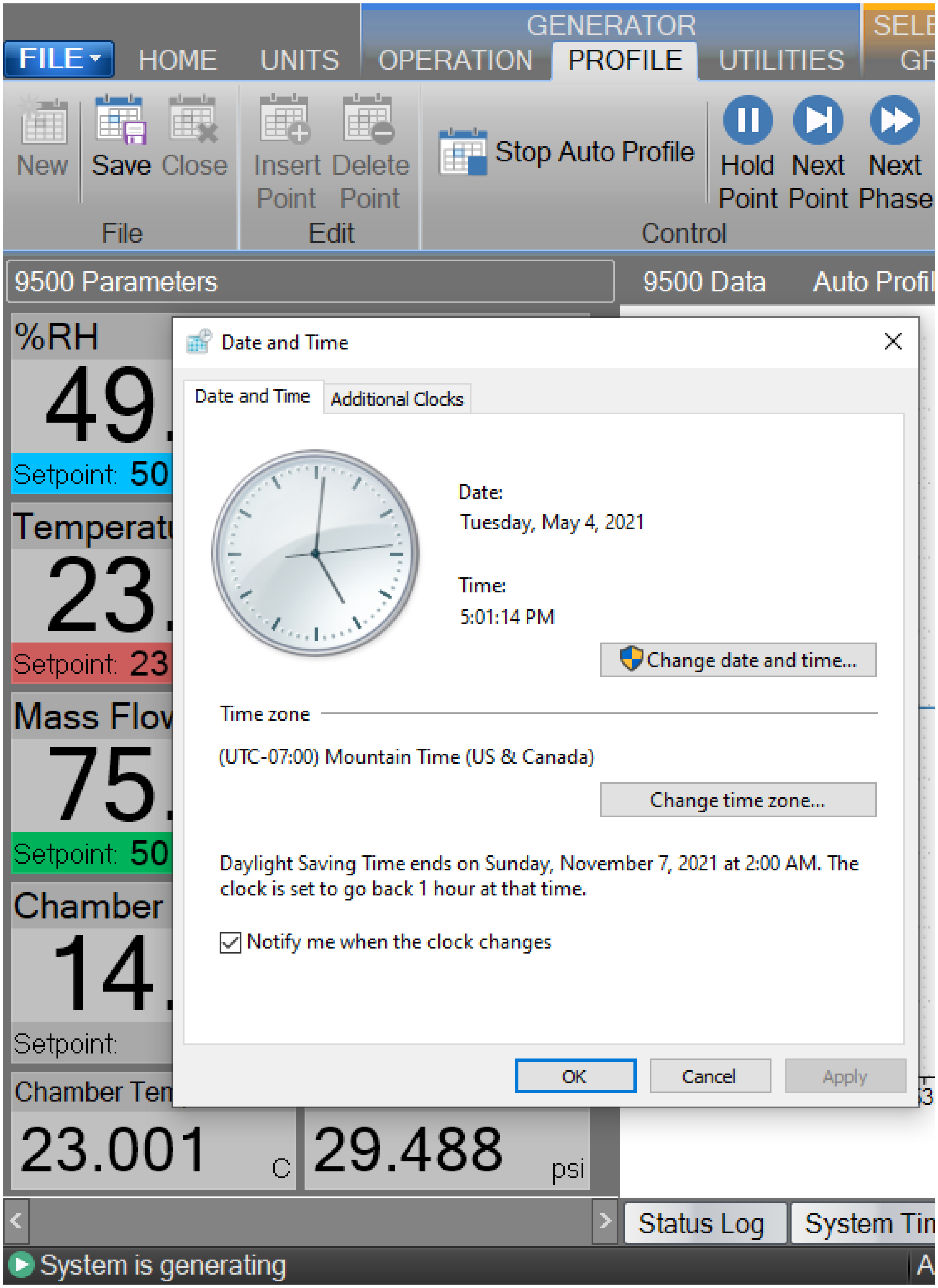
The user can change the current system date and time through the status bar context menu.

> **Note** – *To avoid time stamp confusion, only change the system date and time when the generator is shutdown and not recording data.*

Start by long pressing or right-clicking anywhere within the status bar to open the status bar context menu.



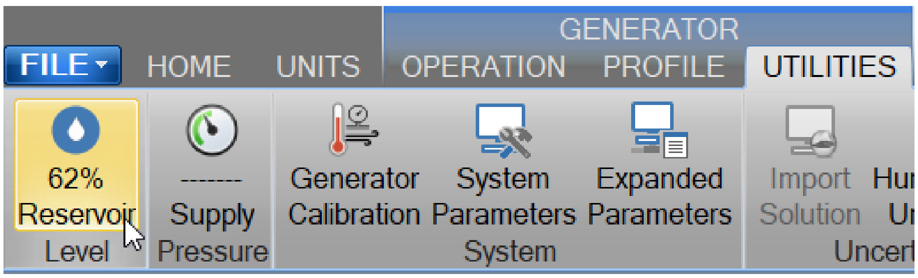
Select “Set Date and Time” from the context menu to open the system Date and Time dialog.



5 Fluid Levels and Bath Control

The Fluid Levels dialog allows the user to view the current levels of the Water Reservoir, Holding Tank, Bath Reserve, and Bath, along with the states of the liquid level sensors. The dialog allows the user to fill tanks and control the bath level.

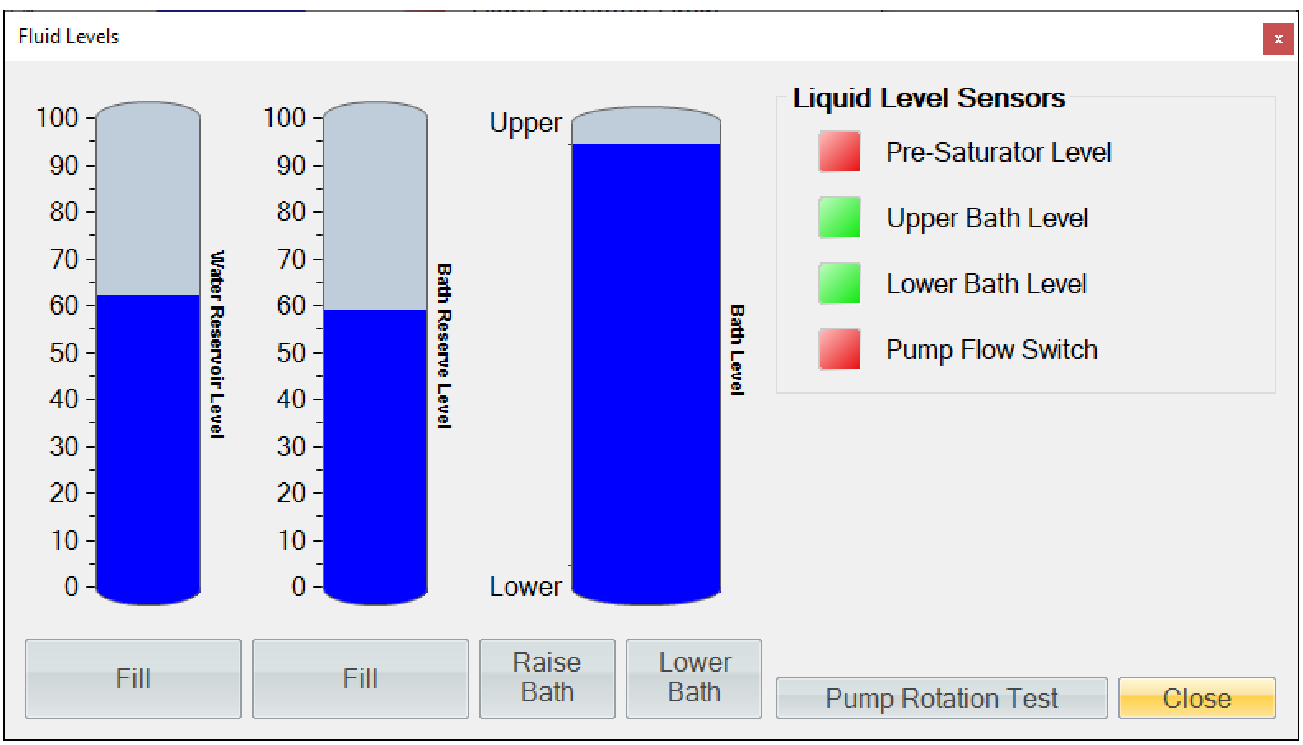
Select Reservoir Level from the Generator Utilities menu to access the Fluid Level dialog.



For more information, refer to section 12.4 Fluid System

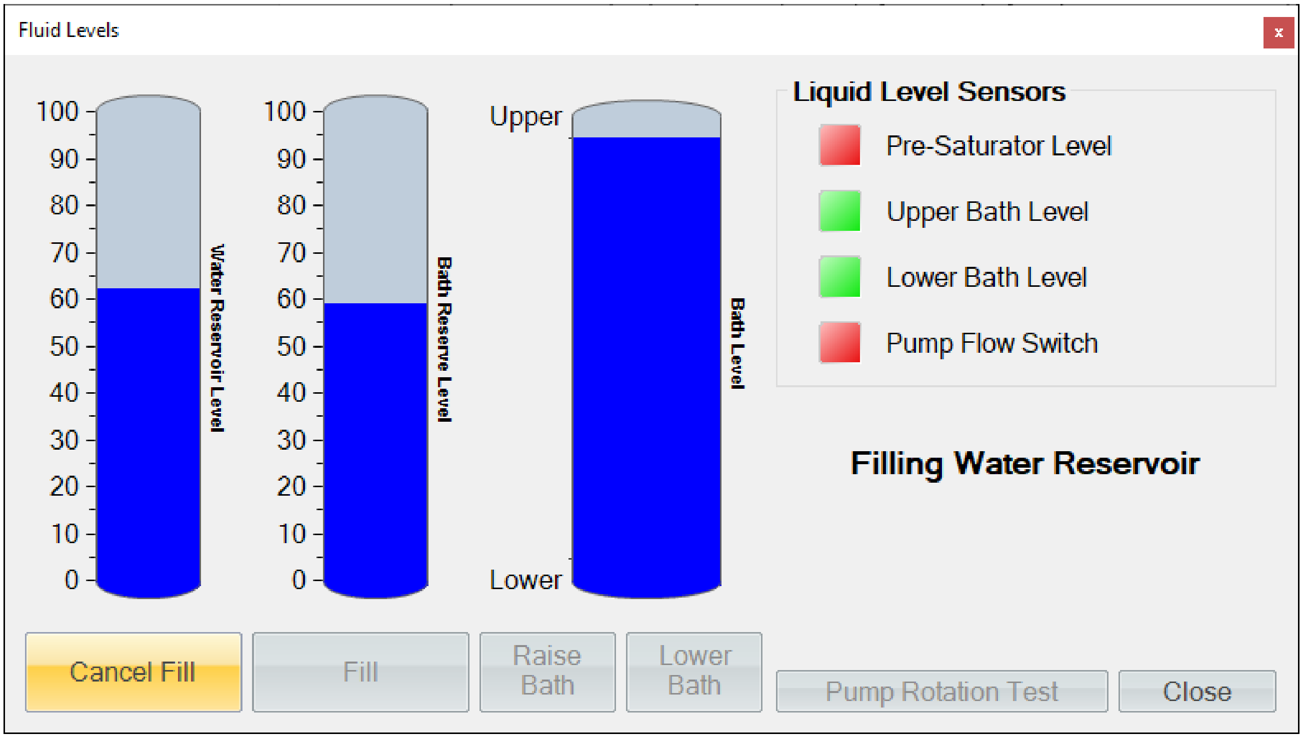
5.1 Water Reservoir Level

The Water Reservoir Level is the measured distilled water level in the water reservoir and indicates the amount of distilled water available to fill the pre-saturator during operation. This is the distilled water supply used by the generator to generate a humidified gas output.



5.1.1 Fill Water Reservoir

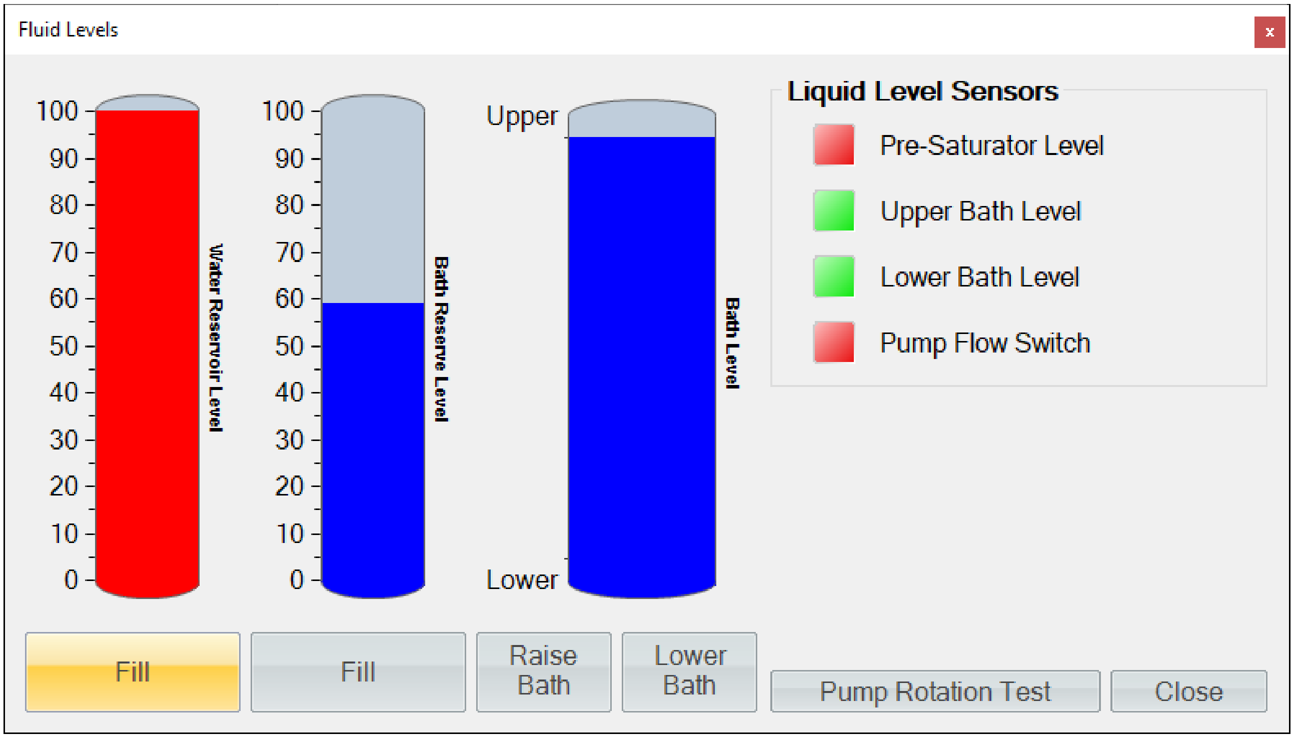
The system must be shut down and vented of pressure before filling the water reservoir. To fill, attach a funnel or ensure the water supply is connected to the fill port near the countertop's middle back. The port is labeled "Distilled Water In." Once the water supply is connected, the user can begin filling by clicking the "Fill" button below the tank. The distilled water capacity is roughly 3.5 gallons from empty with a 3.25-gallon working level.



The system opens the fill solenoid to allow distilled water into the water reservoir. The system indicates that it is filling with the message "Filling Water Reservoir" and continues the filling process until the reservoir is full. Once the reservoir's level reaches 100%, the system automatically stops and closes the fill solenoid. The user can cancel the filling operation anytime by clicking the "Cancel Fill" button below the tank.

> **Note -** *If the water reservoir runs out of water and the system shuts down with the "Unable to Fill Pre-Saturator Reservoir" error, you must refill the water reservoir to a minimum of 75% full before trying to generate again. It is always recommended to fill the reservoir and holding tank to 100% whenever filling is required.*

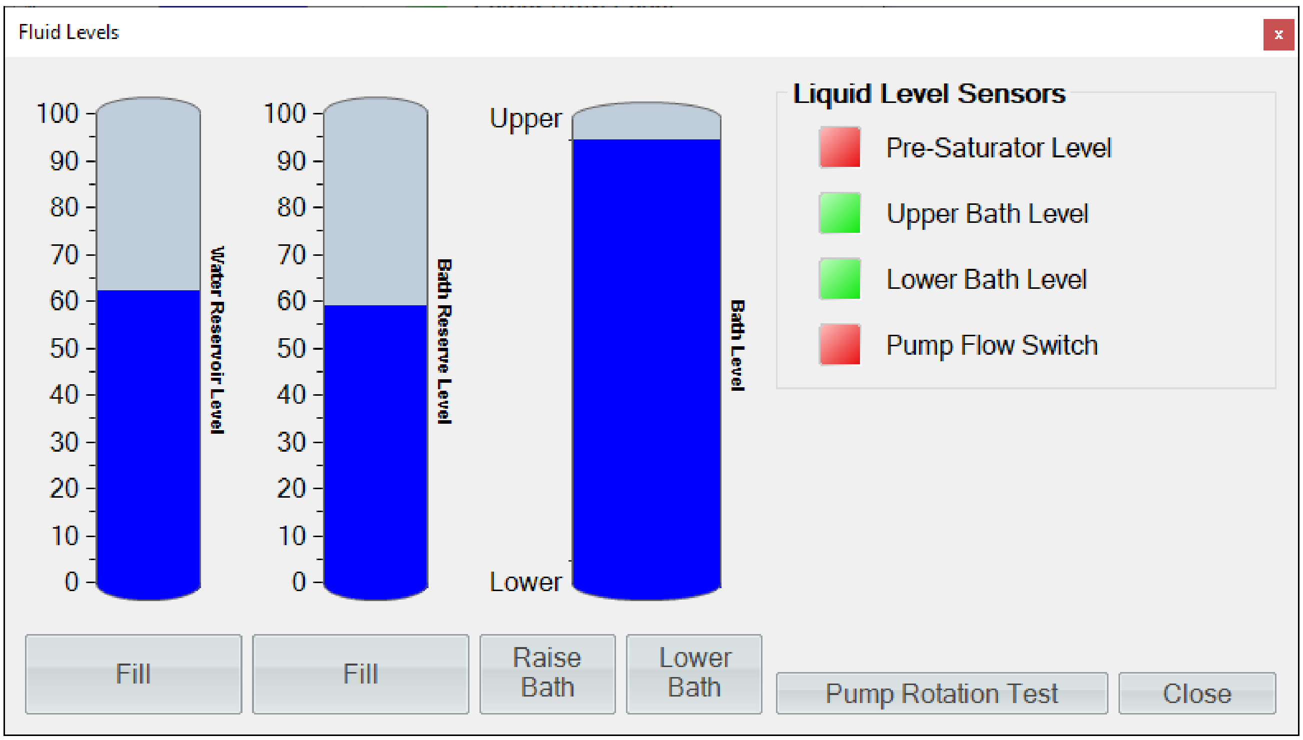
It is possible to overfill the tank depending on the rate of the distilled water supply. The system indicates an overfilled condition by displaying the tank level in red. In most cases, this is not an issue, but if the system is filled over 110%, pressure control may become erratic, and some water may need to be drained from the tank.



5.2 Bath Reserve Level

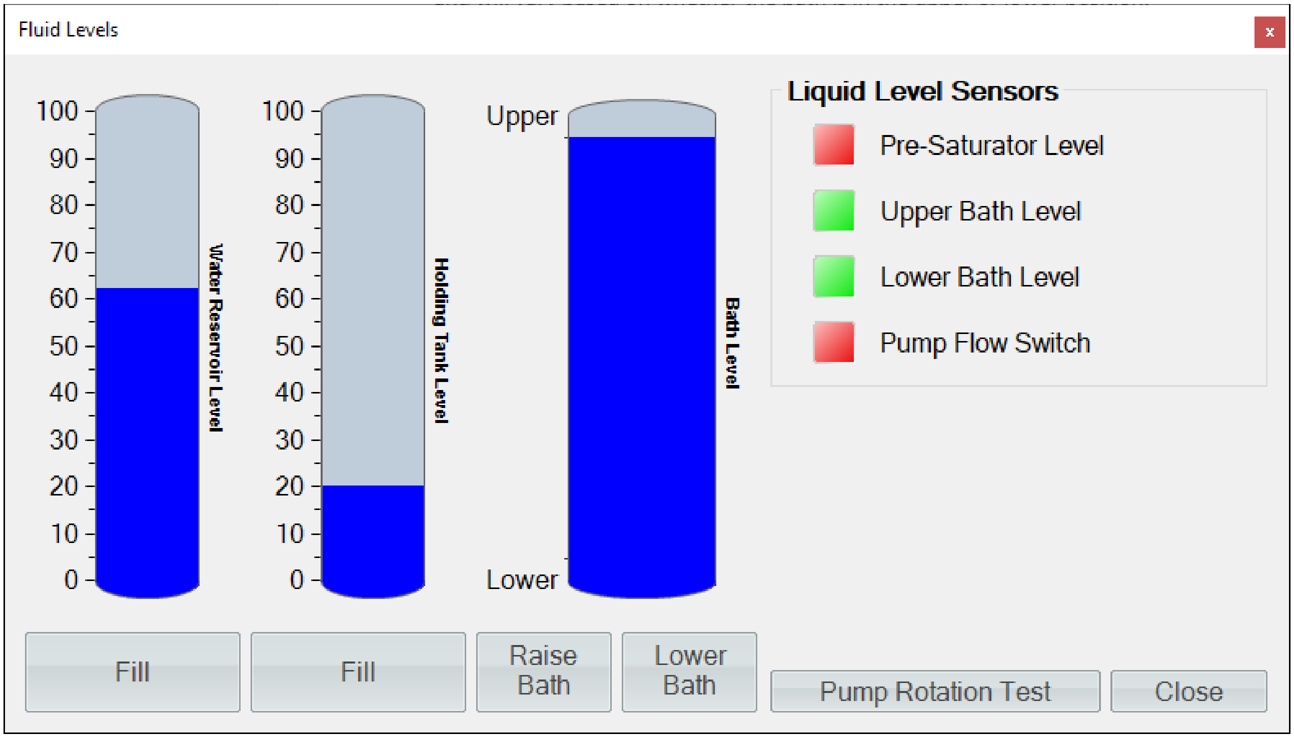
The Bath Reserve Level is a calculated level value showing a 0% to 100% scale of the available water for the bath in the Holding Tank. Water is removed or added to the Holding Tank as the Bath is raised or lowered, and its level changes accordingly. The Bath Reserve level indicates only what is in reserve for the bath. The bath reserver is roughly 2 gallons.

> **Note** – *If the system was off for a long time or if a portion of the bath water evaporates, the calculated bath reserve level may be slightly off, given the amount of lost water in the bath. To correct this, the user can raise and lower the bath to allow the generator to recalculate the reserve level.*
>
> **Note** – *This is a temperature-sensitive calculation, and the calculated level may vary based on the bath fluid temperature.*



5.3 HOLDING TANK LEVEL

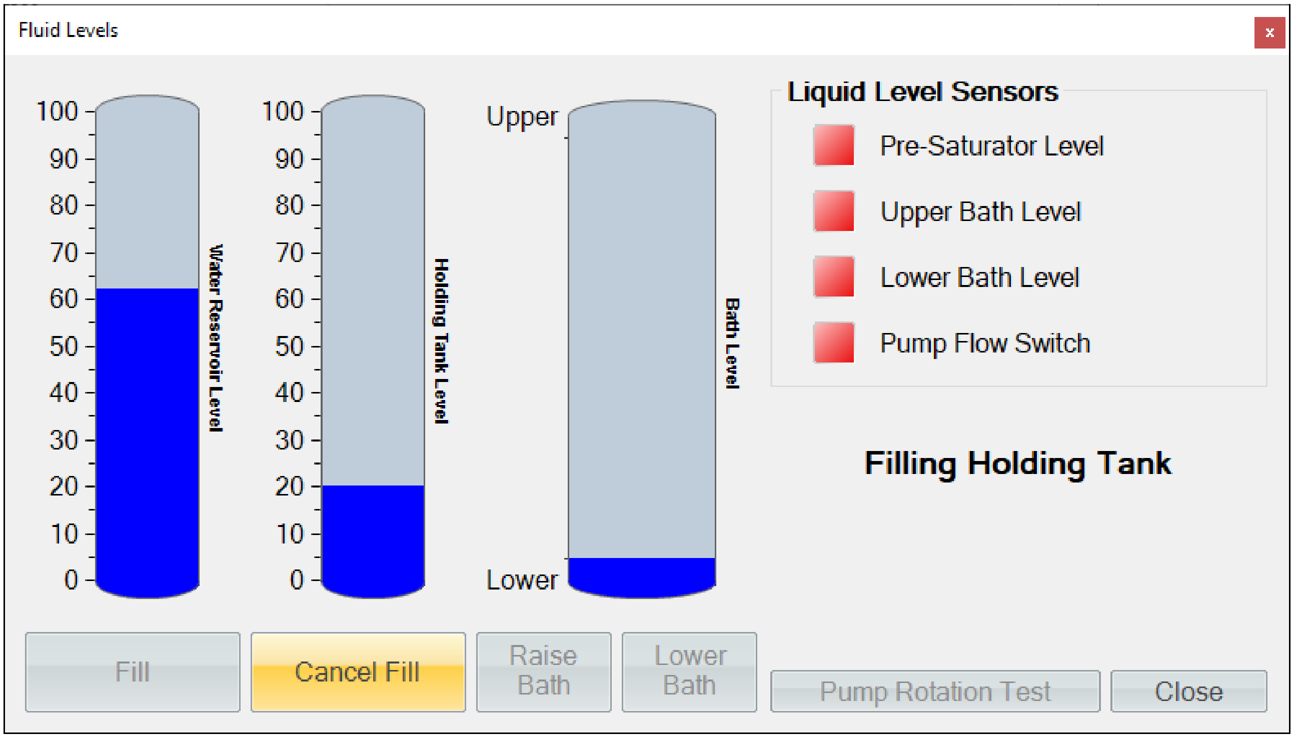
The Holding Tank Level is the measured water level in the bath holding tank. It can be viewed by double-tapping or double-clicking the Bath Reserve Level tank. The actual water level in the holding tank varies based on whether the bath is in the upper or lower position.



5.3.1 Fill Holding Tank

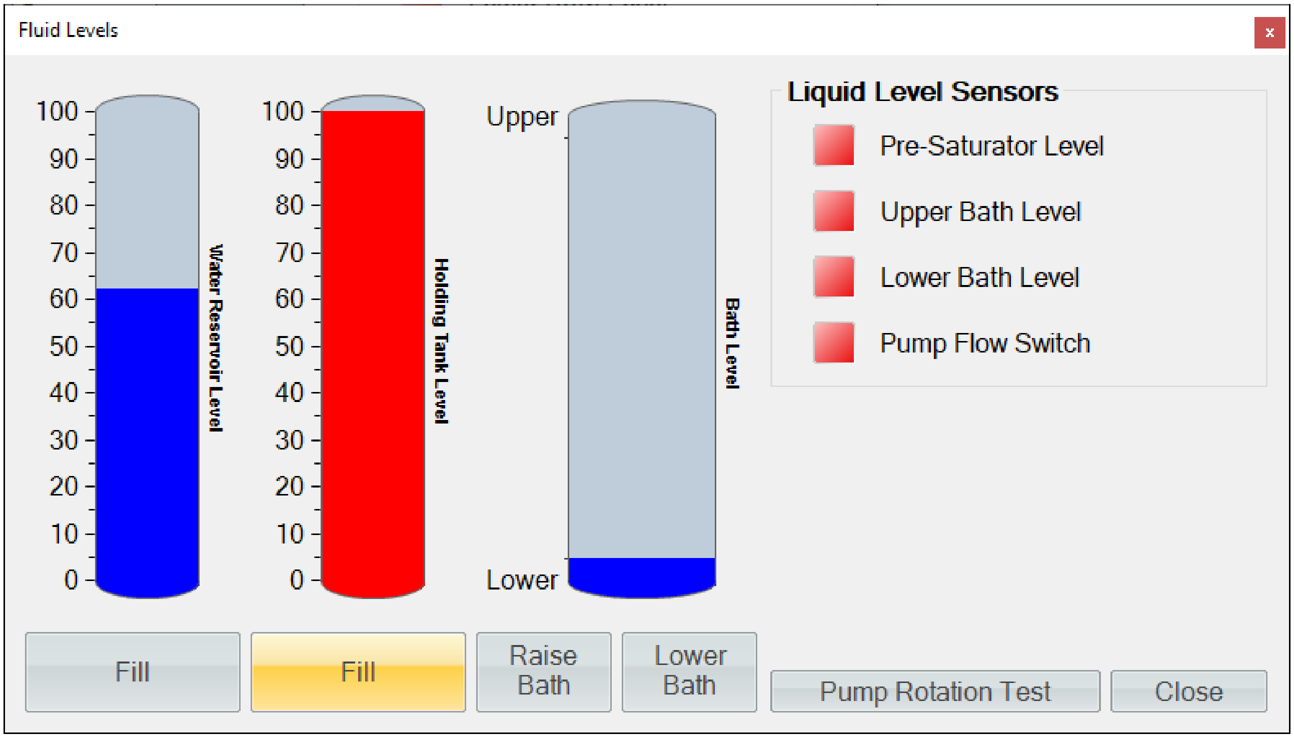
The system must be shut down, and the bath must be in the lower position before the Holding Tank can be filled. To fill, attach a funnel or ensure the water supply is connected to the fill port near the countertop's middle back. The port is labeled “Distilled Water In.” This is the same port used to fill the Water Reservoir Level. Once the water supply is connected, the user can begin filling by clicking the “Fill” button below the Bath Reserve Level or Holding Tank Level indication. This automatically switches the display to the Holding Tank instead of the Bath Reserve Level if not already displayed. The Holding Tank water capacity is roughly 7 gallons from empty.

> **Note** – *It is recommended to only fill the holding tank when the bath is near ambient temperature.*



The system opens the fill solenoid to allow distilled water into the holding tank. The system indicates that it is filling with the message "Filling Holding Tank" and continues the filling process until the holding tank is full. Once the tank level reaches 100%, the system automatically stops and closes the fill solenoid. The user can cancel the filling operation anytime by clicking the "Cancel Fill" button below the tank.

It is possible to overfill the holding tank depending on the rate of the distilled water supply. The system indicates an overfilled condition by displaying the holding tank level in red. This is not an issue in most cases, but excess water can flow back into the bath if the system is filled over 110%. This can also result in an inaccurate calculated Bath Reservoir and Bath Level. If this occurs, it is recommended to drain some water from the bath until the overfill condition is removed.

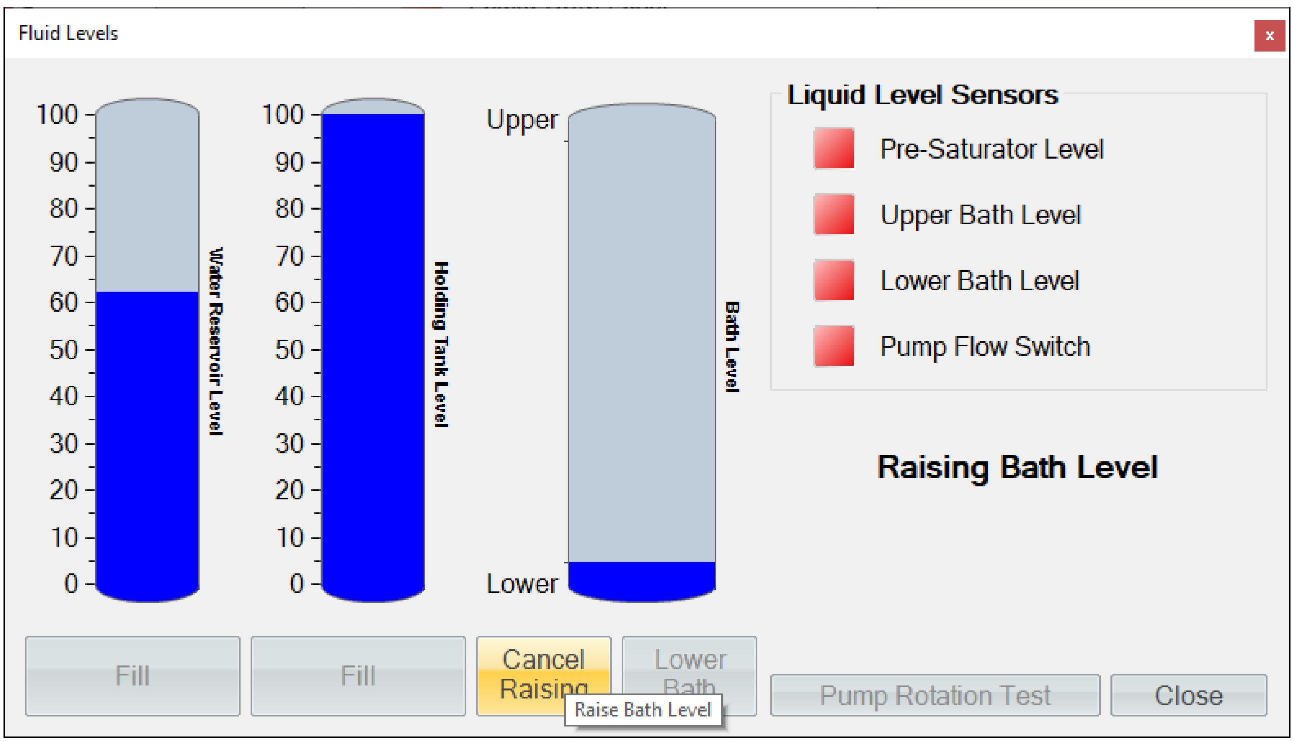


5.4 Bath Level

The Bath Level shows the current state of the bath (at the upper level, at the lower level, or transitioning between the two). When the Lower and Upper Bath Level Sensors indicate red, the bath is at the lower level. When the Lower and Upper Bath Level Sensors indicate green, the bath is at the upper level. When the Lower Bath Level Sensor indicates green, but the Upper Bath Level Liquid Level Sensor indicates red, the bath is transitioning between the lower and upper levels. The system calculates this transition and should only be used for a visual indication while the bath is being raised or lowered.

5.4.1 Raising the Bath

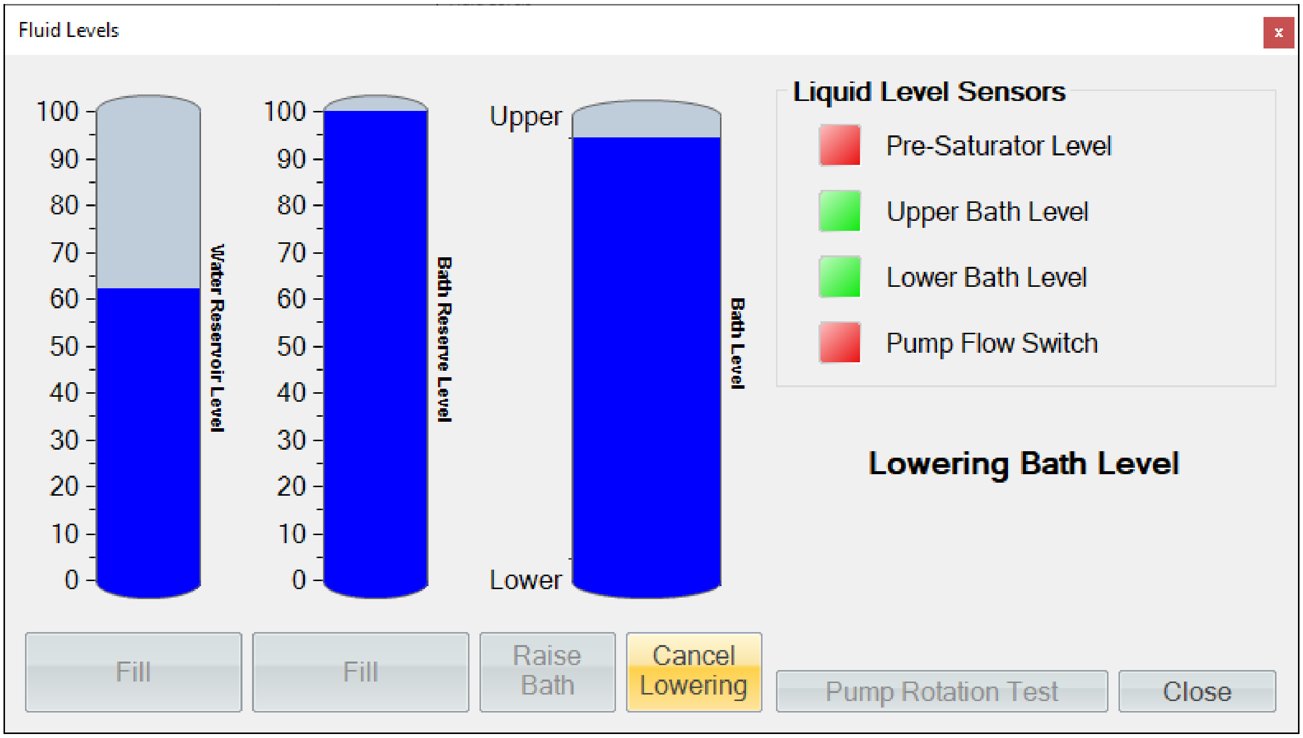
The user can click the "Raise Bath" button to raise the bath. This can be done when the generator is shutdown or generating.



The system begins transferring water from the holding tank to the bath. The system indicates that it is raising the bath with the message "Raising Bath Level" and continues the process until the bath level reaches the Upper Bath Level as indicated by the level sensor. The user can cancel the raising process anytime by clicking the "Cancel Raising" button.

5.4.2 Lowering the Bath

The user can click the "Lower Bath" button to lower the bath. This can be done when the generator is shutdown or generating.



The system begins transferring water from the bath to the holding tank. The system indicates that it is lowering the bath with the message "Lowering Bath Level" and continues the process until the bath level reaches the Lower Bath Level as indicated by the level sensor. The user can cancel the lowering process anytime by clicking the "Cancel Lowering" button.

CAUTION!

DO NOT LEAVE THE BATH LEVEL IN A STATE THAT IS NEITHER UP NOR DOWN. THE SYSTEM AUTOMATICALLY MAINTAINS THE BATH LEVEL WHILE GENERATING AT EITHER THE UPPER OR LOWER LEVEL AND LEAVING THE BATH BETWEEN LEVELS CAN RESULT IN POSSIBLE ERROR MESSAGES RELATING TO THE BATH LEVEL MAINTENANCE.

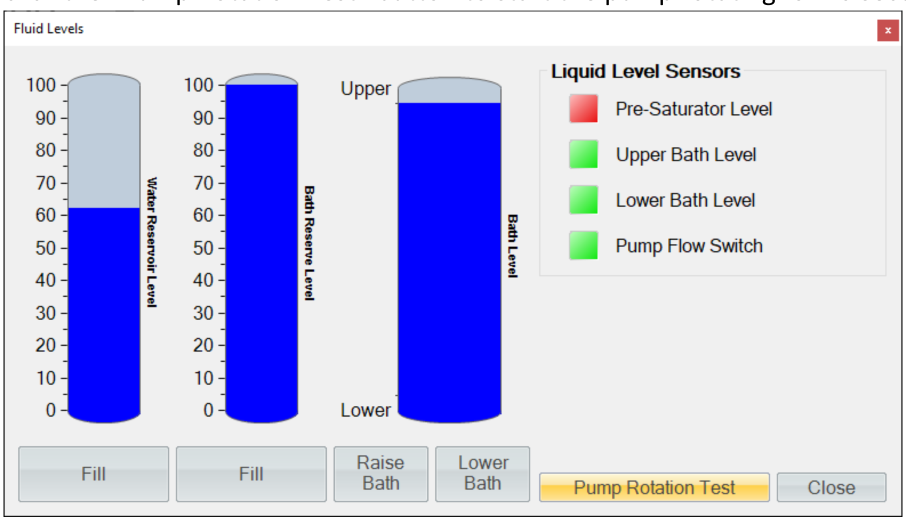
5.5 Pump Rotation Test

The Pump Rotation Test is used to test the rotation of the fluid pump to assure correct operation and purge air when filling the temperature bath.

IMPORTANT!

THIS PROCEDURE MUST BE PERFORMED UPON INSTALLATION TO ENSURE THE BATH FLUID PUMP ROTATES IN THE PROPER DIRECTION. DO NOT OPERATE THE SYSTEM UNTIL THIS PROCEDURE HAS BEEN PERFORMED.

1. Remove the rear generator access panel.
2. With main electric service applied, press main system "POWER" switch to ON.
3. Allow the touch panel PC to boot and ControLog to connect to the generator.
4. Open the Fluid Levels dialog by selecting Reservoir Level from the Generator Utilities menu.
5. While observing the circulation pump fan (visible thru the pump end housing fan grill), tap or click the "Pump Rotation Test" button to start the pump rotating for 10 seconds.



The pump should rotate in the direction of the arrow indicated on the pump unit itself.

CAUTION!

THE PUMP DOES NOT HAVE DRY RUN CAPABILITY.

6. If the pump rotated in the wrong direction, close the Fluid Levels dialog, select Turn off from the File menu and wait for the touch panel PC to shut down. Switch the main system "POWER" to OFF.
7. Disconnect main electric service, switch input power connections L1 and L3 at TB-MAIN *or* main power box connection, then repeat steps 2 through 5.

CAUTION!

ALWAYS PROPERLY SHUTDOWN THE TOUCH PANEL PC BEFORE SWITCHING OFF THE GENERATORS POWER.

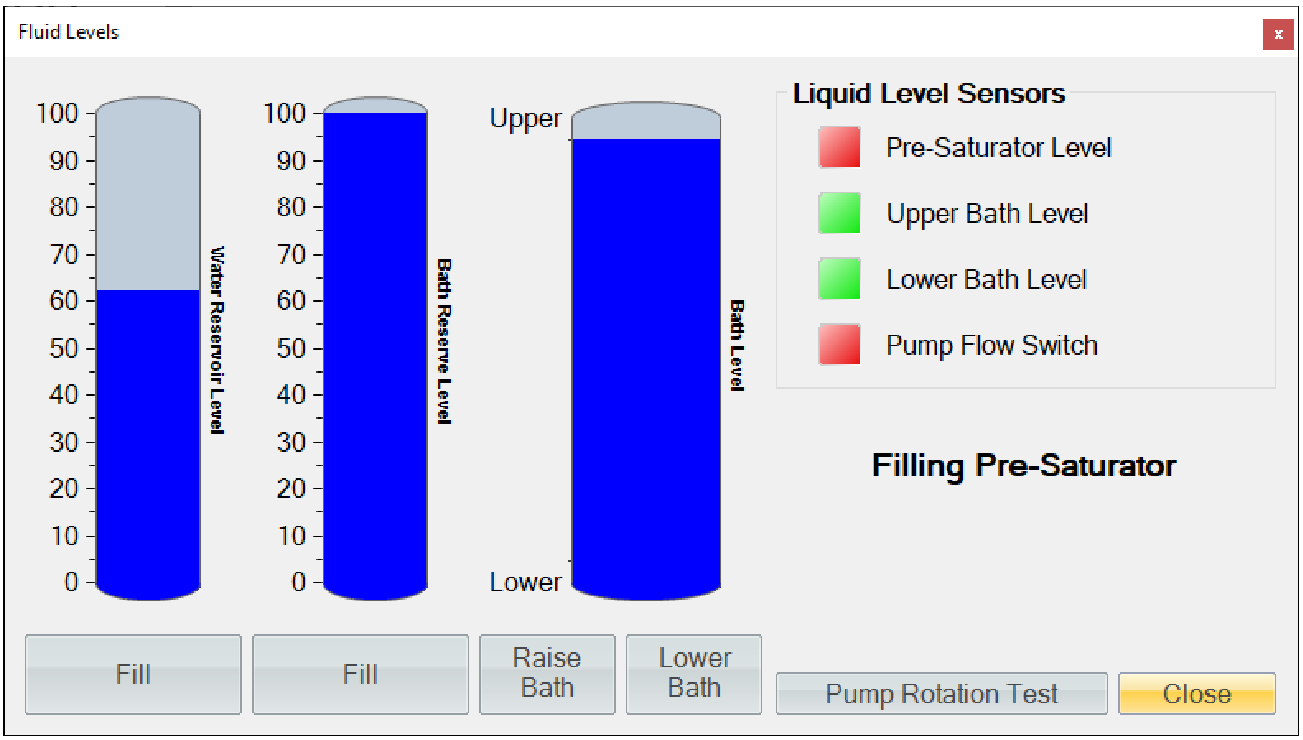
8. Replace generator access panels once the pump rotation is in the correct direction.

5.6 Liquid Level Sensors

Liquid Level Sensors indicate a discrete state of the given sensor. Red indicates no water sensed, and green indicates water is sensed. The exception is the Flow Switch, where red indicates no fluid flow and green indicates the presence of fluid flow.

5.6.1 Pre-Saturator Level

The Pre-Saturator Level is a discrete indication of the pre-saturator (PSAT) water level. When the system is shutdown, a tap or click of the label or indicator starts the filling process for the pre-saturator. This feature is mainly used after the water reservoir tank is filled or when the pre-saturator has been drained.



The system opens the pre-saturator fill solenoid to allow distilled water to flow from the reservoir to the pre-saturator. The system indicates that it is filling with the message “Filling Pre-Saturator” and continues the filling process until the pre-saturator is full, as indicated by the pre-saturator Level indication turning green. Once filled, the system automatically stops and closes the pre-sat fill solenoid. The user can cancel the filling operation by clicking the label or indicator again. The pre-saturator capacity is roughly 1.3 gallons (5 Liters).

Note - *The system automatically fills the pre-saturator as needed while generating.*

5.6.2 Upper Bath Level

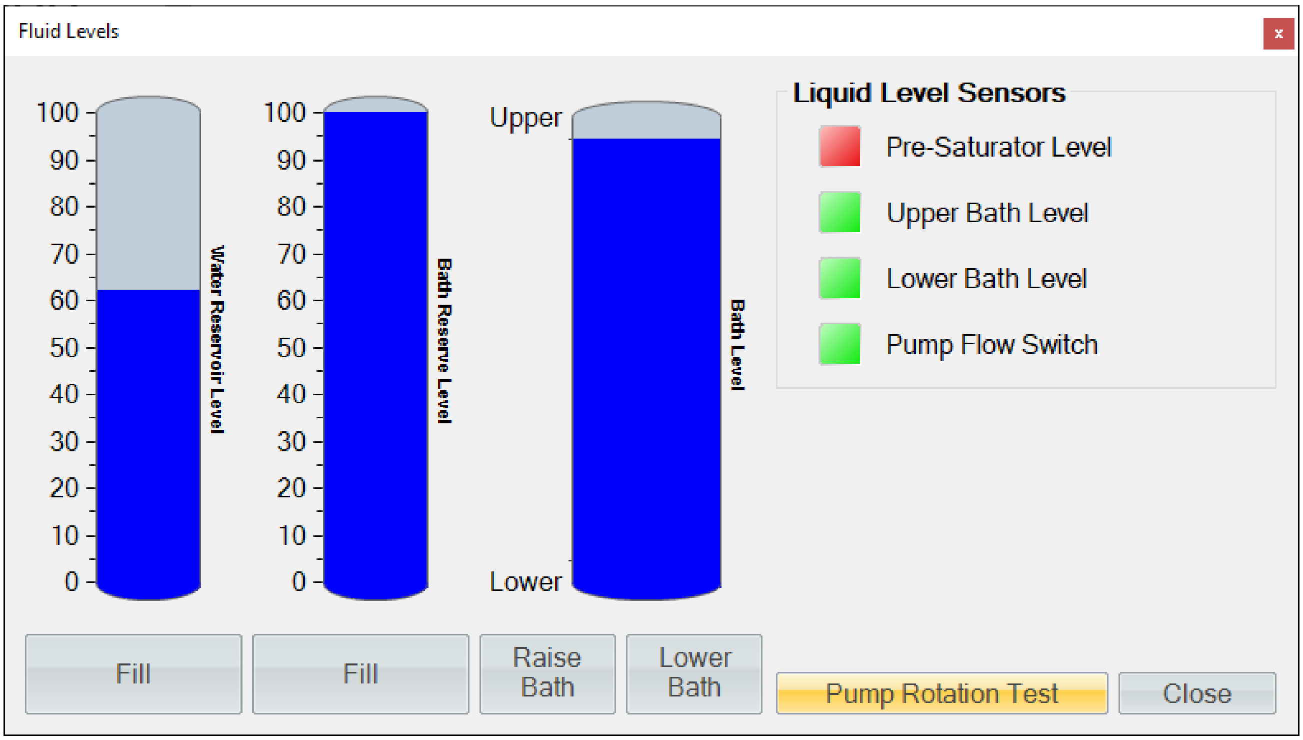
The Upper Bath Level is a discrete indication of the presence of water at the upper bath level probe. The bath is at the upper level when this indication is true (green).

5.6.3 Lower Bath Level

The Lower Bath Level is a discrete indication of the presence of water at the lower bath level probe. The bath is at the lower level when this indication is false (red).

5.6.4 Pump Flow Switch

The Pump Flow Switch (FS1) is a discrete indication that the water circulation pump is operating correctly. When the flow switch indication is red, water is not being circulated within the system. Water only circulates when operating in the Generate mode or performing a pump rotation test.



6 CALIBRATION

Proper calibration of the temperature and pressure transducers is critical to the accuracy of the generated humidity. Each time a probe or transducer is calibrated, its current calibration coefficients and data are stored on disk. Calibration of the system requires the following support equipment:

Note - *The following information is a recommendation for calibrating the Thunder Scientific 9500 Humidity Generator. It is the user's responsibility to ensure the standards used meet/exceed their organization's specific test limit/guard banding requirements.*

1) **Temperature**, range 0 to +72 °C (standard range) or -10 to +72 °C (low temp range):

   - Precision temperature bath of specified range with a liquid medium (recommend FC-77 Fluorinert, a 3M product).
     Note - *Less stable baths may require the use of a thermal block.*
   - Standard or reference thermometer (PRT/RTD) of specified range with an accuracy low enough to assure ±0.015 °C test limit or guard band.

2) **Chamber Pressure**, range ambient to 23 psi absolute:

   - Stable static gas pressure source.
   - Standard or reference pressure gauge with an accuracy low enough to assure ±0.0021 psiA test limit or guard band.

3) **Saturation Low Pressure**, range ambient to 45 psi absolute:

   - Static gas pressure source with the stability of ±0.01 % of range or better.
   - Standard or reference pressure gauge with an accuracy low enough to assure a ±0.0042 psiA test limit or guard band.

4) **Saturation High Pressure**, range ambient to 325 psi absolute:
   - Static gas pressure source with the stability of ±0.01 % of range or better.
   - Standard or reference pressure gauge with an accuracy low enough to assure a ±0.03 psiA test limit or guard band.

5) **Flow**, range 0 to 100 standard liters/min:
   - Reference flow meter with an accuracy low enough to assure ±2.0 % of full-scale (100.0 *± 2.0% = ±2.0 liter/min) test limit or guard band.
     Note – *Flow is standardized with a reference temperature of 21.1 °C at 760 mmHg*

6.1 TEMPERATURE CALIBRATION

The temperature calibration procedure is used with a precision temperature bath to calibrate the temperature probes. Using the temperature bath to generate up to five known temperatures, the coefficients are calculated automatically by the computer and used to update the system calibration. Calibration reports are generated and can be saved for each temperature probe after each calibration sequence.

Refer to drawing: 9500D901-1, 9500D901-8, 9500D901-9, 9500D901-10 and 9500D903

6.1.1 Equipment Required

1. Precision Temperature Bath.
2. Standard or Reference thermometer.
3. 7/16” wrench
4. Phillips-Head screwdriver
5. 5/32” Hex ball driver

6.1.2 Calibration Procedure

For safety purposes, perform a Shutdown, Turn off the system from the File menu, switch the main system “POWER” to OFF and remove the power cord before removing any panel.

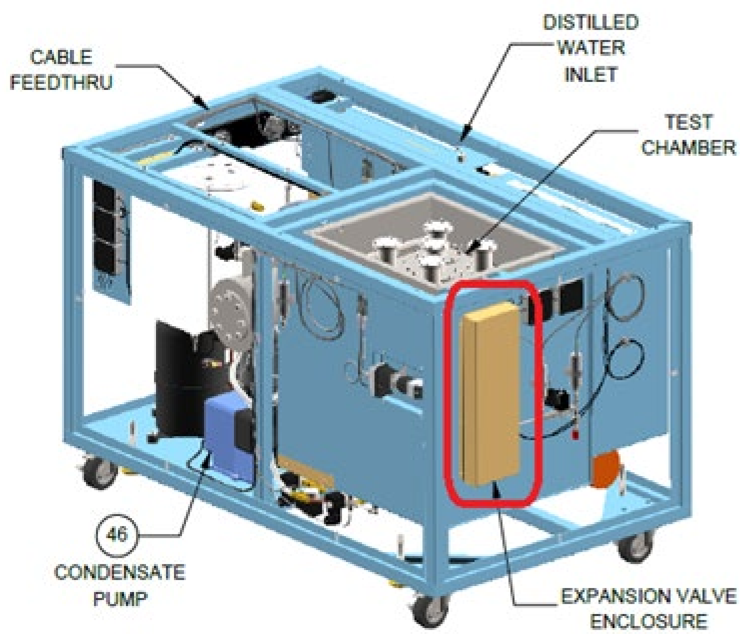
CAUTION!

ALL SYSTEM PRESSURE MUST BE VENTED BEFORE PROCEEDING.

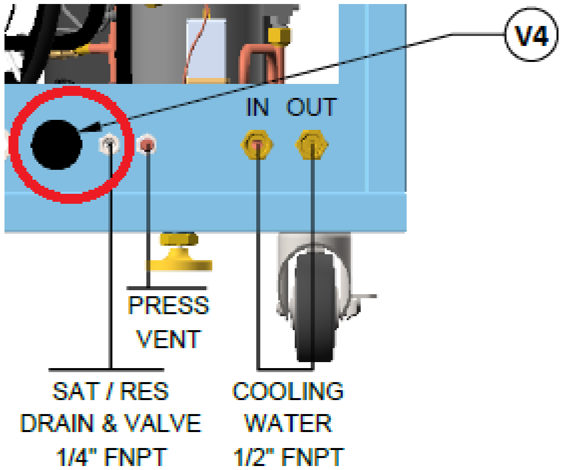
Bring a precision temperature bath with a reference thermometer to the system and install temperature probes to be calibrated into the temperature bath.

To remove temperature probes from the system:

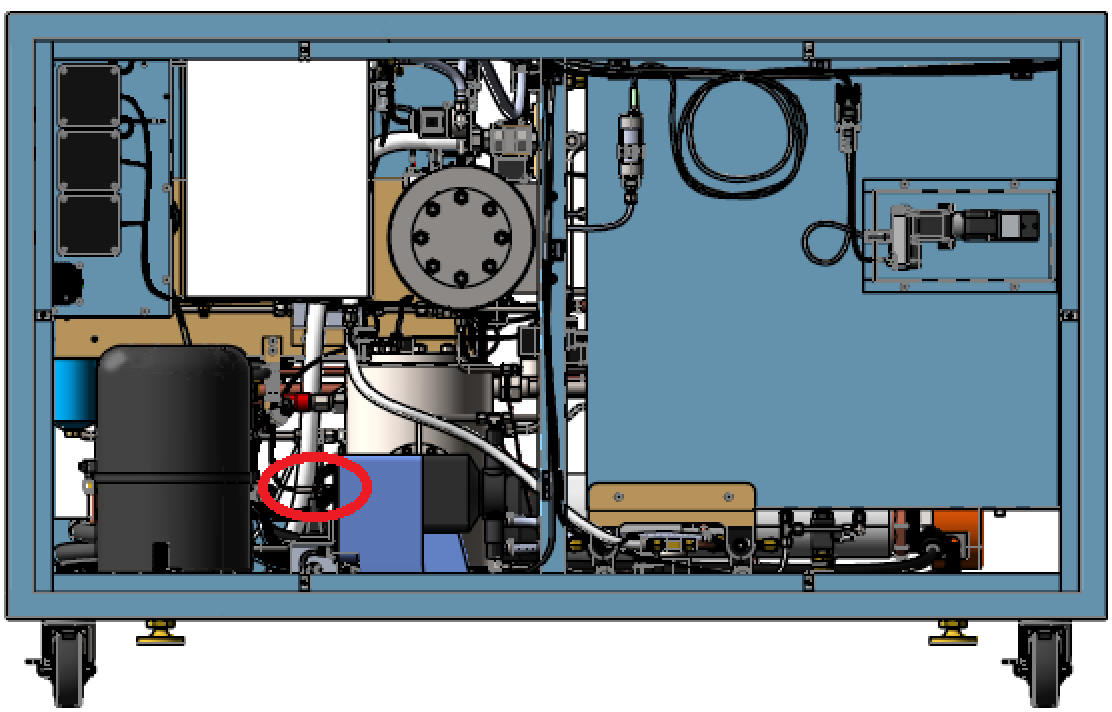
- Remove all four console access panels.
- Remove the seven countertop screws and remove the countertop (Refer to the Countertop Mounting Locations drawing *9500D903*).
- Remove the expansion valve encloser cover on the right side of the system (circled in red below) to access the Saturator (RTD3) and Expansion Valve (RTD5) temperature probes. Refer to drawing *9500D901-9* for additional views.



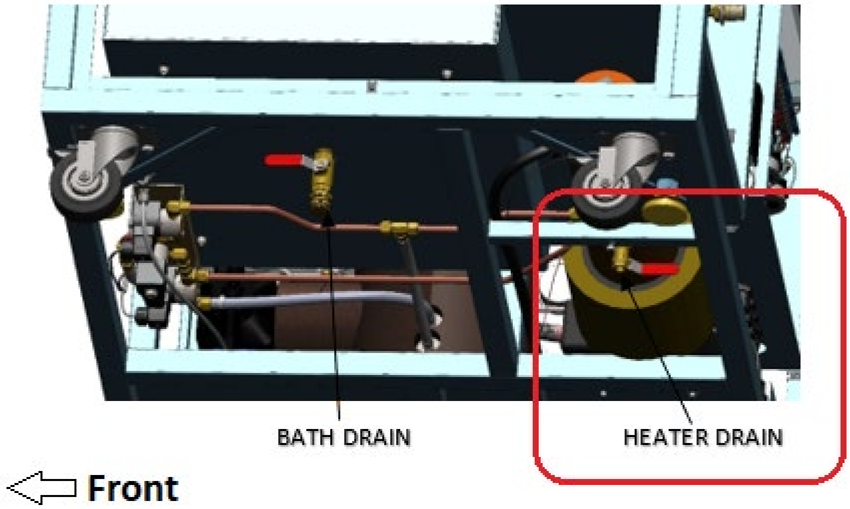
- Remove foam insulation to gain access to the probe fittings. Remove the foam insulation above the expansion valve RTD5.
- Loosen RTD3 and RTD5 probe fitting nuts and carefully remove the temperature probes.
- Before removing the Pre-Saturator temperature probe, the pre-saturator (PSAT) water must be drained. Locate the Sat/Res drain valve (V4) at the lower rear of the system. Open the valve (circled in red below) to drain the water from the pre-saturator.



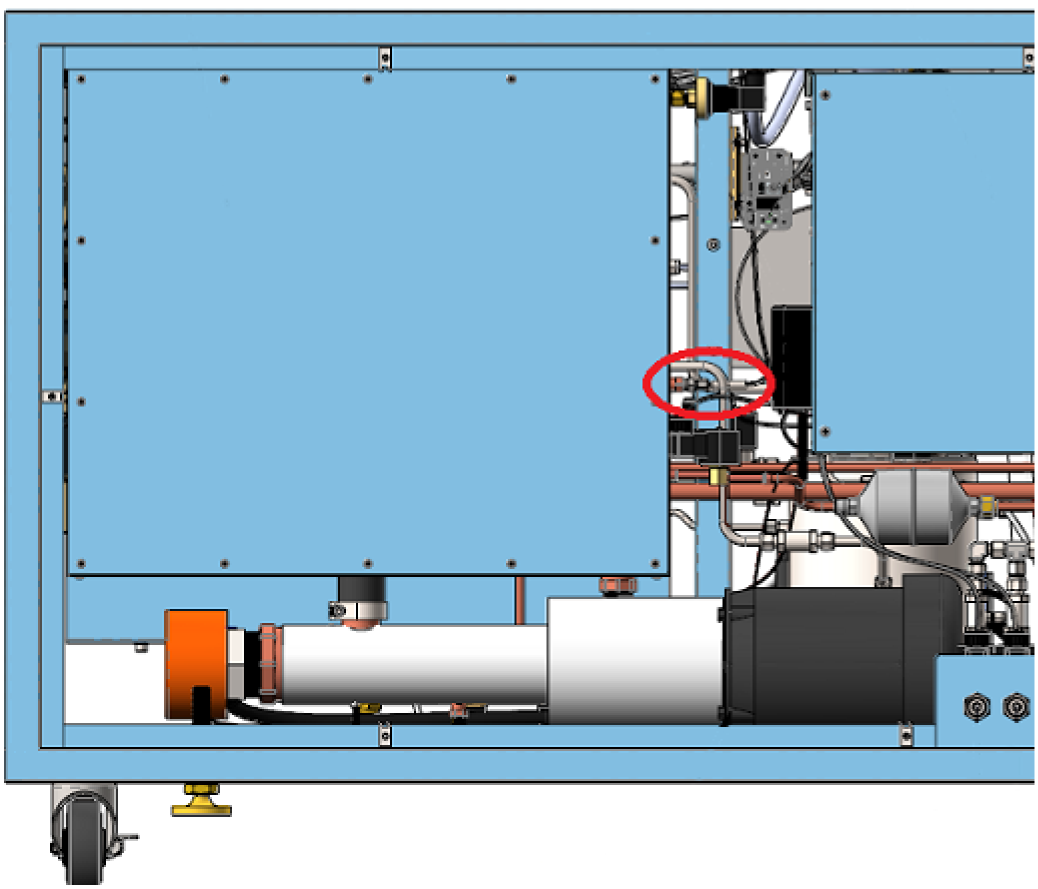
- Locate the Pre-Saturator RTD4 circled in red below. Refer to drawing *9500D901-8* for additional views.



- Loosen the RTD4 probe fitting nut and carefully remove the temperature probe.
- Before removing the Bath Fluid RTD1, the bath heater housing must be drained. Connect a hose to the bath heater housing drain valve (V6) (valve is 1/4" FNPT) located directly under the insulated heater housing near the back of the generator. Open the drain valve (handle vertical) and drain completely (approximately 9 Liters), then close the valve (handle horizontal).



- Removal of Bath Fluid RTD1 located on the right side of the refrigeration enclosure (circled in red below) can now be done. Refer to drawing *9500D901-10* for additional views.



- The Chamber Temperature RTD2 is not removed; instead, the temperature probe cable length is extended into the chamber and out through the top. Sufficient cable length is provided to reach into the temperature bath. Before doing so, loosen the outer fitting on the left side of the bath enclosure just to the right of the reservoir. Simultaneously push the temperature probe cable while pulling the cable into the chamber until all excess cable has been extended.

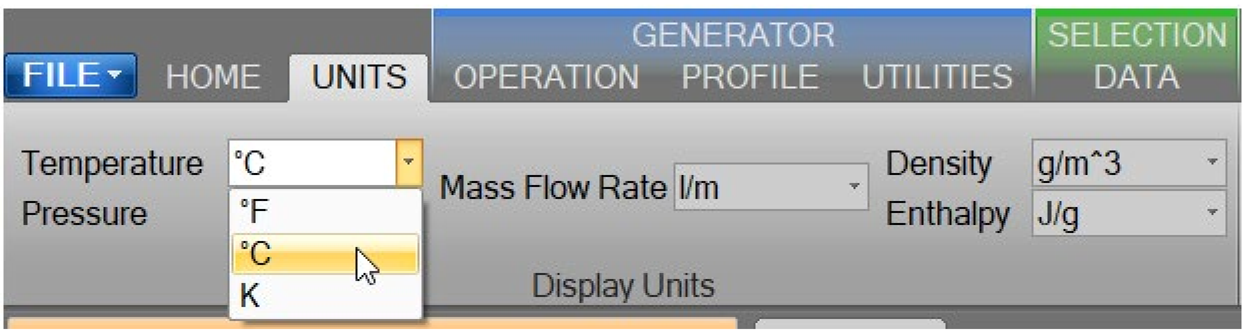
Note - *The Cabinet Temp (RTD6) does not require calibration and cannot be removed.*

- Restore power.
- Allow the touch panel PC to boot and ControLog to connect to the generator.

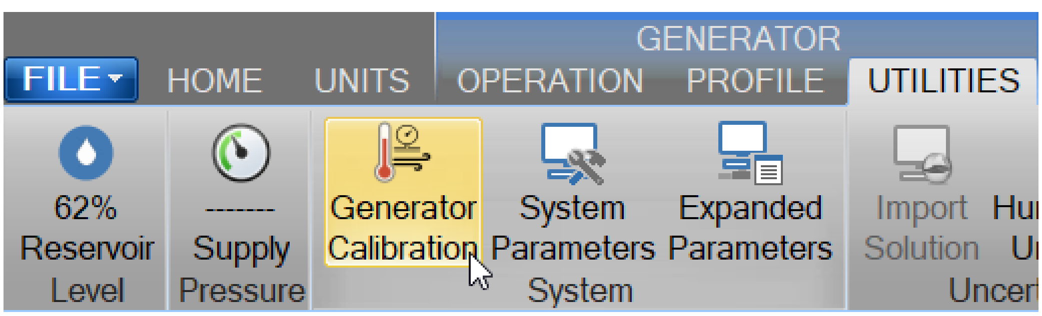
CAUTION!

DO NOT ENABLE CONTROL BY SELECTING GENERATE WITH ANY TEMPERATURE PROBE REMOVED FROM THE SYSTEM.

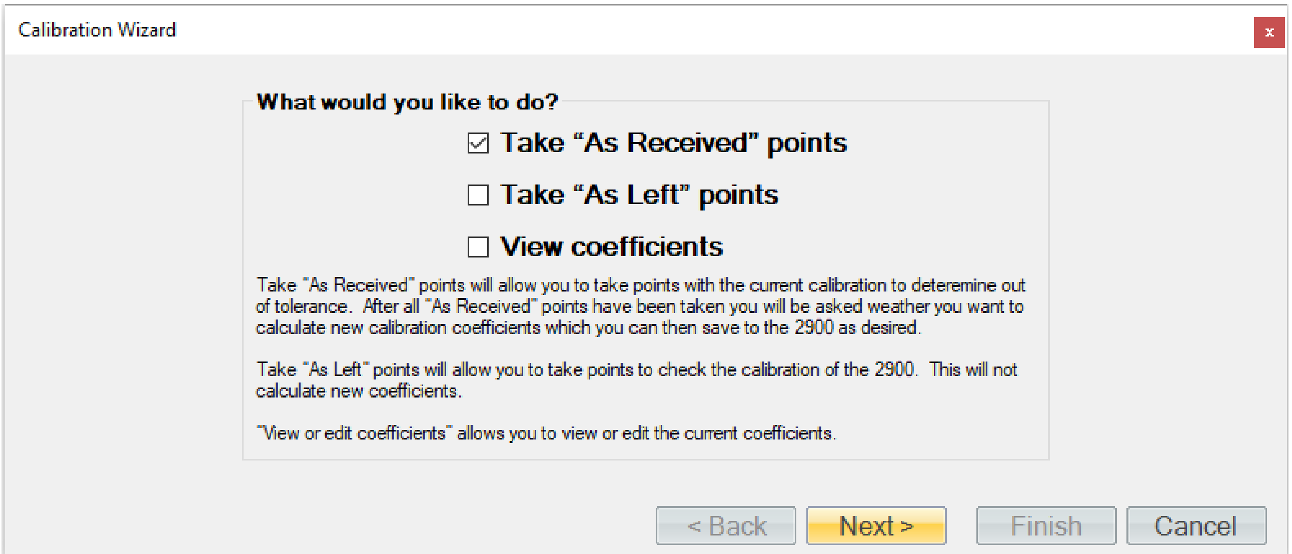
From the Units menu tab, select the desired temperature units for calibration (°C is recommended). Once calibration has begun, the units should not be changed again until the calibration is complete.



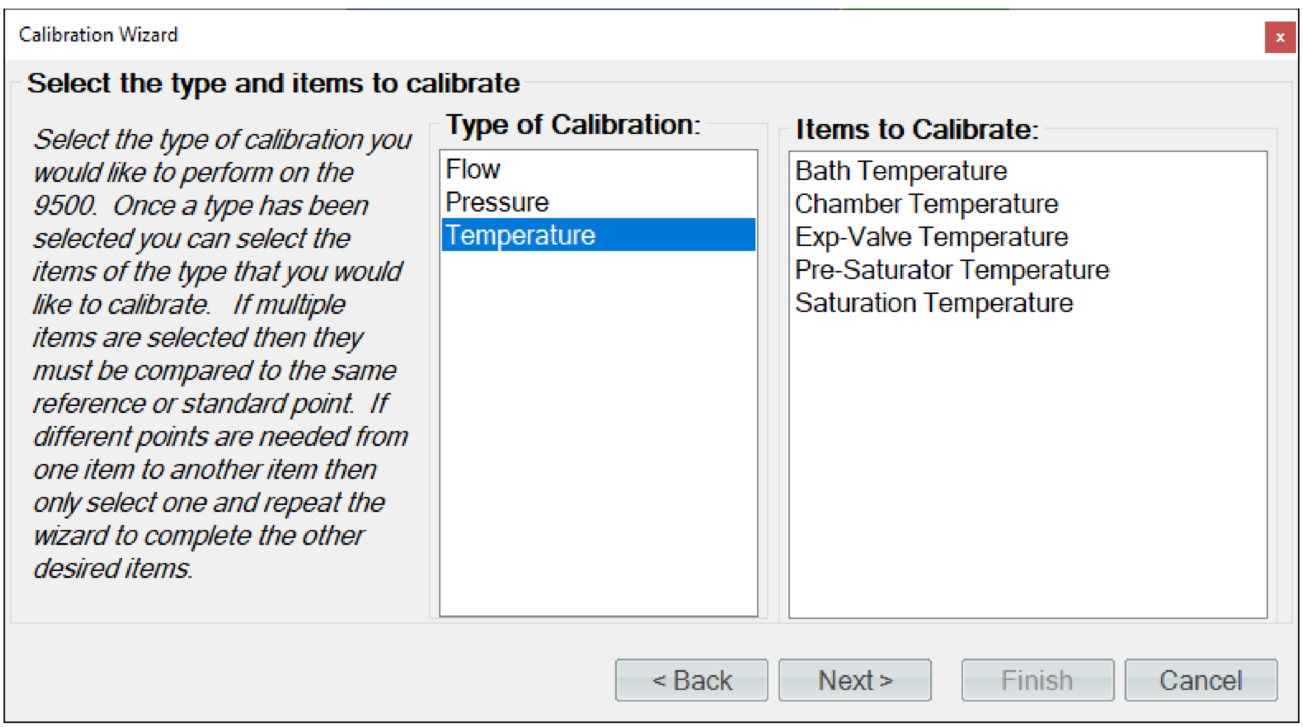
Select Generator Calibration from the Utilities menu tab to open the Calibration Wizard.



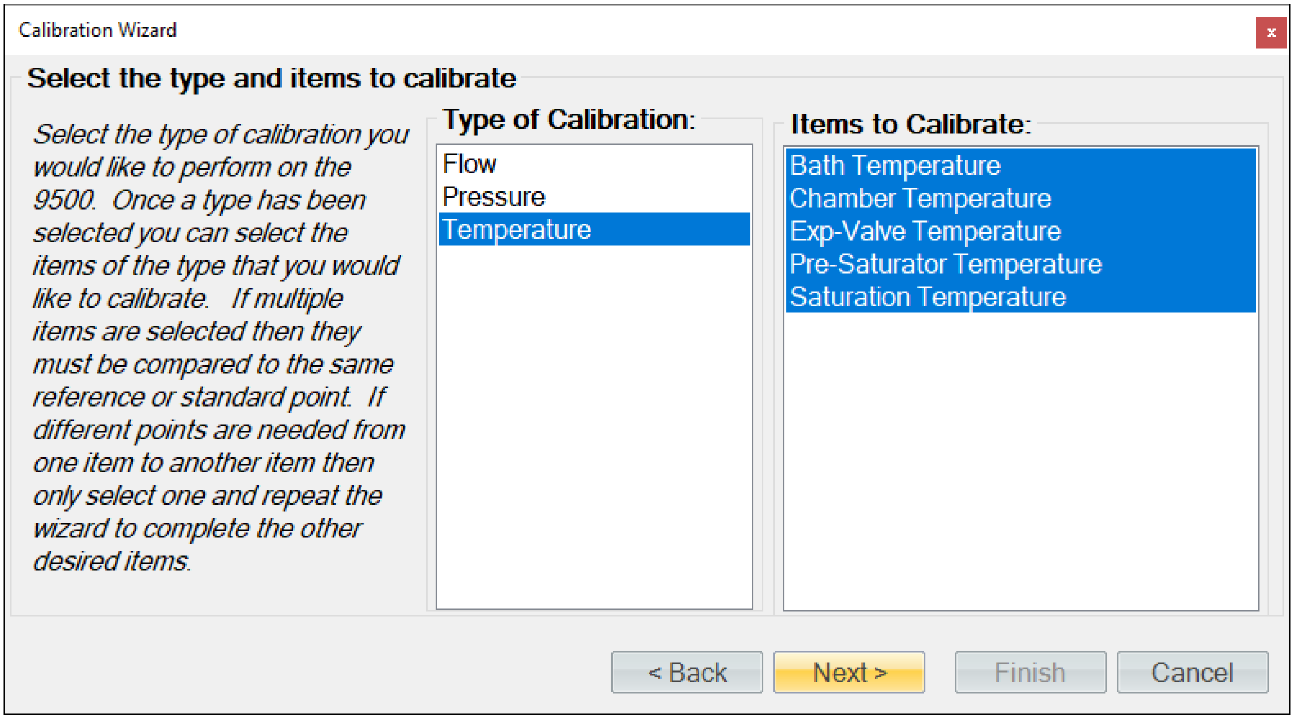
Select "Take "As Received" points." This allows the user to take points with the current calibration to determine out of tolerance. After all the "As Received" points have been taken, the user is asked whether they want to calculate new calibration coefficients.



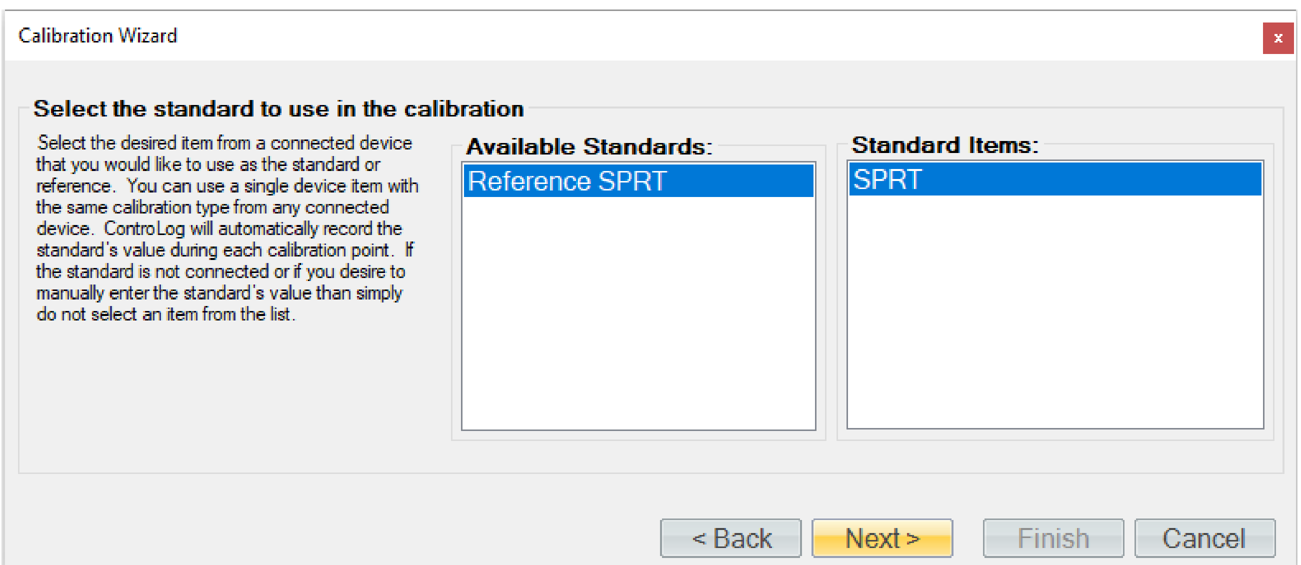
Set the type of calibration to Temperature.



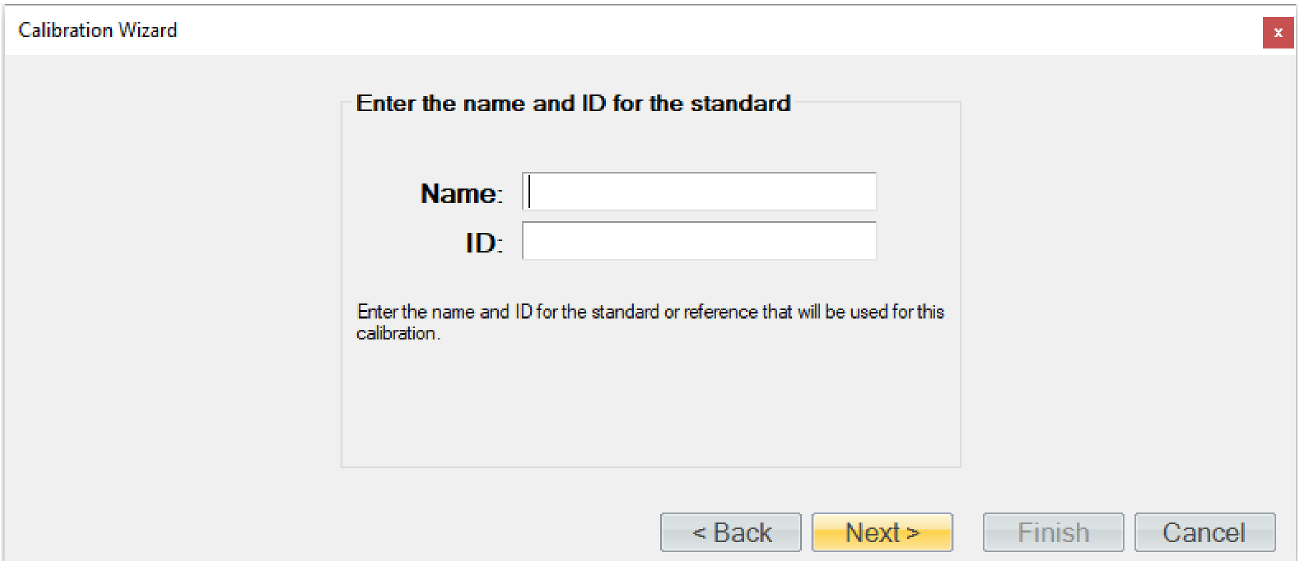
Select the temperature probes to be calibrated. In most cases, this is all five probes, but the user can calibrate any given probe separately or together.



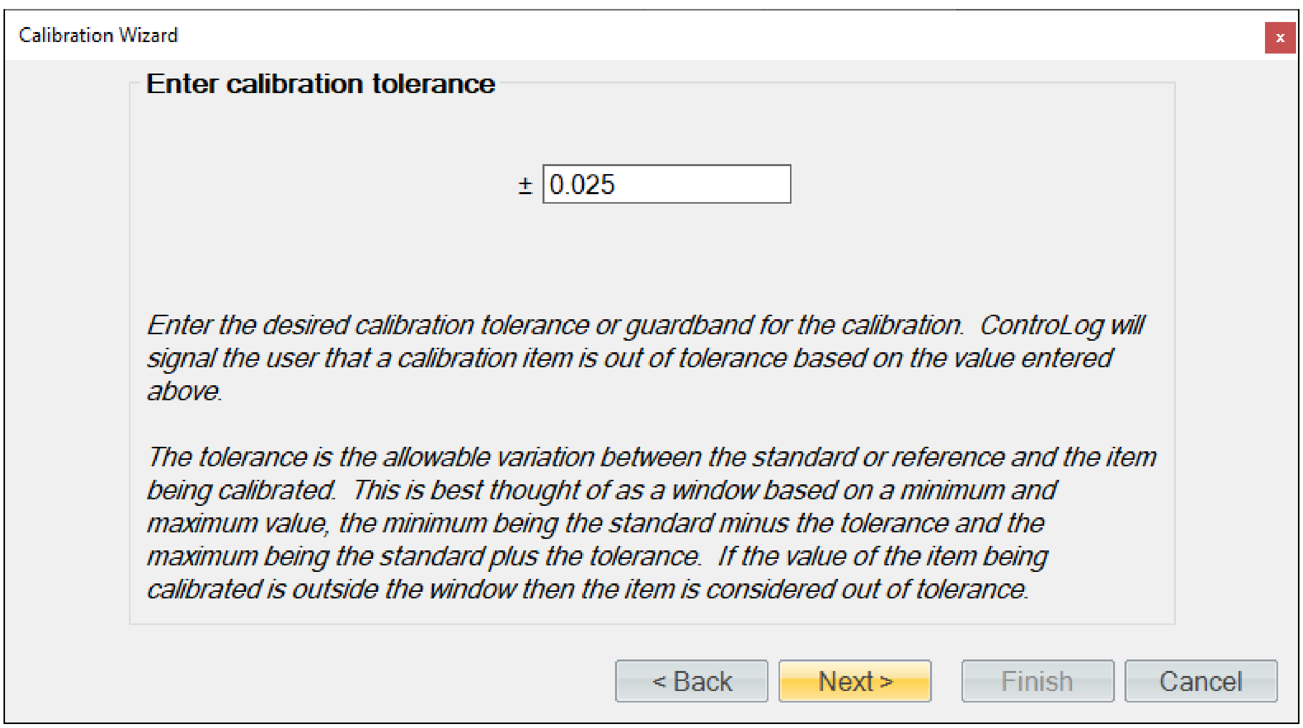
If the temperature standard is a connected device (refer to section 10 Connections), you may select it for calibration. You can use a single device item with the same calibration type from any connected device. ControLog automatically records the standard's value during each calibration point. If the standard is not connected or you desire to enter the standard's value manually, then do not select an item from the list.



Enter the Name and ID of the standard being used. This information is populated on the calibration report. Selecting “Next” without entering a Name results in ControLog giving the standard a generic name.

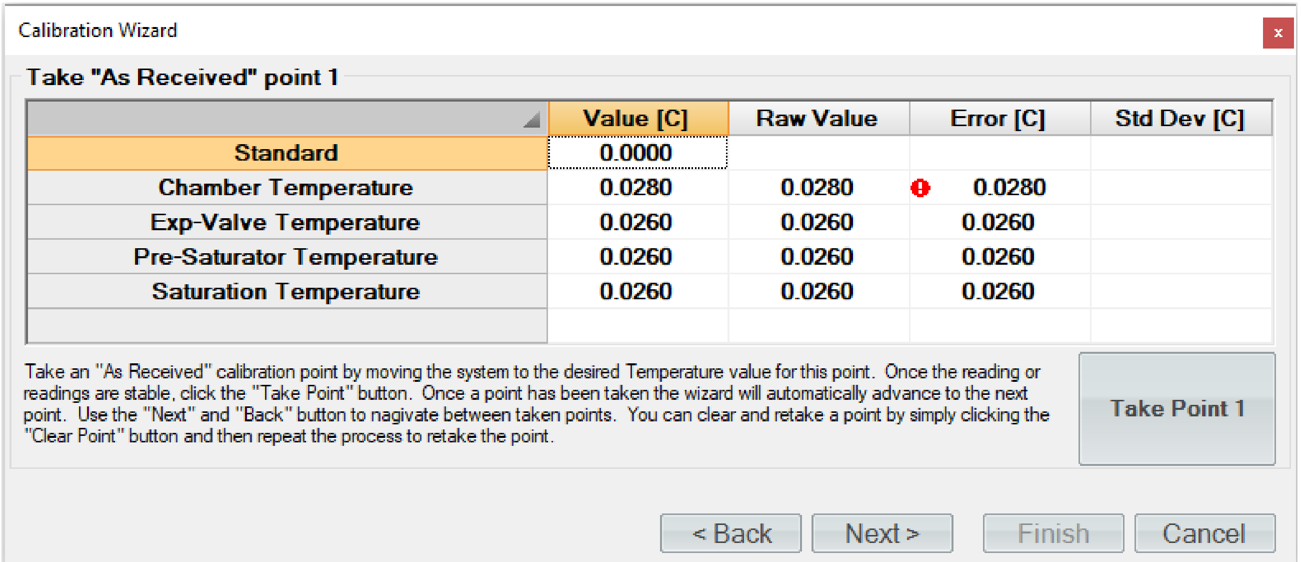


Enter the desired calibration tolerance or guard band for the calibration. ControLog signals the user that a calibration item is out of tolerance based on this entered value.



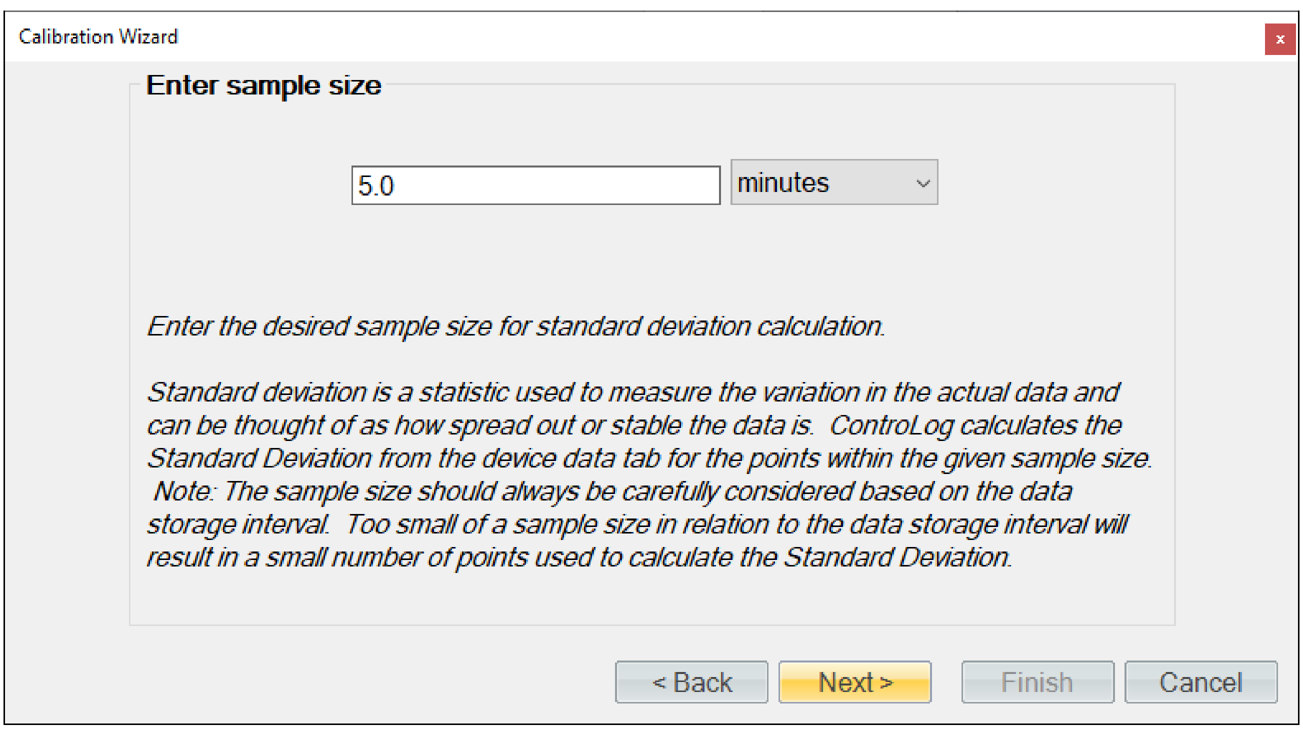
The tolerance is the allowable variation between the standard or reference and the calibrated item. This is best thought of as a window based on a minimum and maximum value, the minimum being the standard minus the tolerance and the maximum being the standard plus the tolerance. If the value of the item being calibrated is outside the window, then the item is considered out of tolerance.

An out-of-tolerance condition is indicated by a red circle with an exclamation point for the out-of-tolerance probe in the Error column.



Enter the sample size used to perform the standard deviation calculation. The sample size is the given time that ControLog uses to determine which data points to use to determine the standard deviation of each probe.

> **Note -** *The number of points used is based on the selected data storage rate and the desired sample size. For example, if the data storage rate is every 30 seconds, a sample size of 5 minutes results in 10 points being used to calculate the standard deviation.*

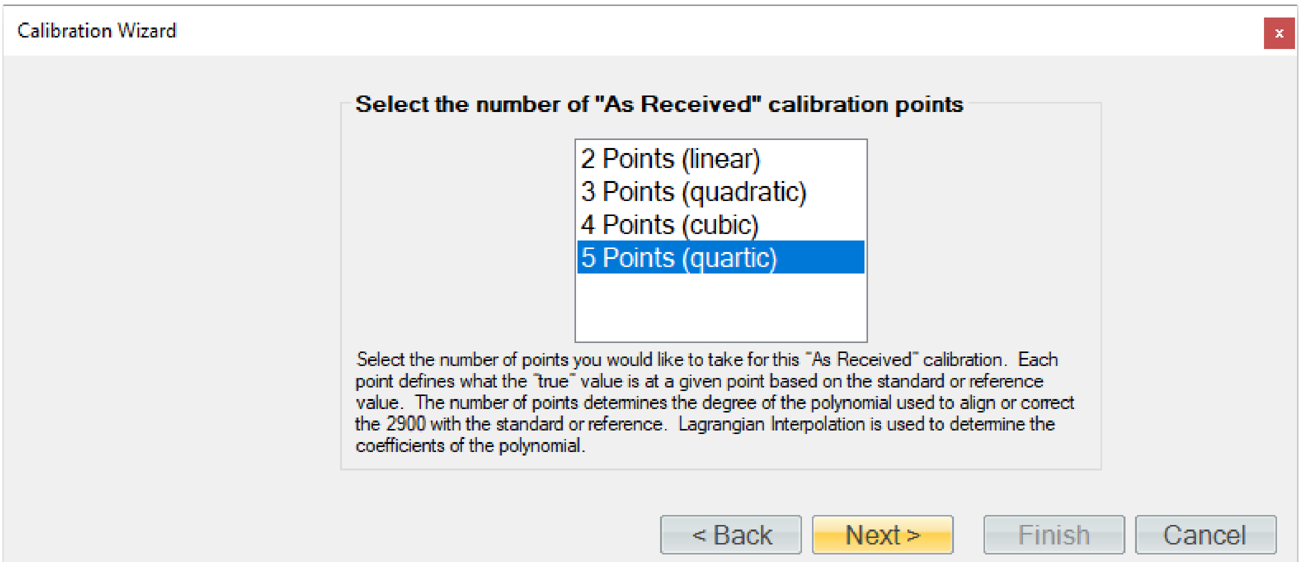


Select the number of points you would like to take for this “As Received” calibration. Each point defines the “true” value at a given point based on the standard or reference value. The number of points determines the degree of the polynomial used to align or correct the generator with the standard or reference.

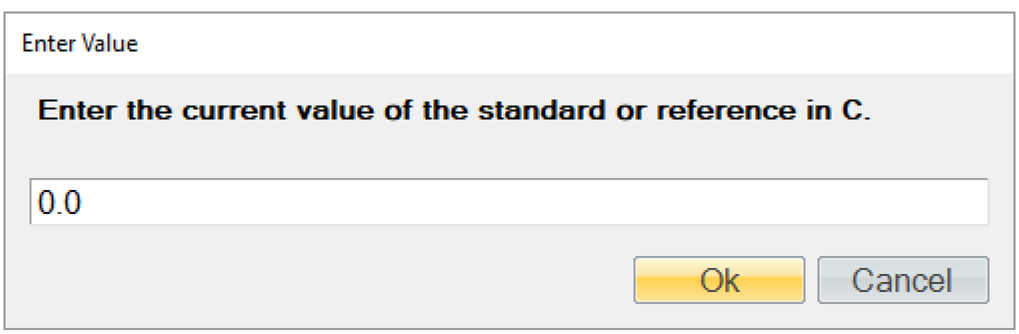
Five calibration points are recommended for all temperature probes using the following temperature points:

- 0 °C, 17.5 °C, 35 °C, 52.5 °C, and 70 °C.

Note - *The specific points can be different from those listed above. Use best metrology practices when determining which points to take.*

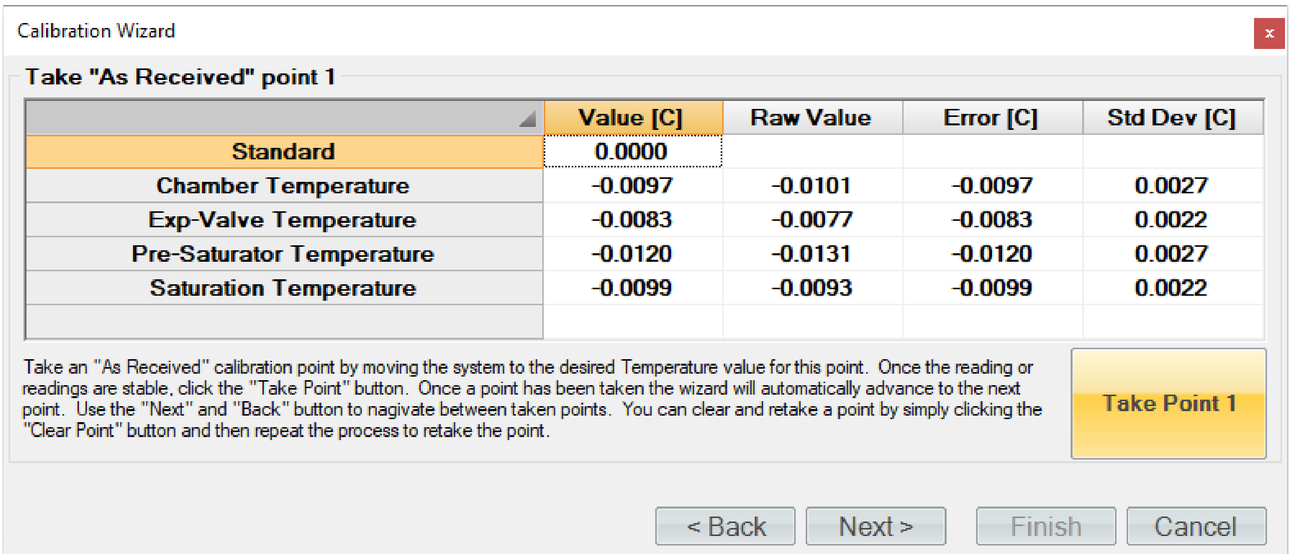


Using the temperature bath, generate the first temperature point (0 °C). If the standard is not a connected device, then ControLog asks for the value before taking the point. You can also enter a standard or reference value before taking a point by clicking the cell in the “Standard” and “Value” columns. This is useful for seeing error values before a point is taken.

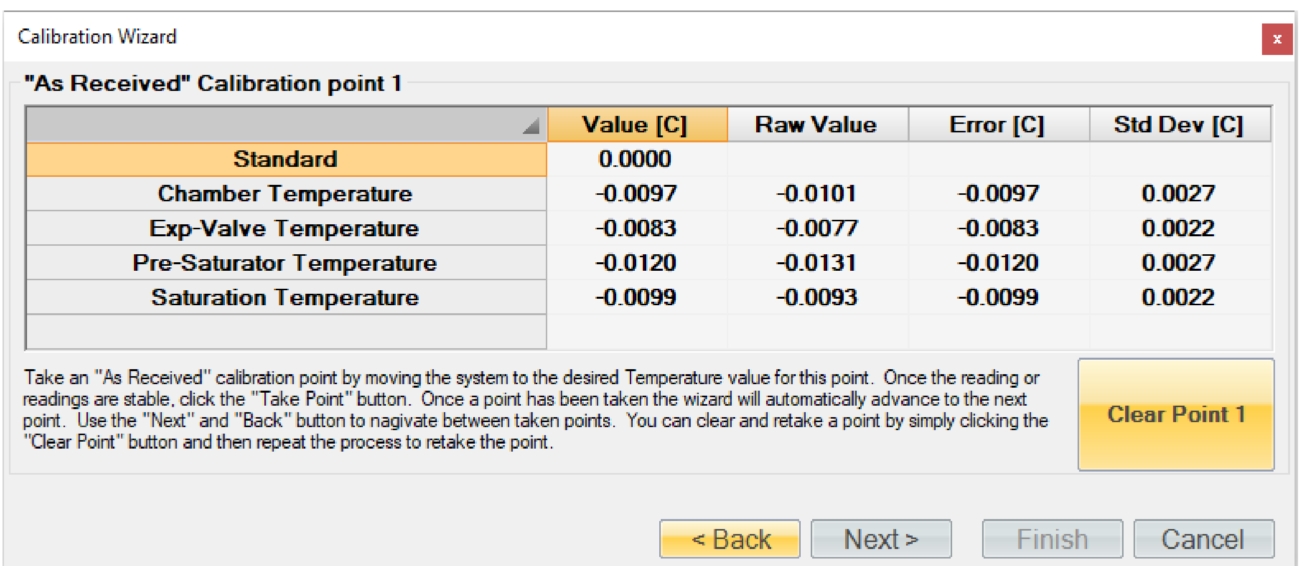


Note – *In the following “Take Point” example screenshots, Bath Temperature is not shown, but it is recommended to calibrate it at the same time as the other four probes.*

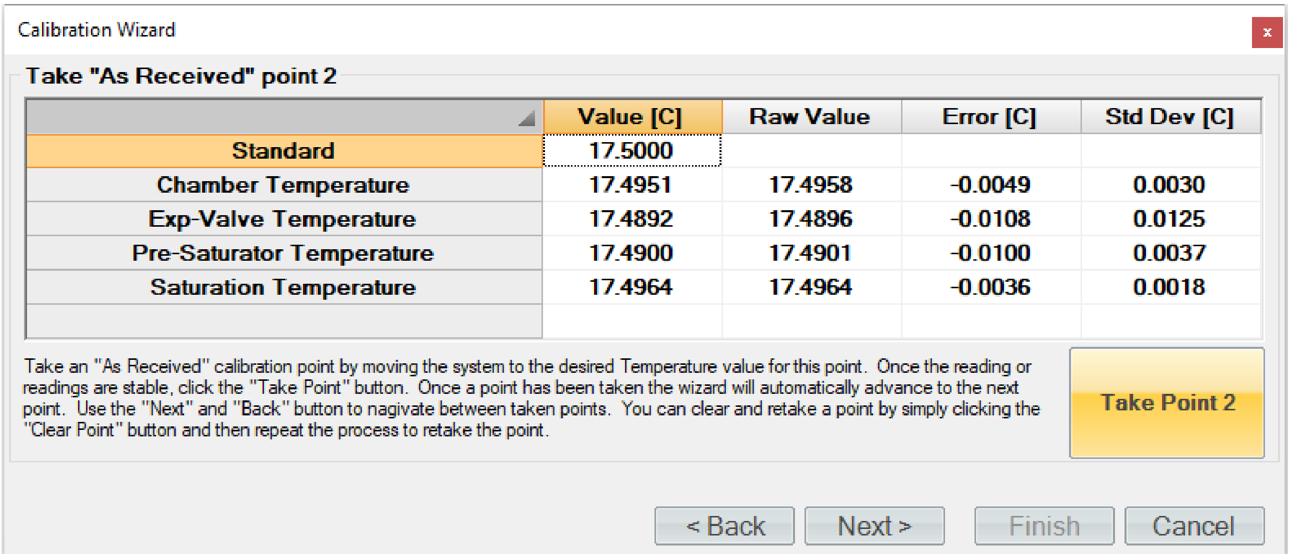
Once the readings are stable, click the “Take Point” button. Then, once a point has been taken, the wizard automatically advances to the next point.



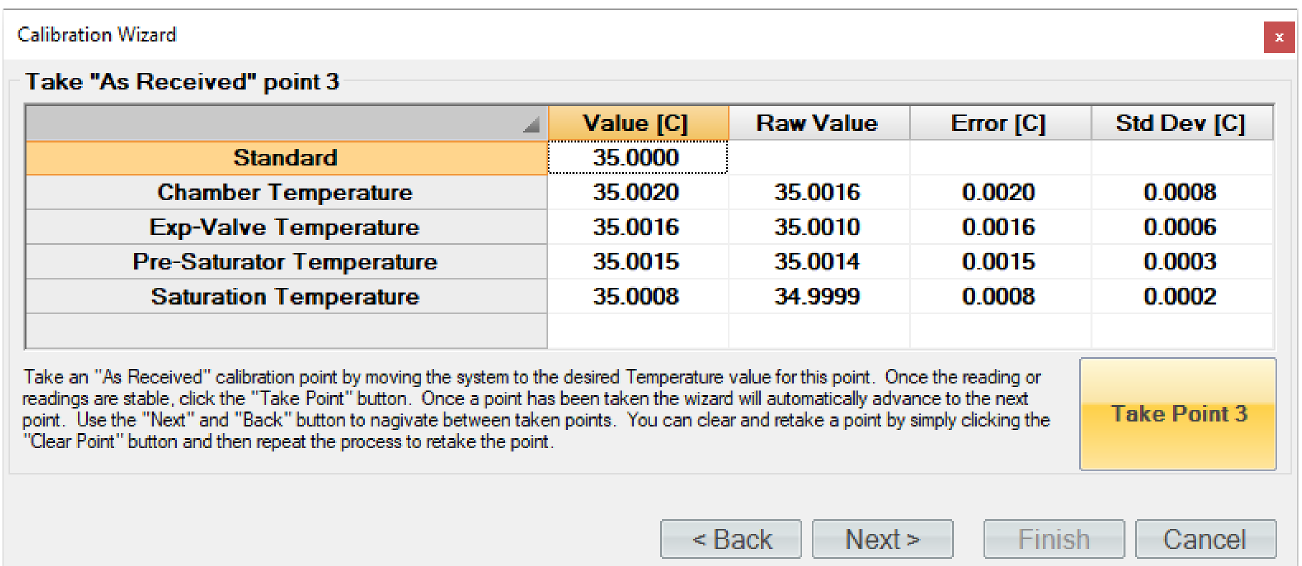
Tip - *Use the “Next” and “Back” buttons to navigate between taken points. You can clear and retake a point by simply clicking the “Clear Point” button and then repeating the process to retake the point.*



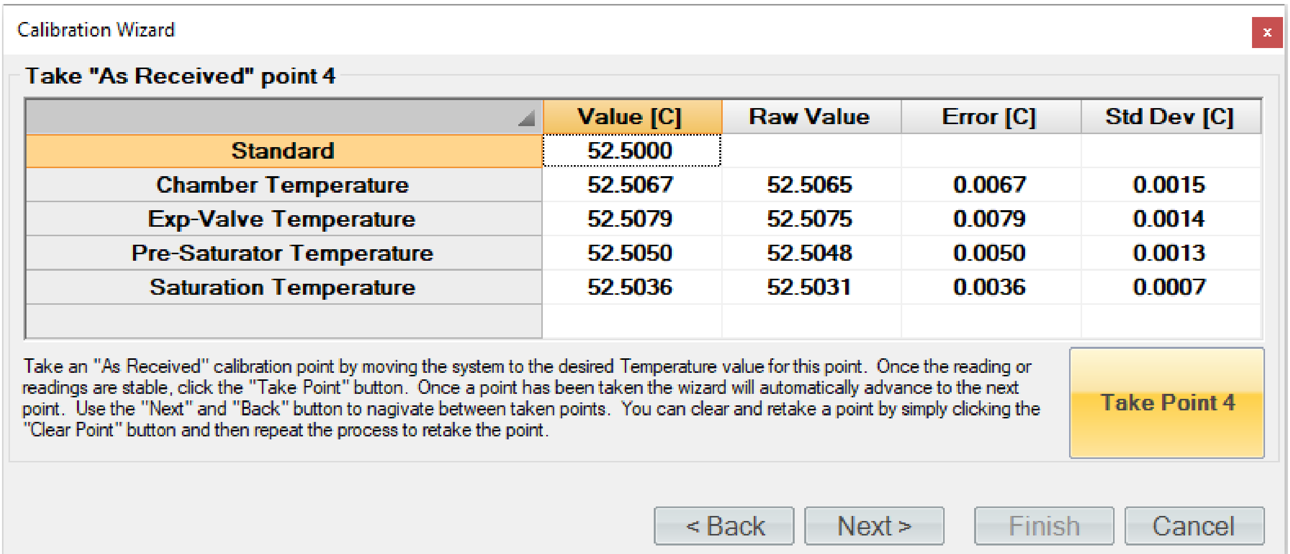
Using the temperature bath, generate the second temperature point (17.5 °C). Once the readings are stable, enter the value of the standard and click the “Take Point” button.



Using the temperature bath, generate the third temperature point (35 °C). Once the readings are stable, enter the value of the standard and click the “Take Point” button.

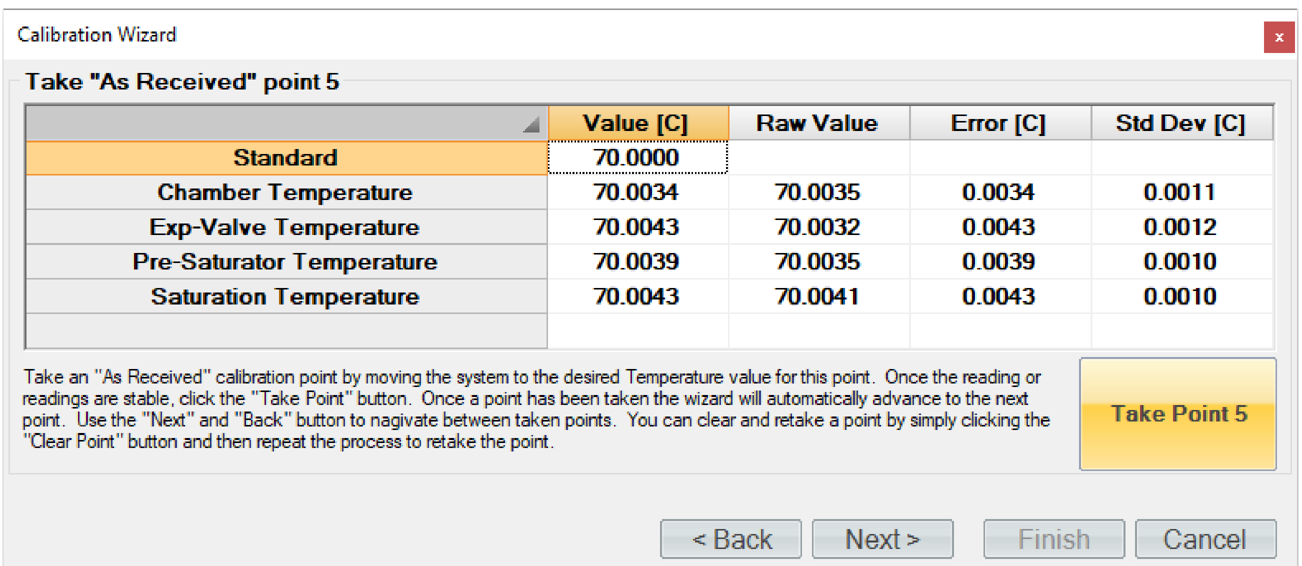


Using the temperature bath, generate the fourth temperature point (52.5 °C). Once the readings are stable, enter the value of the standard and click the “Take Point” button.



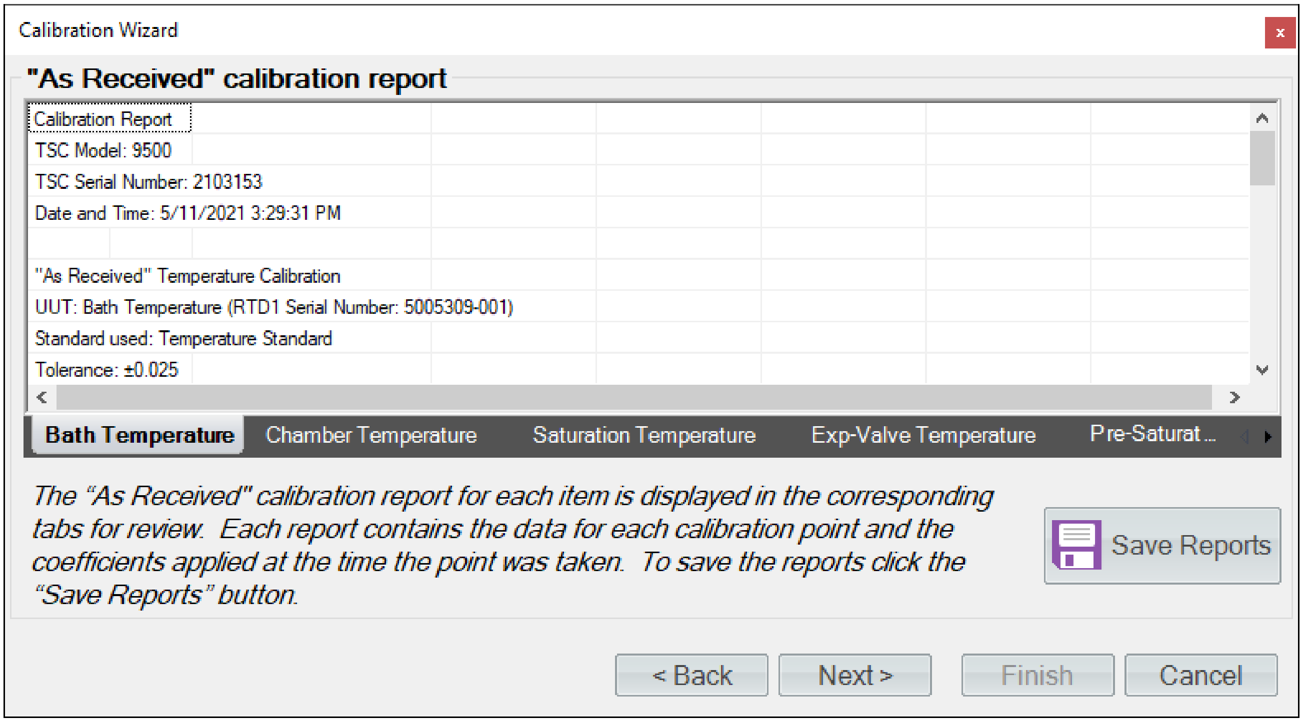
	Value [C]	Raw Value	Error [C]	Std Dev [C]
Standard	52.5000			
Chamber Temperature	52.5067	52.5065	0.0067	0.0015
Exp-Valve Temperature	52.5079	52.5075	0.0079	0.0014
Pre-Saturator Temperature	52.5050	52.5048	0.0050	0.0013
Saturation Temperature	52.5036	52.5031	0.0036	0.0007

Using the temperature bath, generate the last temperature point (70 °C). Once the readings are stable, enter the value of the standard and click the “Take Point” button.



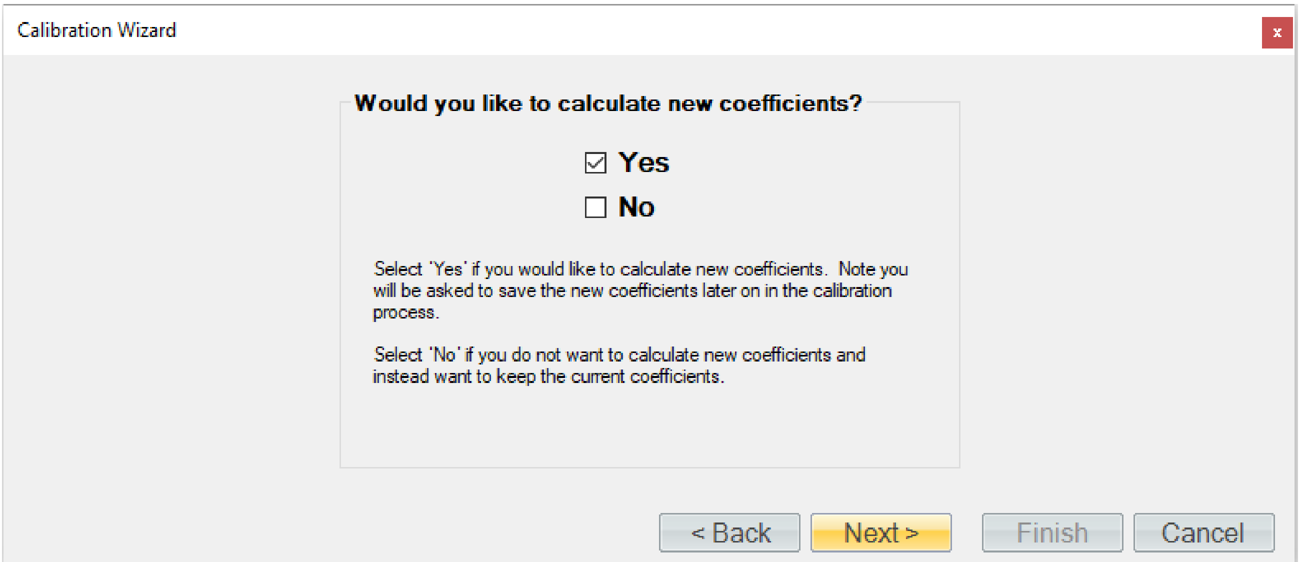
	Value [C]	Raw Value	Error [C]	Std Dev [C]
Standard	70.0000			
Chamber Temperature	70.0034	70.0035	0.0034	0.0011
Exp-Valve Temperature	70.0043	70.0032	0.0043	0.0012
Pre-Saturator Temperature	70.0039	70.0035	0.0039	0.0010
Saturation Temperature	70.0043	70.0041	0.0043	0.0010

ControLog advances to the “As Received” calibration report when all temperature points have been entered. Each temperature probe appears in its own tab that contains the data for each calibration point and the coefficients used when the points were taken.

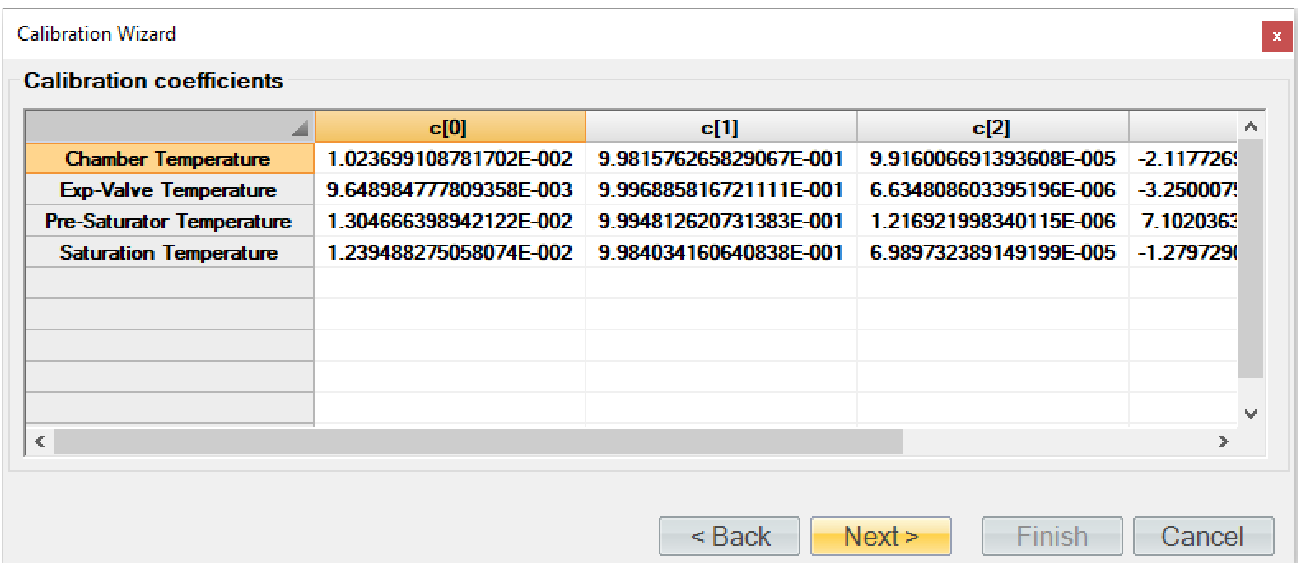


The “Save Reports” button opens a file dialog to save the report. The default file location is …Documents\Thunder Scientific\9500 ControLog\Reports\. If the report is saved in an Excel format, then each probe appears in its own tab within the workbook. If the report is saved in a pdf or text-based format, then a file for each probe calibrated is created.

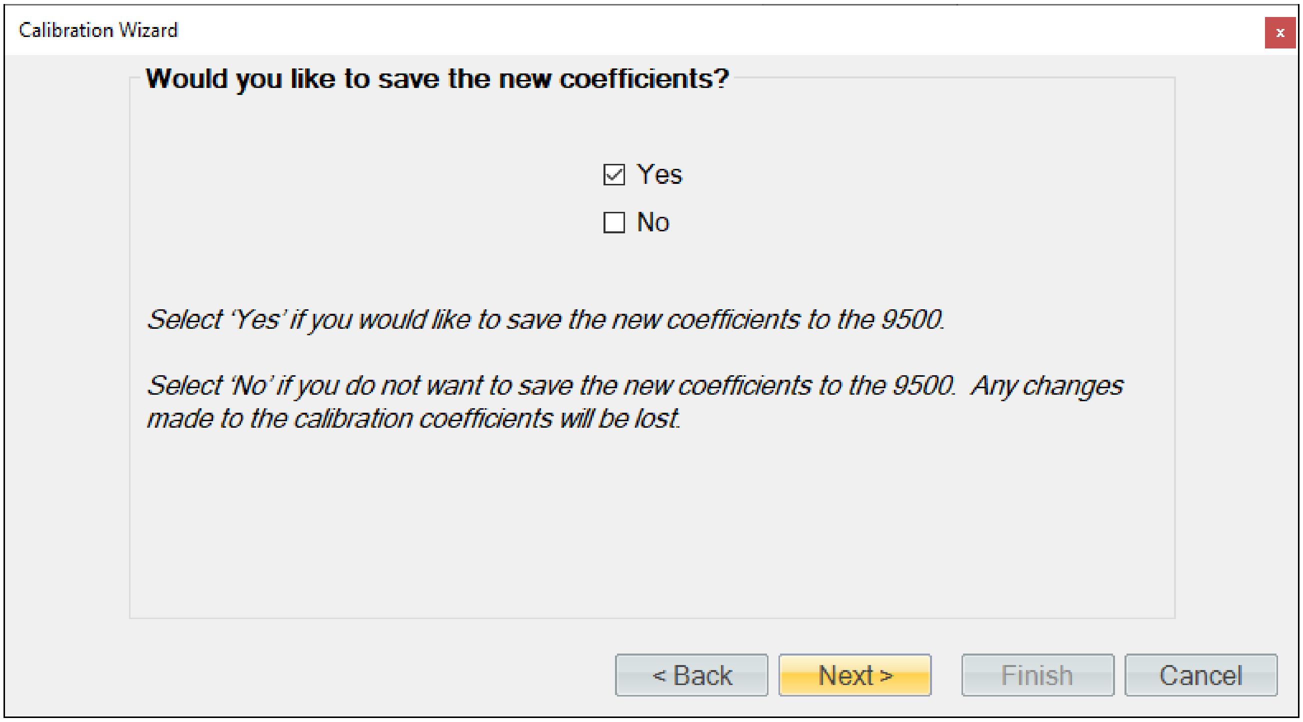
Clicking "Next," asks the user if they want to calculate new coefficients using the "As Received" data points just taken.



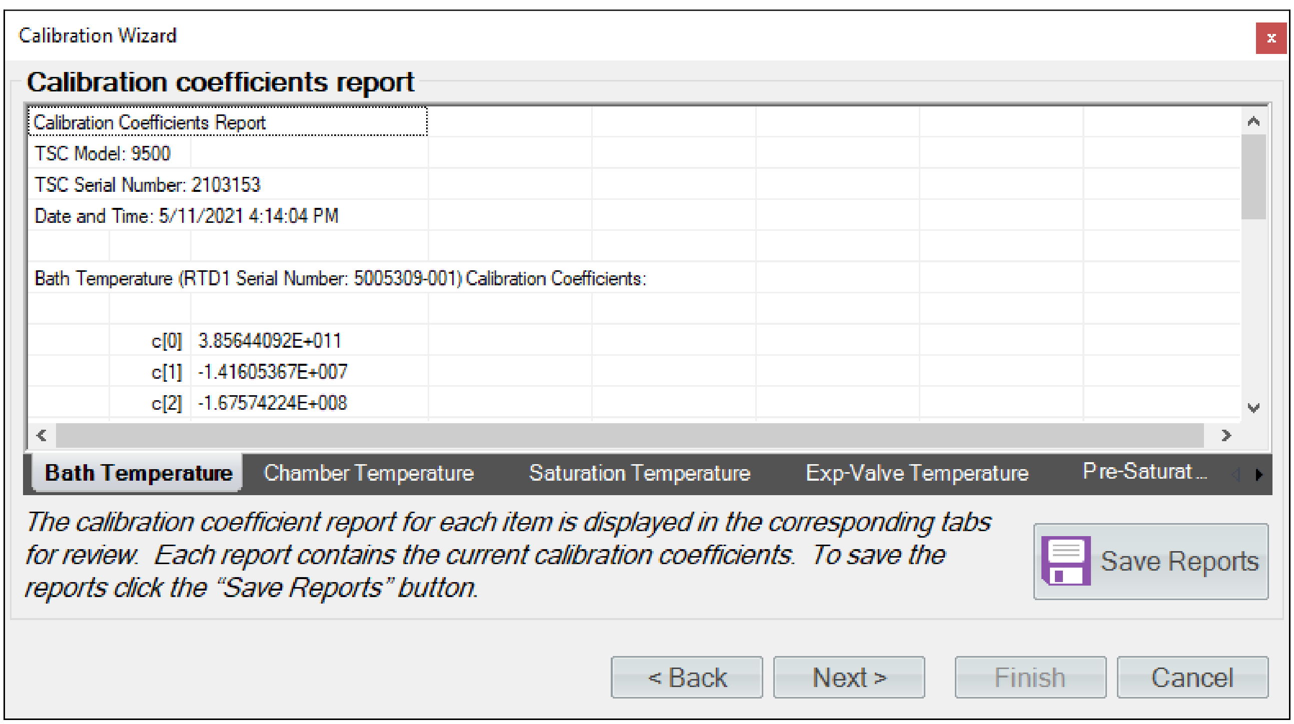
If the user selects to calculate new coefficients, they are calculated and displayed. ControLog issues a message telling the user that the coefficients cannot be calculated if a problem occurs during the calculation.



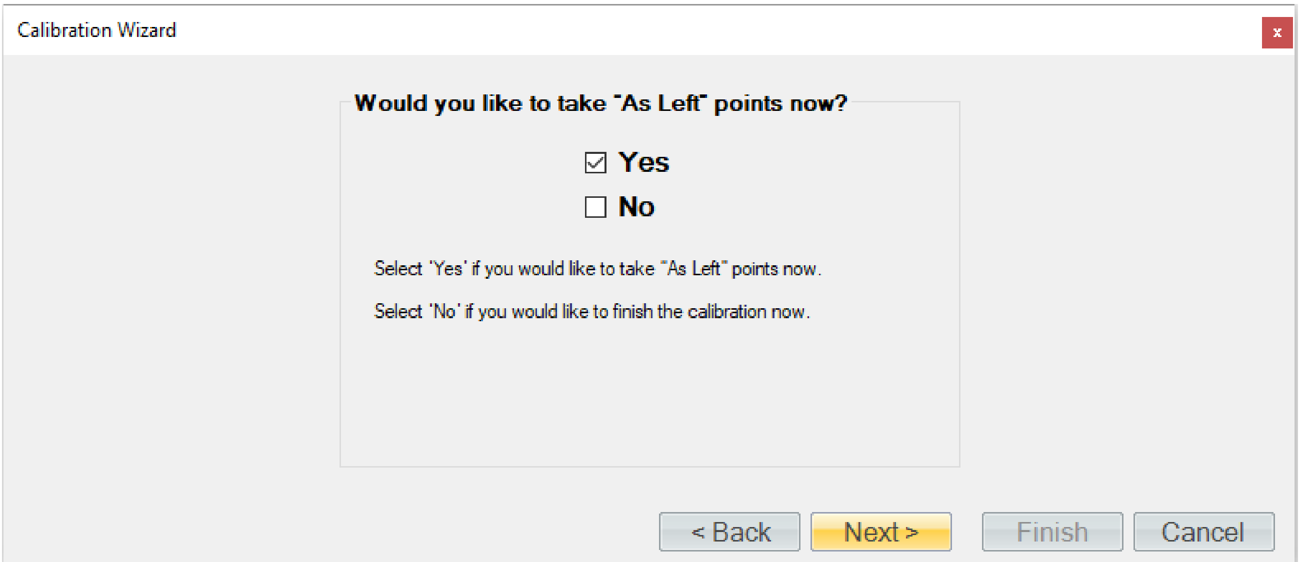
Next, the user is asked to save the new coefficients to the system. Selecting "Yes" results in the current coefficient being over-written by the newly calculated coefficients.



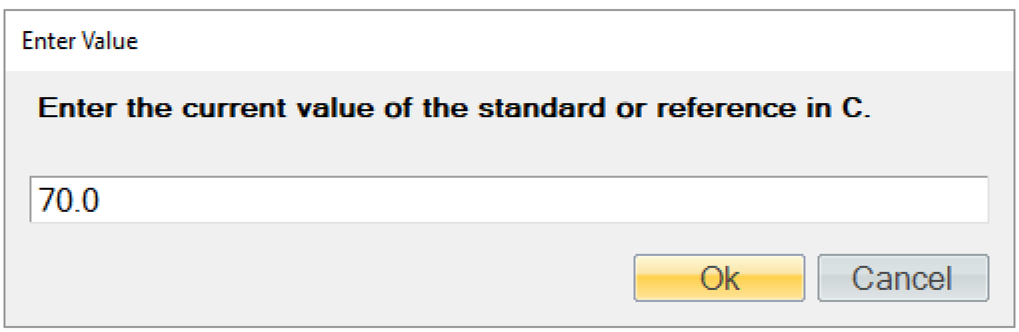
Next, the user can view and save the calibration coefficients report for each probe.



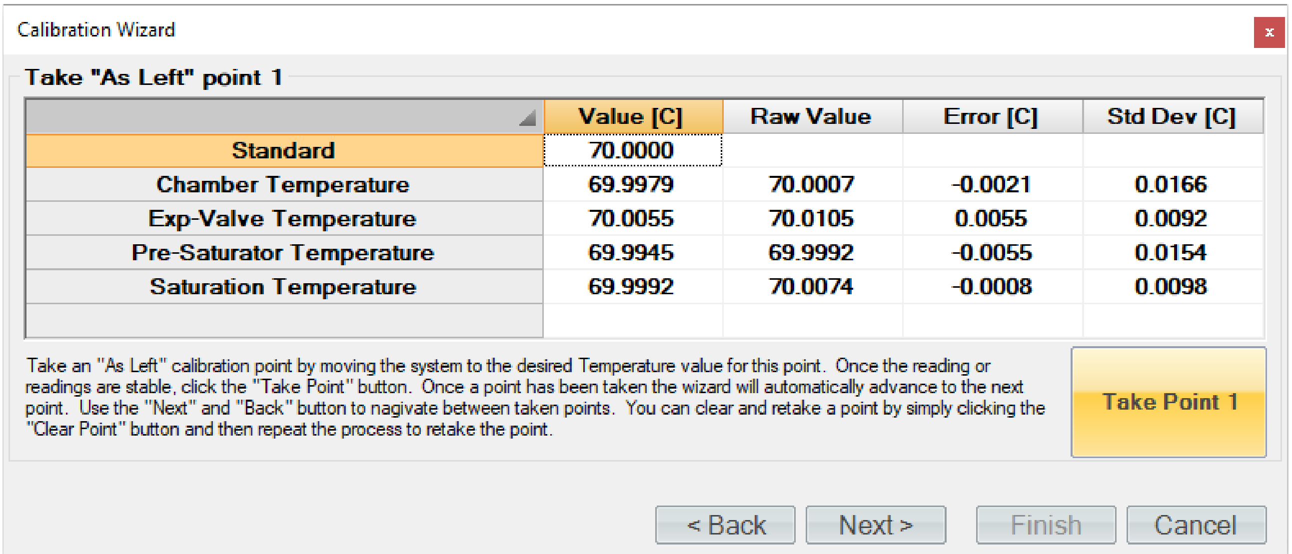
Next, the user can complete the calibration or can choose to take “As Left” points.



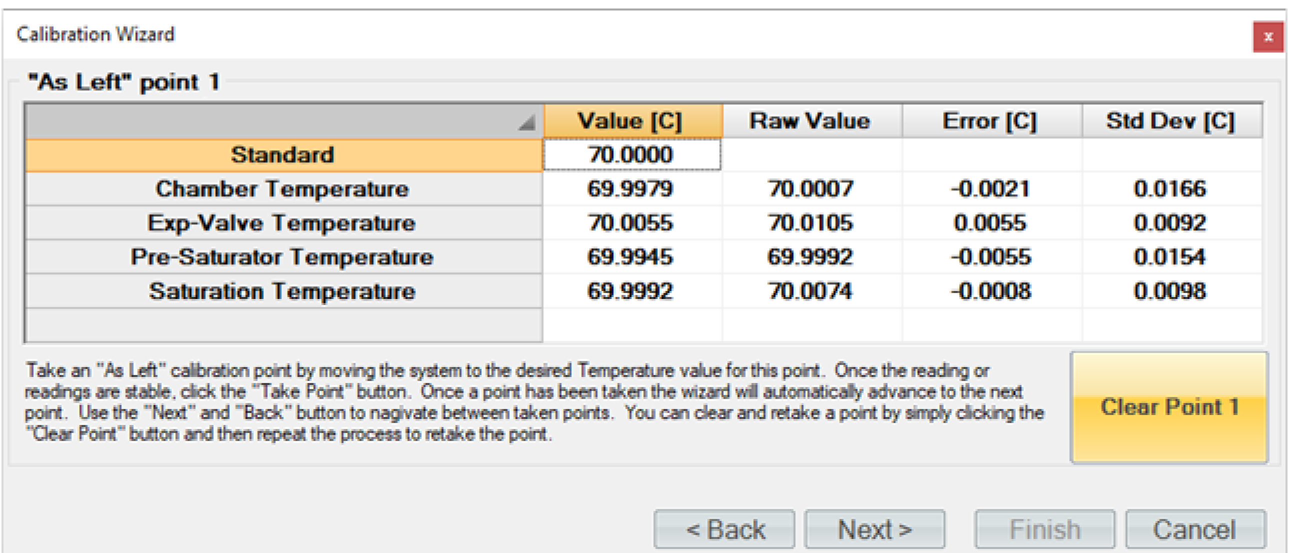
ControLog allows users to take as many “As Left” points as they want. In this example, we check every 10°C points starting at 70 °C and ending at 0 °C. If the standard is not a connected device, then ControLog asks for the value before taking the point. You can also enter a standard or reference value before taking a point by clicking the cell in the “Standard” and “Value” columns. This is useful for seeing error values before a point is taken.



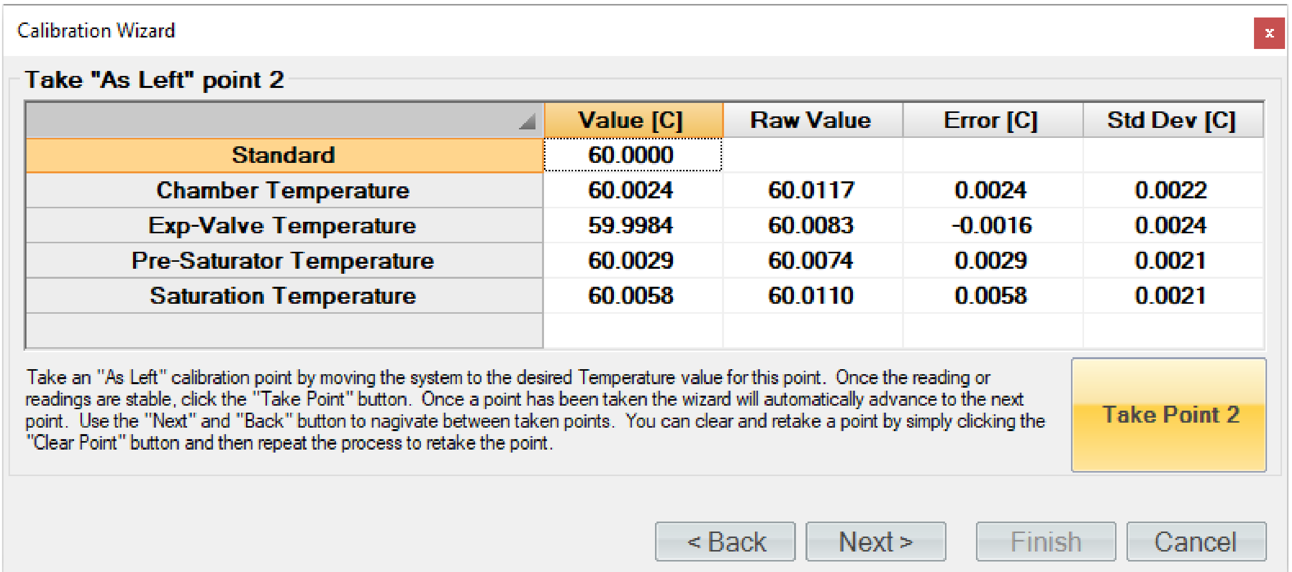
Once the readings are stable, enter the value of the standard and click the "Take Point" button. Once a point has been taken, the wizard automatically advances to the next point.



Tip - *Use the "Next" and "Back" buttons to navigate between taken points. You can clear and retake a point by simply clicking the "Clear Point" button and then repeating the process to retake the point.*



Using the temperature bath, generate the next temperature point (60 °C). Once the readings are stable, enter the value of the standard and click the “Take Point” button.



Calibration Wizard

Take "As Left" point 2

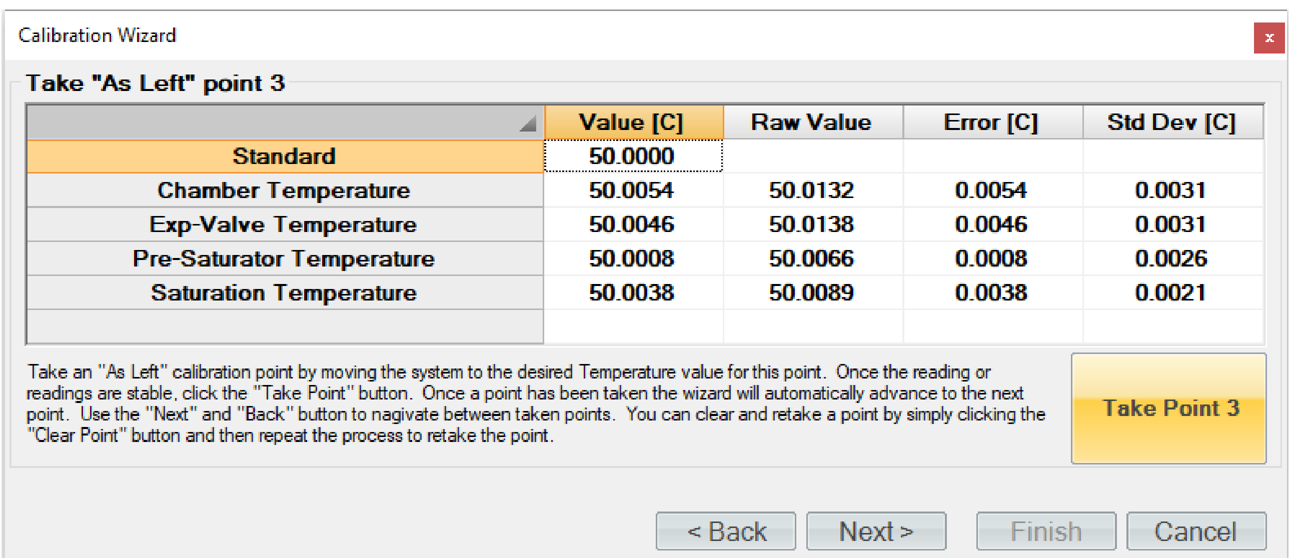
	Value [C]	Raw Value	Error [C]	Std Dev [C]
Standard	60.0000			
Chamber Temperature	60.0024	60.0117	0.0024	0.0022
Exp-Valve Temperature	59.9984	60.0083	-0.0016	0.0024
Pre-Saturator Temperature	60.0029	60.0074	0.0029	0.0021
Saturation Temperature	60.0058	60.0110	0.0058	0.0021

Take an "As Left" calibration point by moving the system to the desired Temperature value for this point. Once the reading or readings are stable, click the "Take Point" button. Once a point has been taken the wizard will automatically advance to the next point. Use the "Next" and "Back" button to nagivate between taken points. You can clear and retake a point by simply clicking the "Clear Point" button and then repeat the process to retake the point.

Take Point 2

< Back | Next > | Finish | Cancel

Using the temperature bath, generate the next temperature point (50 °C). Once the readings are stable, enter the value of the standard and click the “Take Point” button.



Calibration Wizard

Take "As Left" point 3

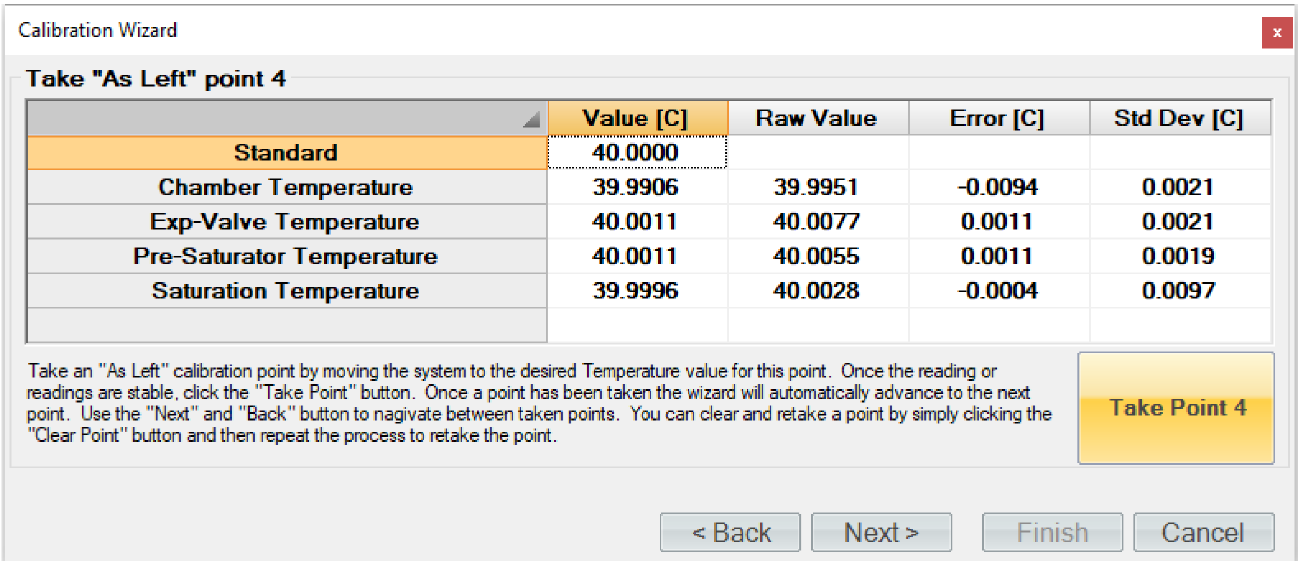
	Value [C]	Raw Value	Error [C]	Std Dev [C]
Standard	50.0000			
Chamber Temperature	50.0054	50.0132	0.0054	0.0031
Exp-Valve Temperature	50.0046	50.0138	0.0046	0.0031
Pre-Saturator Temperature	50.0008	50.0066	0.0008	0.0026
Saturation Temperature	50.0038	50.0089	0.0038	0.0021

Take an "As Left" calibration point by moving the system to the desired Temperature value for this point. Once the reading or readings are stable, click the "Take Point" button. Once a point has been taken the wizard will automatically advance to the next point. Use the "Next" and "Back" button to nagivate between taken points. You can clear and retake a point by simply clicking the "Clear Point" button and then repeat the process to retake the point.

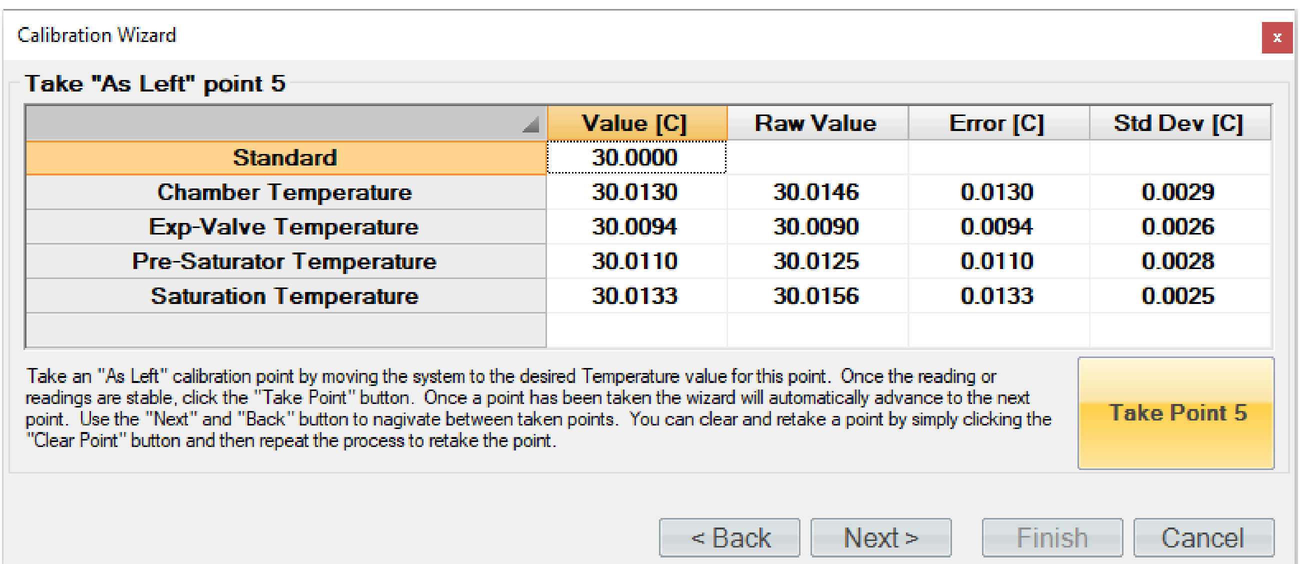
Take Point 3

< Back | Next > | Finish | Cancel

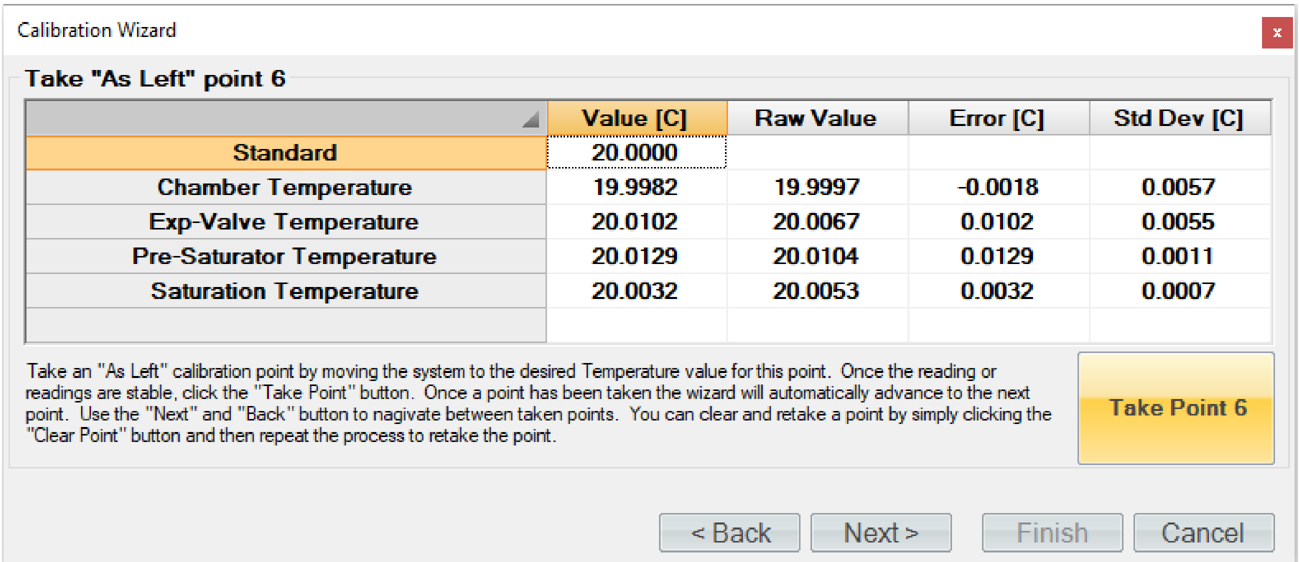
Using the temperature bath, generate the next temperature point (40 °C). Once the readings are stable, enter the value of the standard and click the “Take Point” button.



Using the temperature bath, generate the next temperature point (30 °C). Once the readings are stable, enter the value of the standard and click the “Take Point” button.



Using the temperature bath, generate the next temperature point (20 °C). Once the readings are stable, enter the value of the standard and click the “Take Point” button.

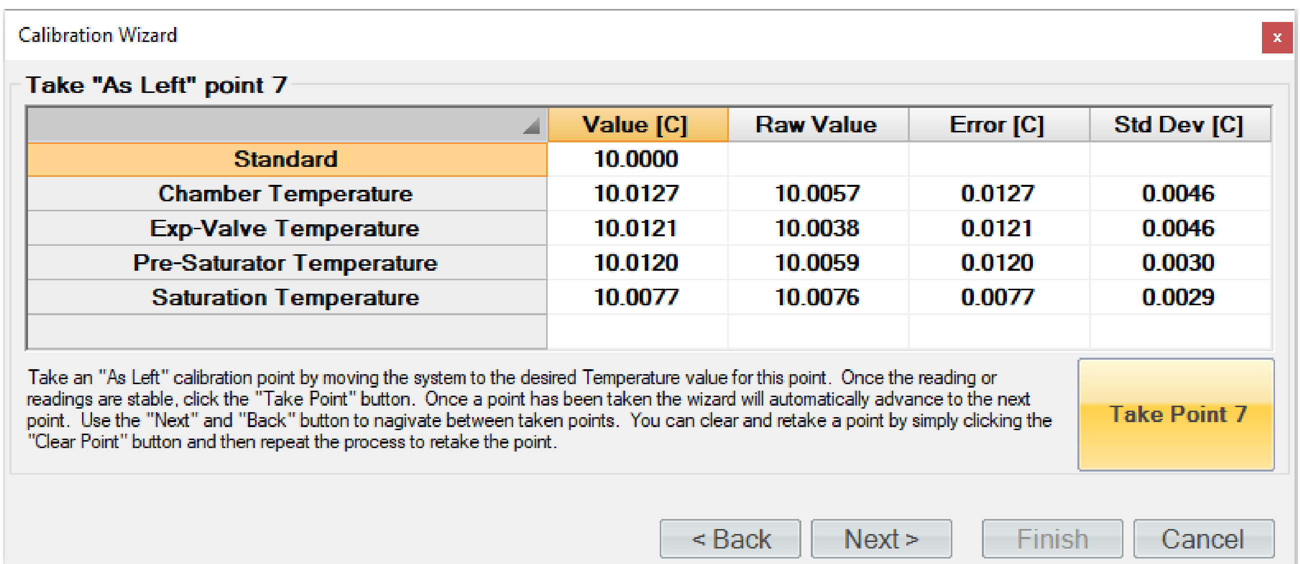

Calibration Wizard

Take "As Left" point 6

	Value [C]	Raw Value	Error [C]	Std Dev [C]
Standard	20.0000			
Chamber Temperature	19.9982	19.9997	-0.0018	0.0057
Exp-Valve Temperature	20.0102	20.0067	0.0102	0.0055
Pre-Saturator Temperature	20.0129	20.0104	0.0129	0.0011
Saturation Temperature	20.0032	20.0053	0.0032	0.0007

Take an "As Left" calibration point by moving the system to the desired Temperature value for this point. Once the reading or readings are stable, click the "Take Point" button. Once a point has been taken the wizard will automatically advance to the next point. Use the "Next" and "Back" button to nagivate between taken points. You can clear and retake a point by simply clicking the "Clear Point" button and then repeat the process to retake the point.

Using the temperature bath, generate the next temperature point (10 °C). Once the readings are stable, enter the value of the standard and click the “Take Point” button.

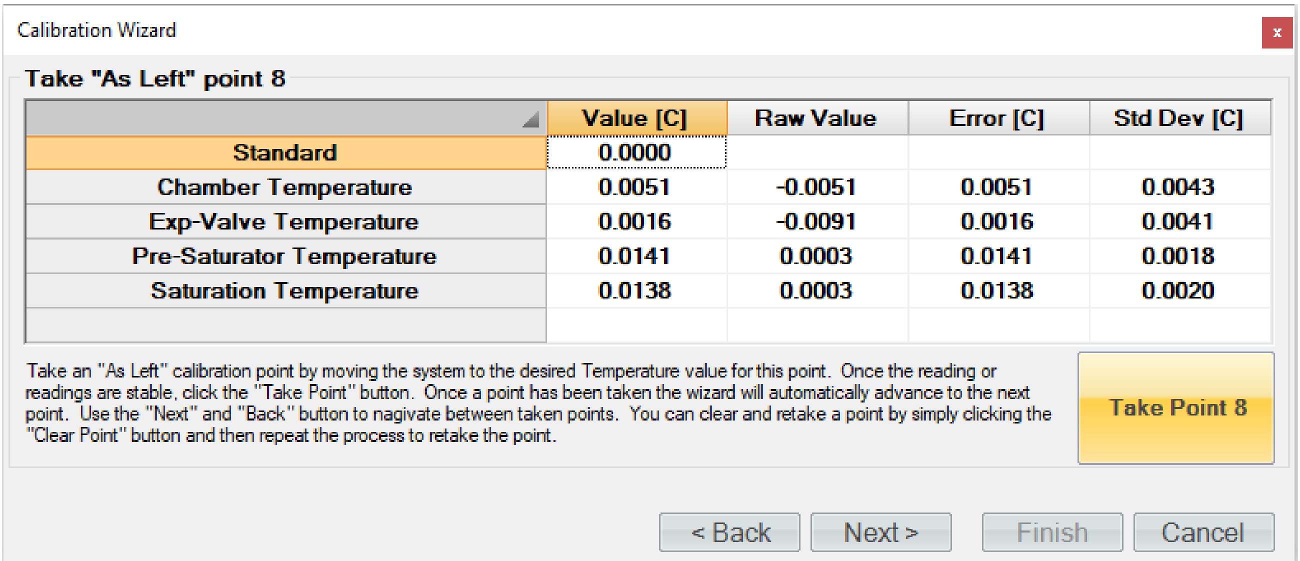

Calibration Wizard

Take "As Left" point 7

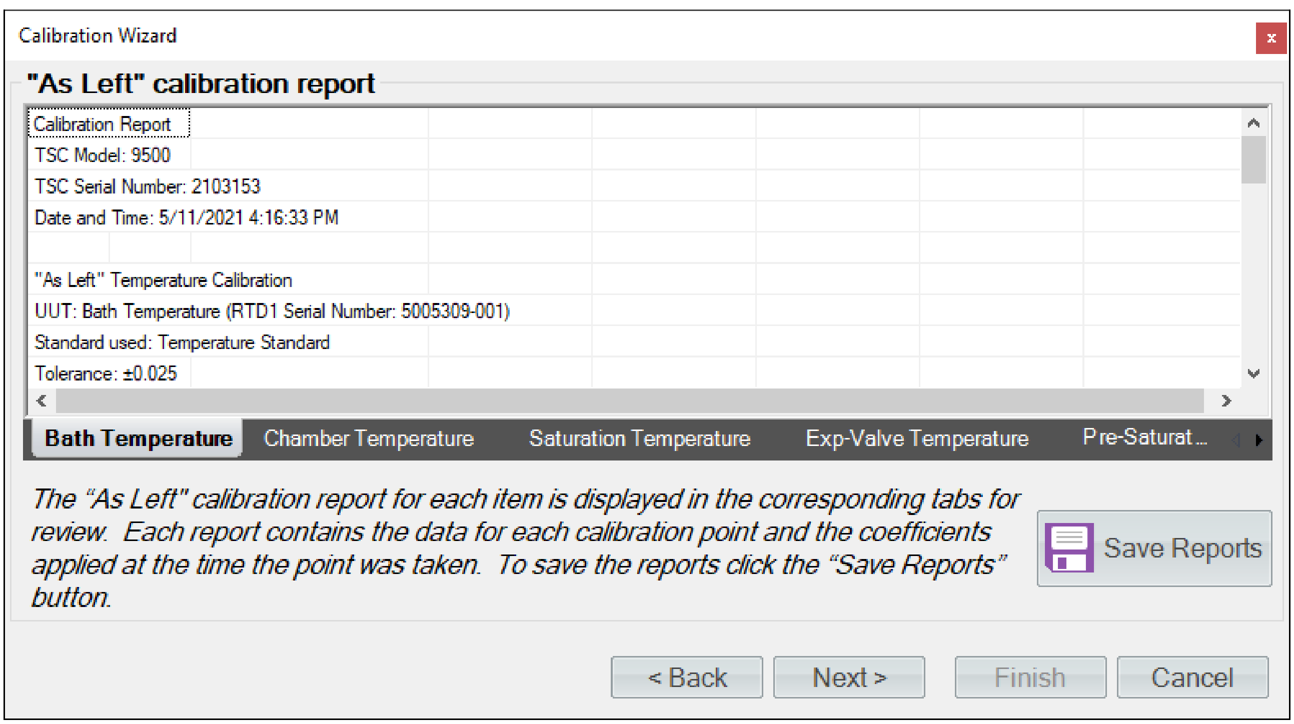
	Value [C]	Raw Value	Error [C]	Std Dev [C]
Standard	10.0000			
Chamber Temperature	10.0127	10.0057	0.0127	0.0046
Exp-Valve Temperature	10.0121	10.0038	0.0121	0.0046
Pre-Saturator Temperature	10.0120	10.0059	0.0120	0.0030
Saturation Temperature	10.0077	10.0076	0.0077	0.0029

Take an "As Left" calibration point by moving the system to the desired Temperature value for this point. Once the reading or readings are stable, click the "Take Point" button. Once a point has been taken the wizard will automatically advance to the next point. Use the "Next" and "Back" button to nagivate between taken points. You can clear and retake a point by simply clicking the "Clear Point" button and then repeat the process to retake the point.

Using the temperature bath, generate the next temperature point (0 °C). Once the readings are stable, enter the value of the standard and click the “Take Point” button.

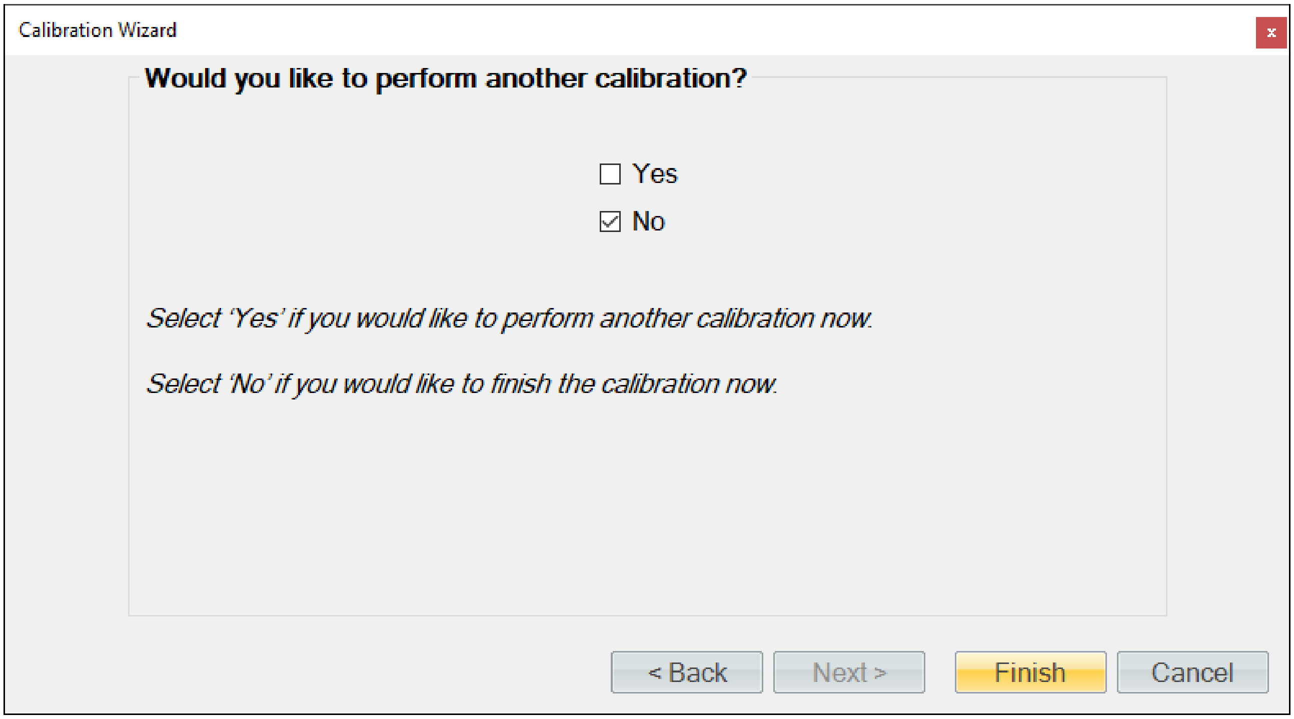


When you have taken the desired amount of “As Left” temperature points, click the “Next” button to view the “As Received” calibration report. Each temperature probe appears in its own tab that contains the data for each calibration point and the coefficients used when the points were taken.



The “Save Reports” button opens a file dialog to save the report. The default file location is …Documents\Thunder Scientific\9500 ControLog\Reports\. If the report is saved in an Excel format, then each probe appears in its own tab within the workbook. If the report is saved in a pdf or text-based format, then a file for each probe calibrated is created.

When finished, close the Temperature Calibration window by selecting “No” and then Finish. Turn off the system from the File menu, and switch the main system “POWER” to OFF. Remove the power cord.



Install temperature probes back into the system:

1. Reinstall all temperature probes making sure they are in the correct positions, then tighten nuts 1/8 turn past finger tight.
2. Reinstall all foam insulation that was removed from around the temperature probes.
3. Reinstall the expansion valve access cover.
4. Reinstall countertop with seven socket head screws to hand tight only.
5. Refill bath fluid and purge bath inlet tube as per section *2.12.5* *Temperature Bath Filling Procedure*.
6. Replace all side panels.
7. Reconnect power.

6.2 Pressure Transducer Calibration

The pressure calibration procedure is used with a precision pressure standard to calibrate the pressure transducers externally or internally. External calibration calibrates the transducer following the manufacturer procedures and stores the coefficients within each transducer or is calculated to be manually entered. The internal calibration calibrates the transducer as part of the system, much like the temperature probes. It uses up to five known pressures, and all coefficients are calculated automatically by the computer and used to update the system calibration. Calibration reports are generated and can be saved for each pressure transducer after each calibration sequence.

Refer to drawing: 9500D901-1, 9500D901-8, 9500D901-9 and 9500D903

> **Note** – *The T2 (TEST CHAMBER), T3 (LOW-RANGE SATURATOR), and T4 (HIGH-RANGE SATURATOR) pressure transducers must be calibrated in the vertical position during either the external or internal calibration procedure.*

6.2.1 Equipment Required

1. 1/2" wrench
2. 9/16" wrench

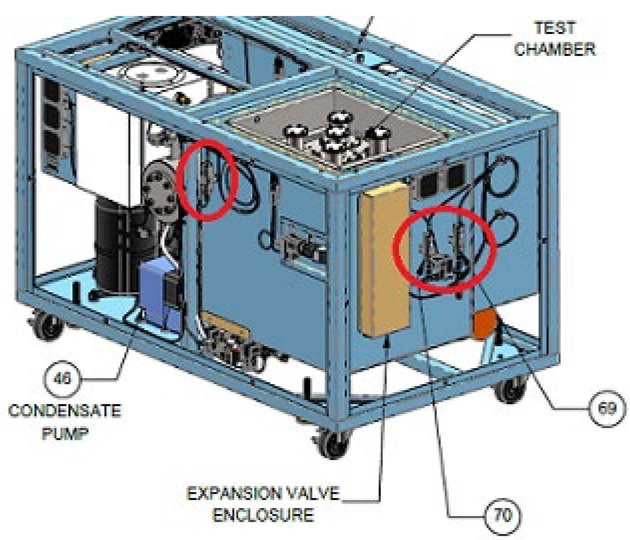
6.2.2 External Calibration Procedure

For safety purposes, perform a Shutdown, Turn off the system from the File menu, switch the main system "POWER" to OFF and remove the power cord before removing any panel.

CAUTION!

ALL SYSTEM PRESSURE MUST BE VENTED BEFORE PROCEEDING.

- Remove the front and right-side panels to access system pressure transducers.
- Using the appropriate tools, remove pressure transducers (locations circled below in red) and send them to a pressure calibration lab.



- Calibrate each transducer over its recommended range following the manufacturer's calibration procedures.

  Note - *Each transducer is operated over a limited range and only requires calibration within these ranges.*

  - Low-Range Transducer - Ambient to 45 psiA.
  - High-Range Transducer - 45 psiA to 325 psiA.
  - Chamber Transducer - Ambient to 23 psiA.

- Re-install transducers.
- Re-Install panels.
- Restore power.
- Allow the touch panel PC to boot and ControLog to connect to the generator.
- External calibration coefficients can be stored using only one of the following methods:

  1. Store coefficients internally in the transducer and enter default coefficients into ControLog.

     Default coefficients for ControLog:
     c0 = 0.0
     c1 = 1.0
     c2 = 0.0
     c3 = 0.0
     c4 = 0.0

  2. Leave factory coefficients stored internally in the transducer and enter the newly calculated external calibration coefficients into ControLog. If less than five coefficients are calculated, then enter zero for any coefficient that is not calculated.

     Refer to section 6.4 Viewing and Editing Calibration Coefficients

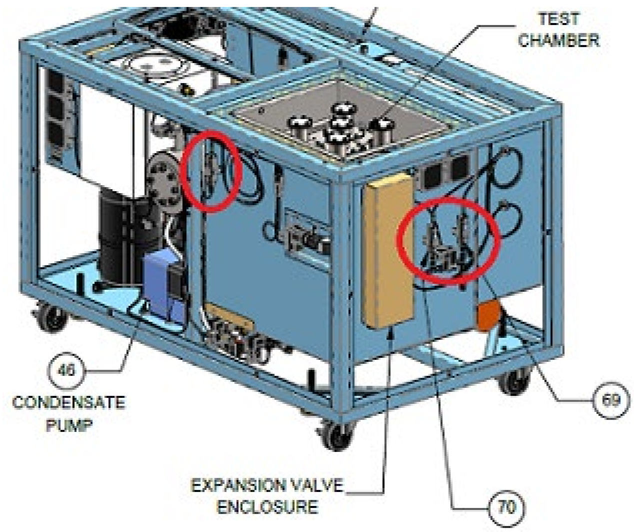
6.2.3 Internal Calibration Procedure

For safety purposes, perform a Shutdown, Turn off the system from the File menu, switch the main system "POWER" to OFF and remove the power cord before removing any panel.

CAUTION!

ALL SYSTEM PRESSURE MUST BE VENTED BEFORE PROCEEDING.

- Remove the front and right-side console panels to access system pressure transducers.
- Using the appropriate tools, remove the pressure transducer to be calibrated (locations circled below in red), leaving it electrically connected to the system.



- Connect transducer to be calibrated to reference pressure gauge.

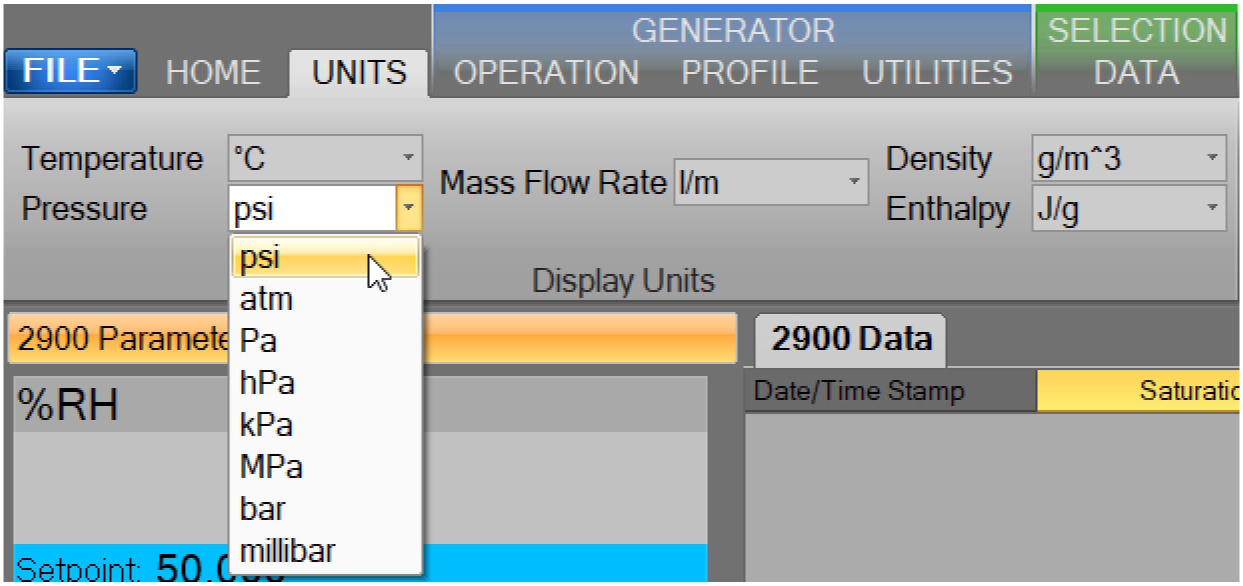
Note - *Only one pressure transducer can be calibrated at any given time. Each transducer is operated over a limited range and only requires calibration within these ranges.*

- Low-Range Transducer - Ambient to 45 psiA.
- High-Range Transducer - 45 psiA to 325 psiA.
- Chamber Transducer - Ambient to 23 psiA.
- Supply Transducer – 0 to 350 psiG.

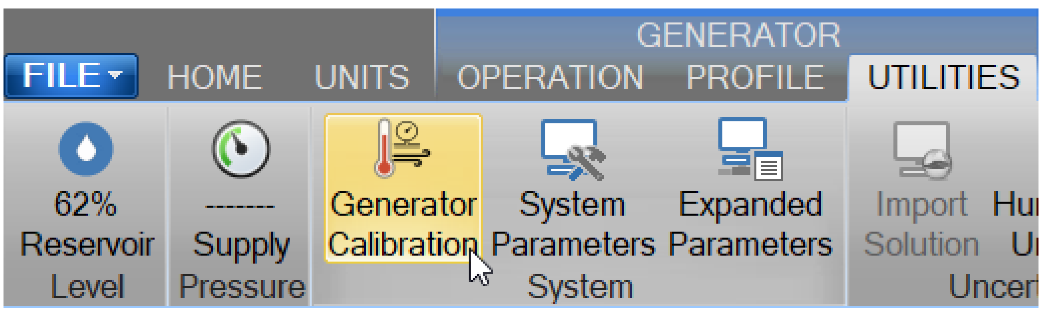
CAUTION!

DO NOT ENABLE PRESSURE CONTROL WITH PRESSURE
TRANSDUCERS DISCONNECTED FROM THE SYSTEM.

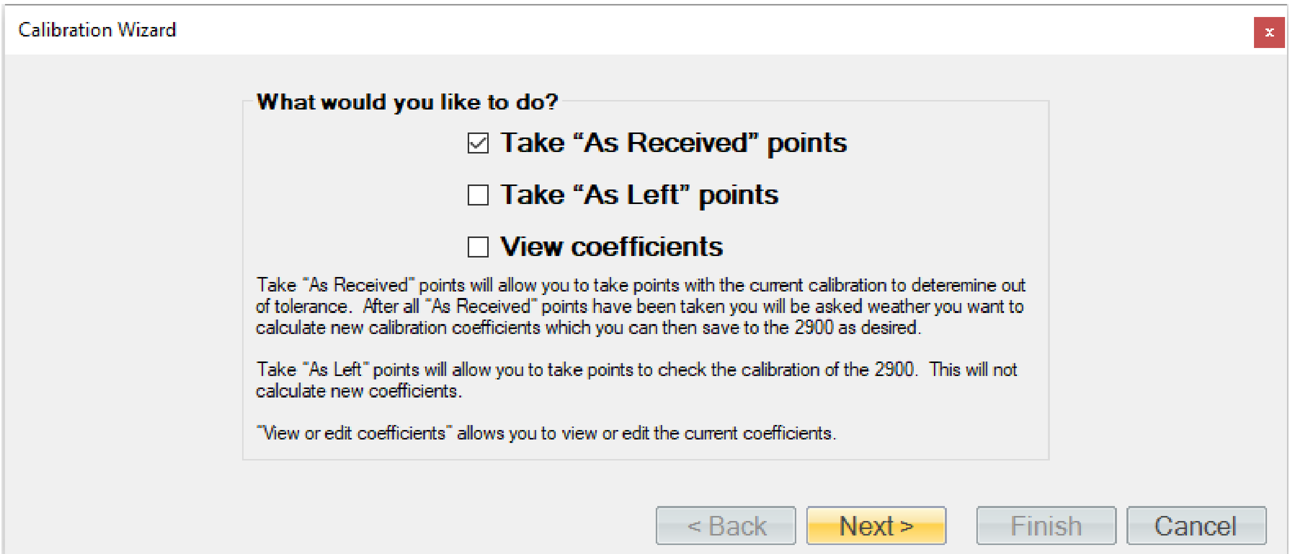
From the Units menu tab, select the desired pressure units for calibration (psi is recommended). Once calibration has begun, the units should not be changed again until the calibration is complete.



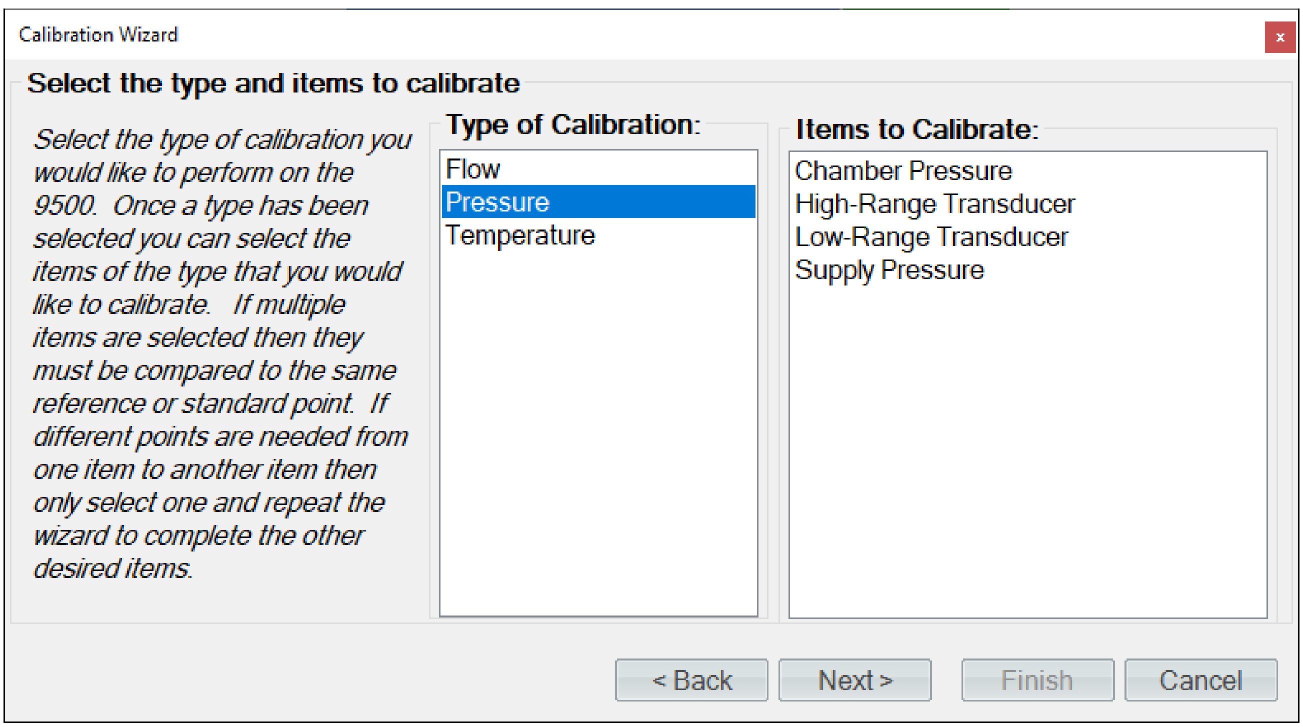
Select Generator Calibration from the Utilities menu tab to open the Calibration Wizard.



Select "Take "As Received" points." This allows the user to take points with the current calibration to determine out of tolerance. After all "As Received" points have been taken, users are asked whether they want to calculate new calibration coefficients.

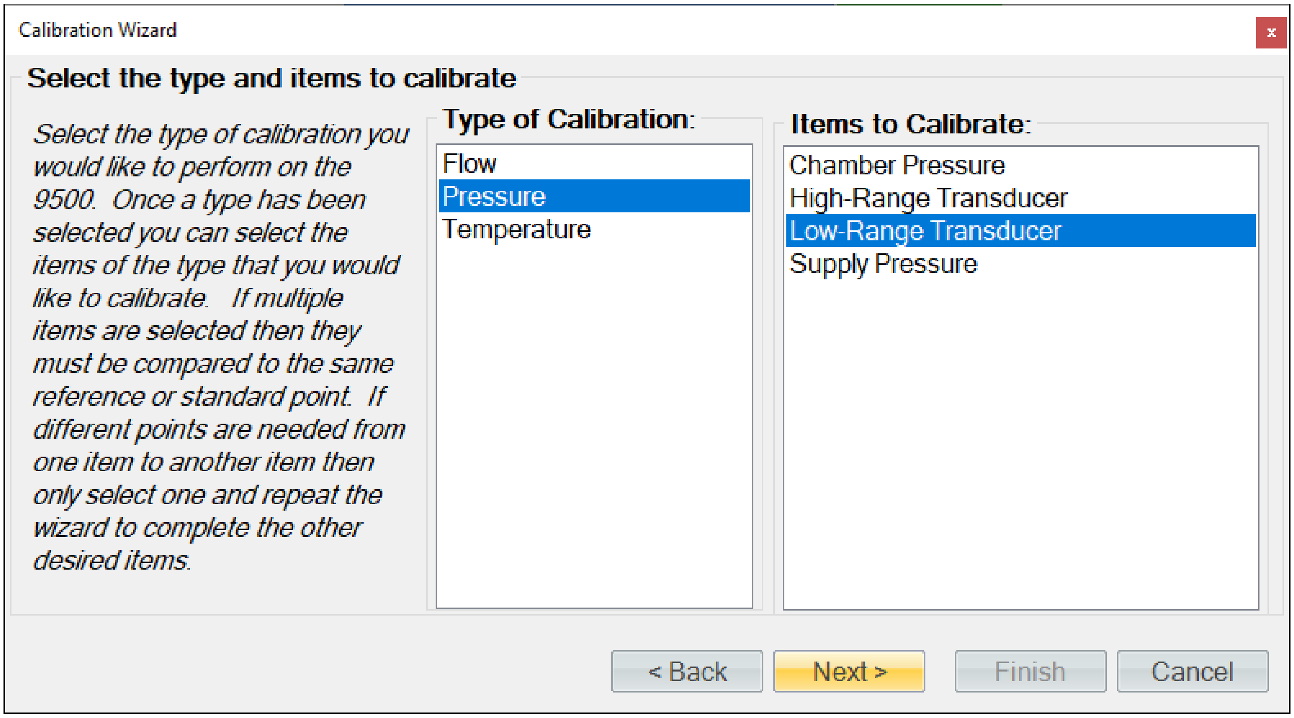


Set the type of calibration to Pressure.

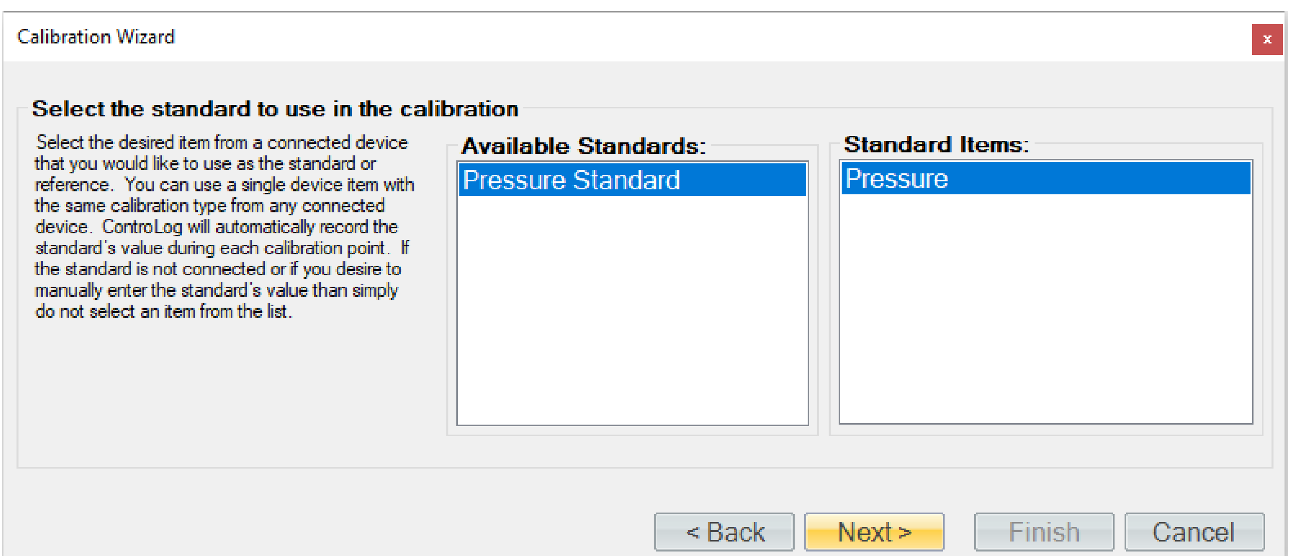


Select the pressure transducer to be calibrated.

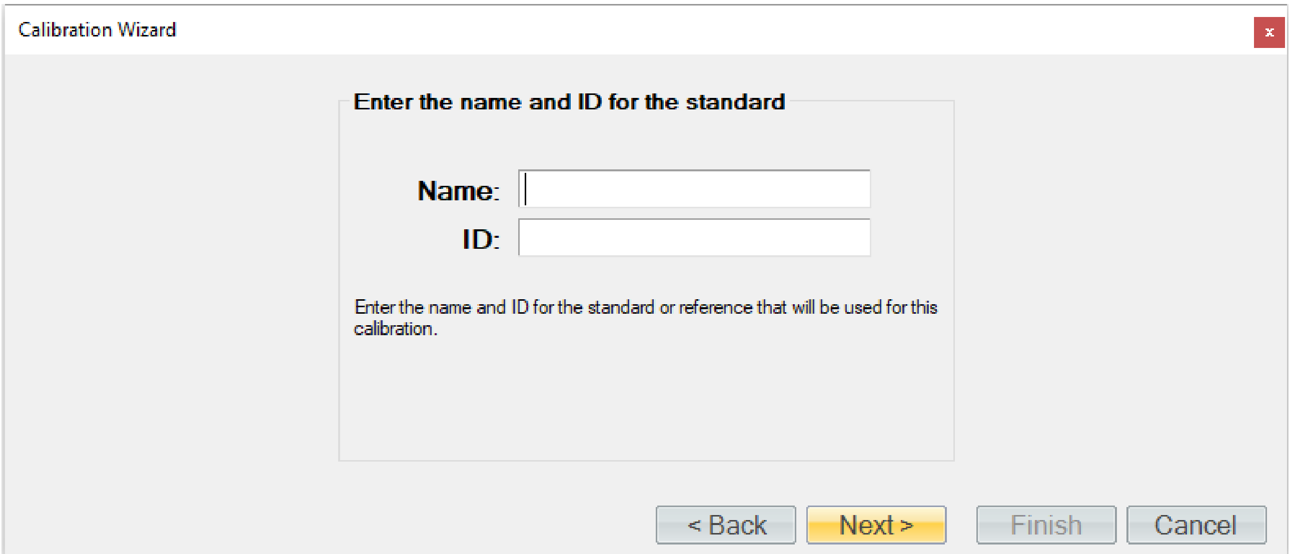
> **Note –** *Only one pressure transducer can be calibrated at any given time due to the different scaling of the transducers.*



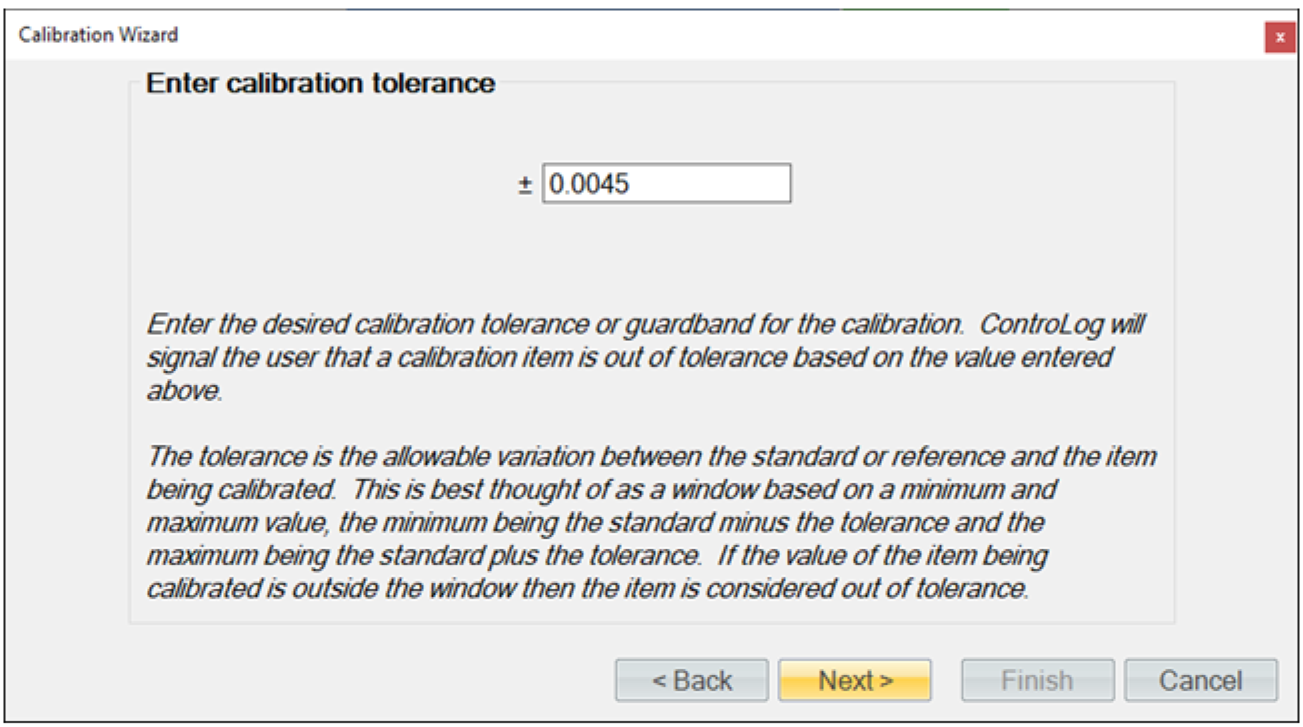
If the pressure standard is a connected device (refer to section 10 Connections), you may select it for calibration. You can use a single device item with the same calibration type from any connected device. ControLog automatically records the standard's value during each calibration point. If the standard is not a connected device or you want to enter the standard's value manually, do not select an item from the list.



Enter the Name and ID of the standard being used. This information is populated on the calibration report. Selecting "Next" without entering a Name results in ControLog giving the standard a generic name.

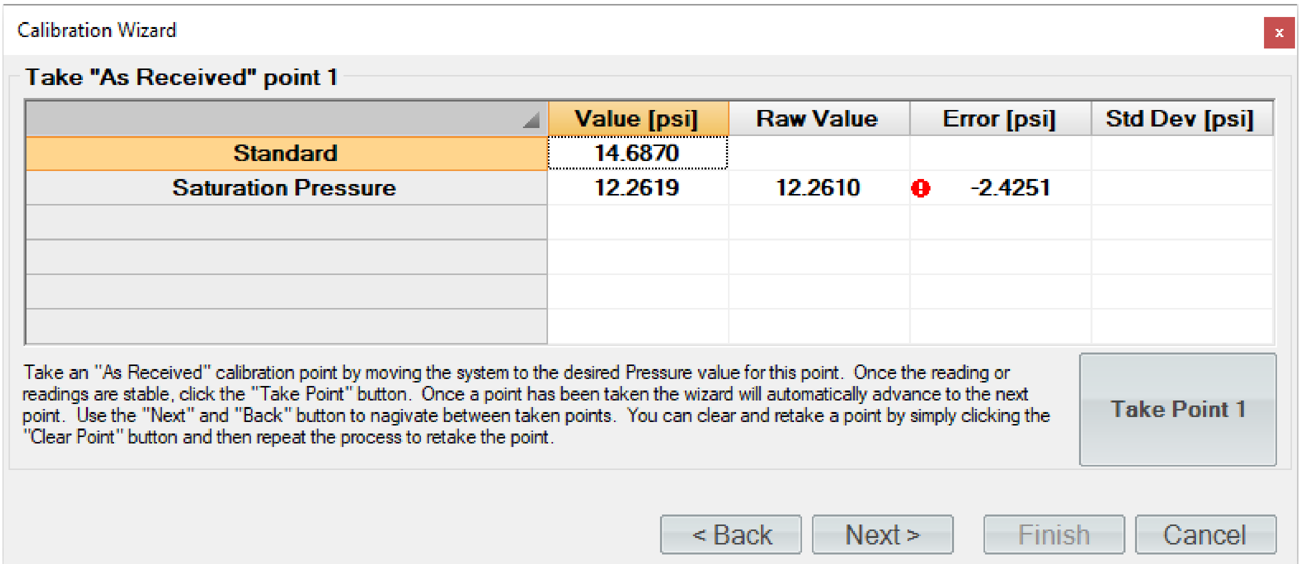


Enter the desired calibration tolerance or guard band for the calibration. ControLog signals the user that a calibration item is out of tolerance based on the value entered below.



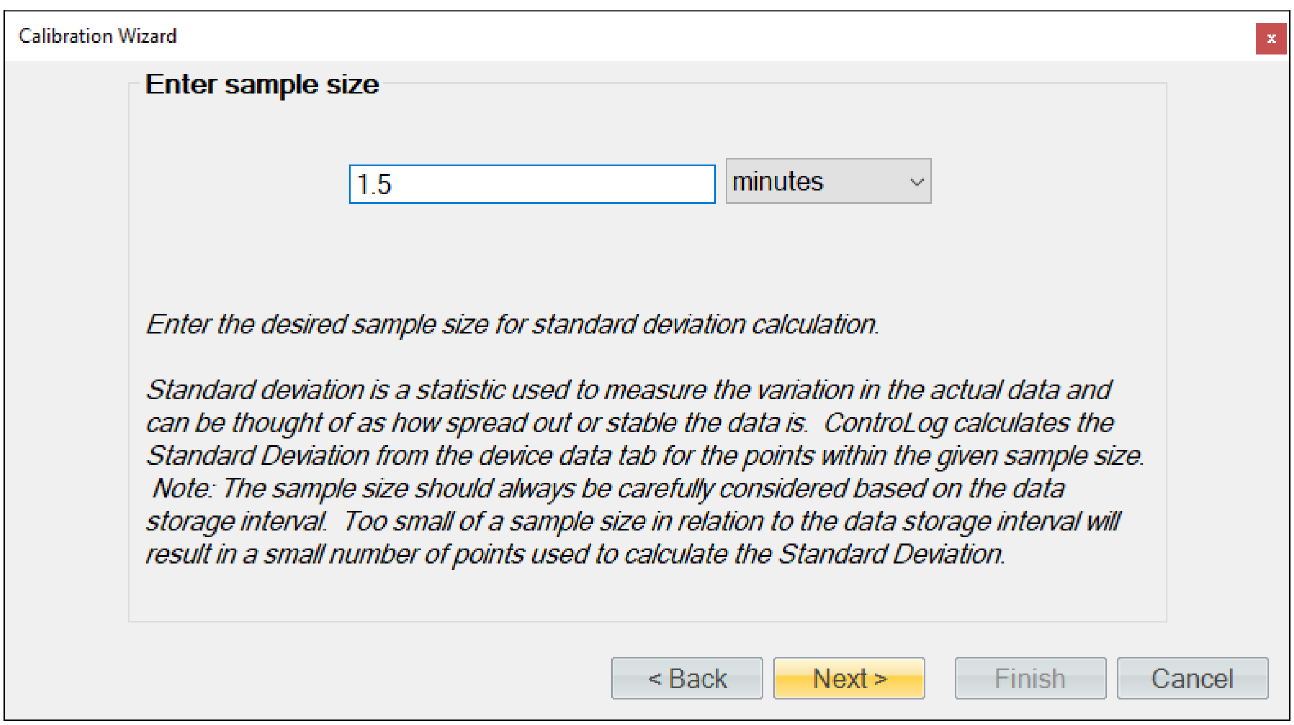
The tolerance is the allowable variation between the standard or reference and the calibrated item. This is best thought of as a window based on a minimum and maximum value, the minimum being the standard minus the tolerance and the maximum being the standard plus the tolerance. If the value of the item being calibrated is outside the window, then the item is considered out of tolerance.

An out-of-tolerance condition is indicated by a red circle with an exclamation point for the out-of-tolerance transducer in the Error column.



Enter the sample size used to perform the standard deviation calculation. The sample size is the given time that ControLog uses to determine which data points to use to determine the standard deviation of each probe.

> **Note -** *The number of points used is based on the selected data storage rate and the desired sample size. For example, if the data storage rate is every 30 seconds, a sample size of 1.5 minutes results in 3 points being used to calculate the standard deviation.*



Select the number of points you would like to take for this “As Received” calibration. Each point defines the “true” value at a given point based on the standard or reference value. The number of points determines the degree of the polynomial used to align or correct the generator with the standard or reference.

Five calibration points are recommended for the low and high-range transducer using the following pressure points:

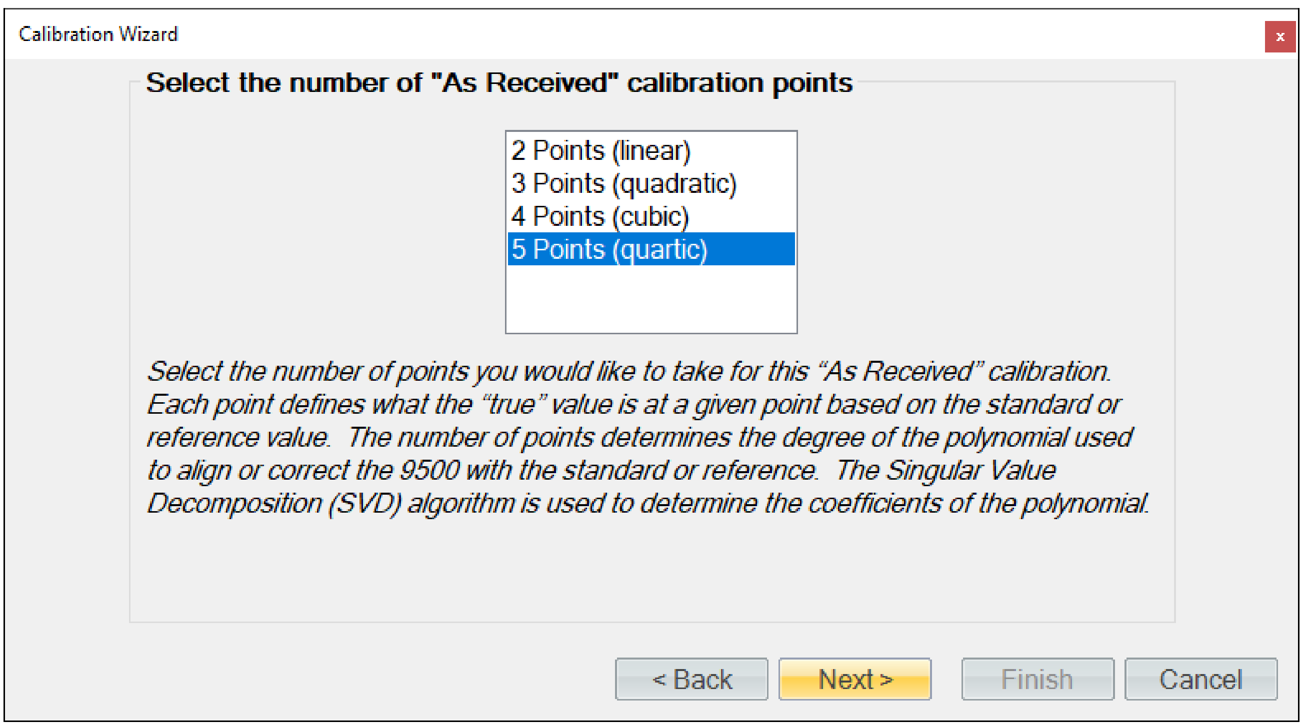
- Low-Range: Ambient, 22.5, 30, 37.5, and 45 psiA.
- High-Range: 45, 115, 185, 255, and 325 psiA.

Three calibration points are recommended for the chamber transducer using the following pressure points:

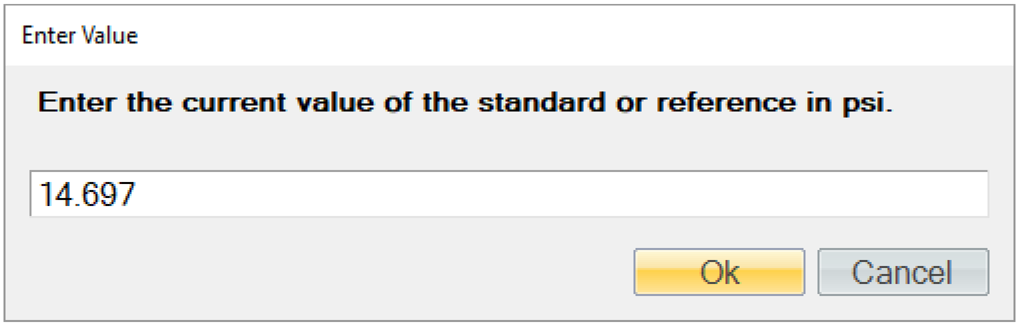
- Chamber: Ambient, 19 and 23 psiA.

Note - *Each transducer is operated at or above ambient pressure, requiring ambient and full-scale calibration only. There is no need for below ambient testing or calibration.*

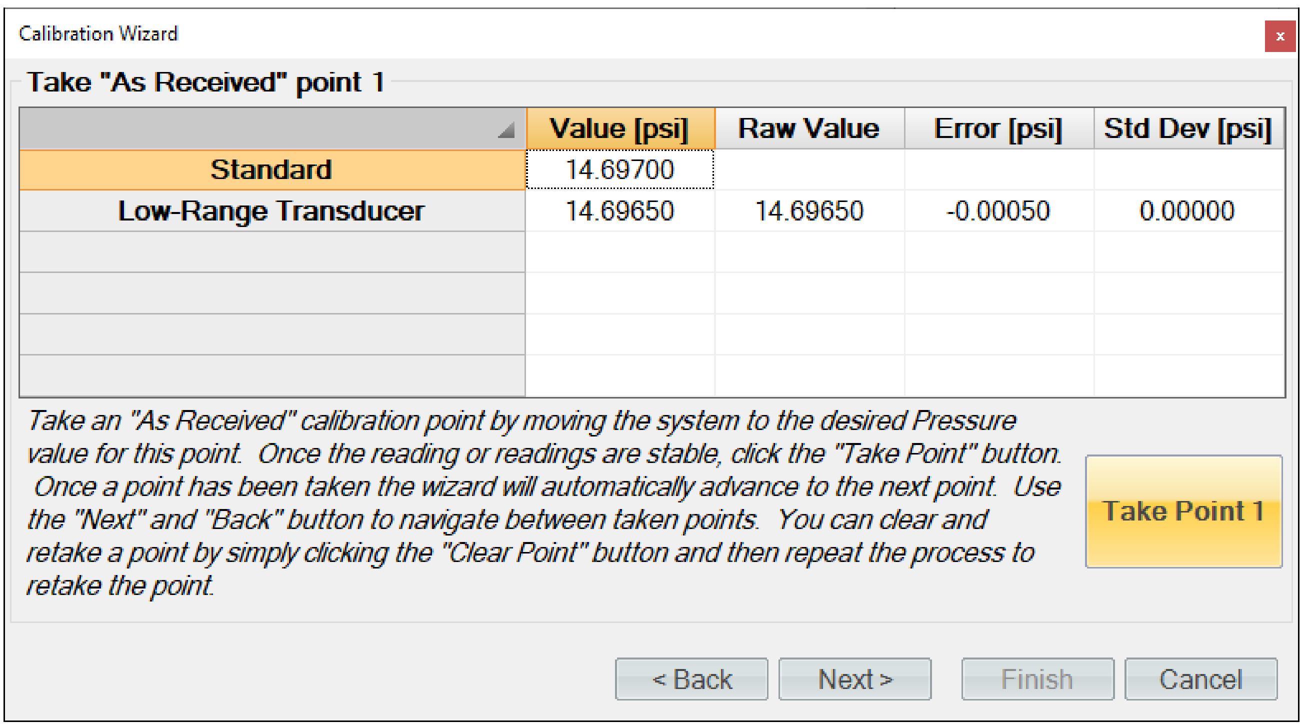
Note - *The specific points can be different from those listed above. Use best metrology practices when determining which points to take.*



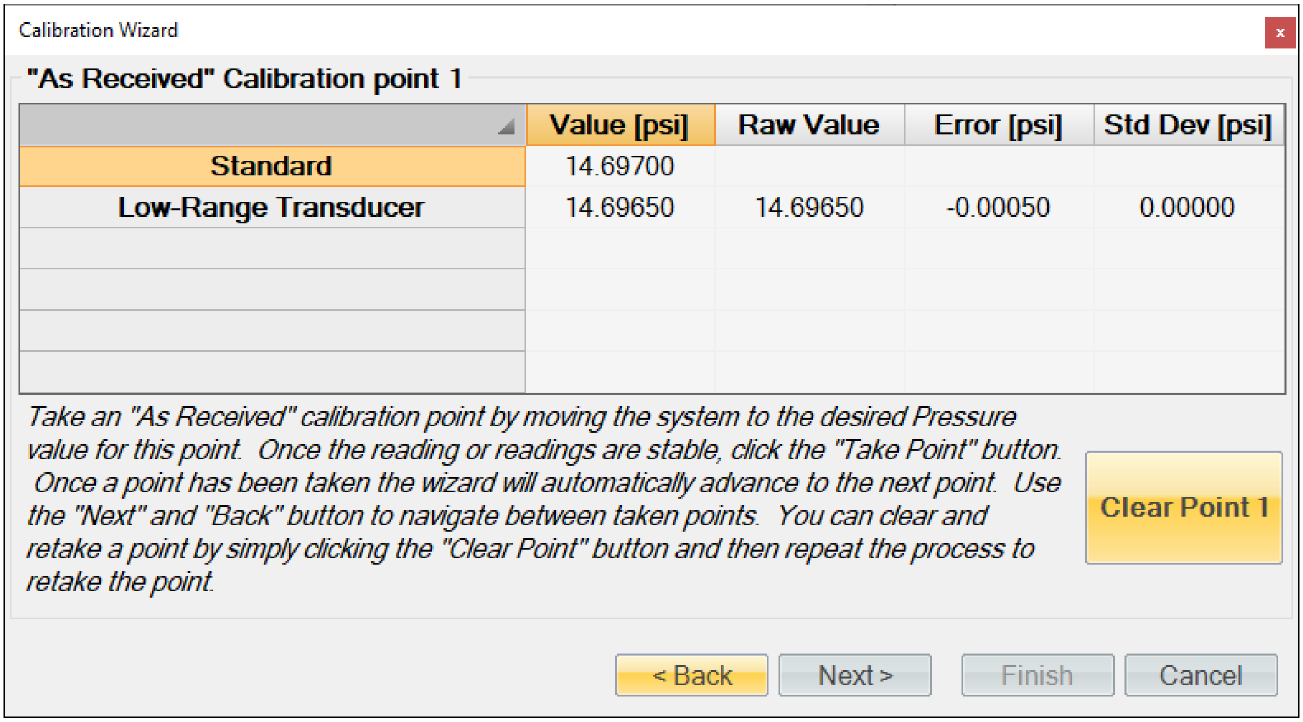
Using the pressure standard, generate and measure an ambient pressure. If the standard is not a connected device, then ControLog asks for the value before taking the point. You can also enter a standard or reference value before taking a point by clicking the cell in the "Standard" and "Value" columns. This is useful for seeing error values before a point is taken.



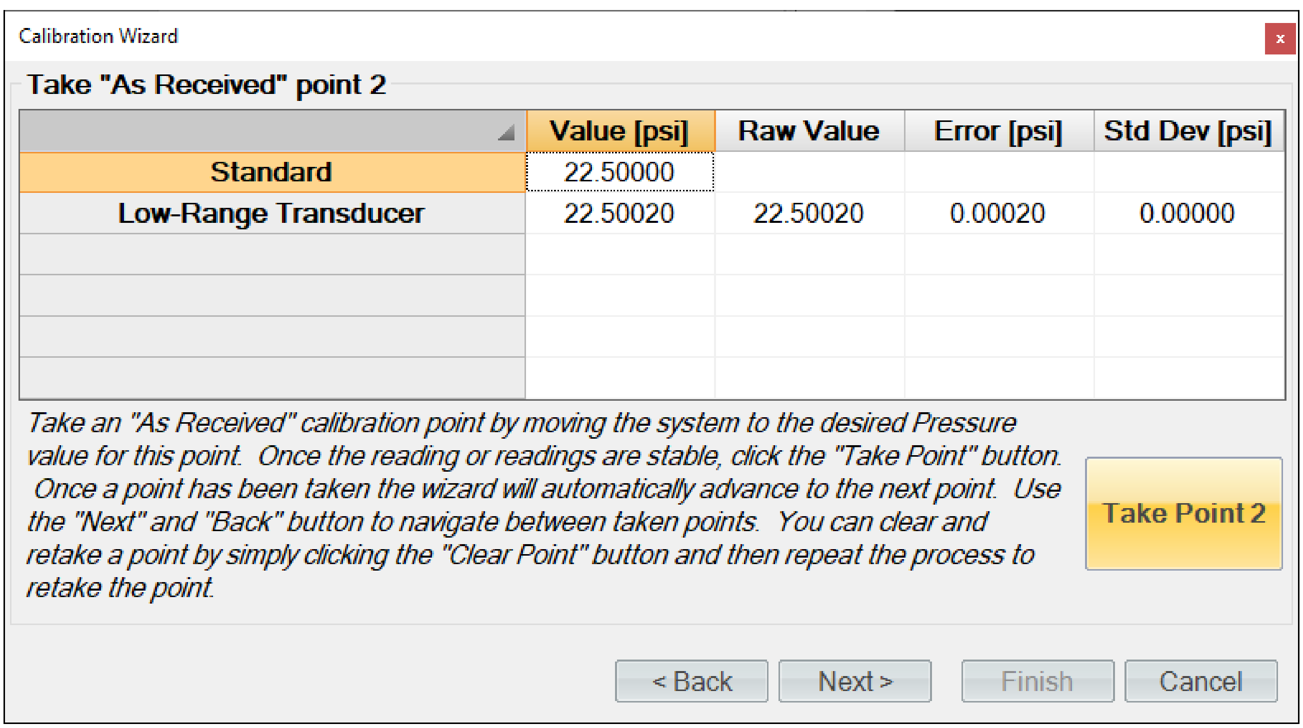
Once the reading is stable, click the "Take Point" button. Once a point has been taken, the wizard automatically advances to the next point.



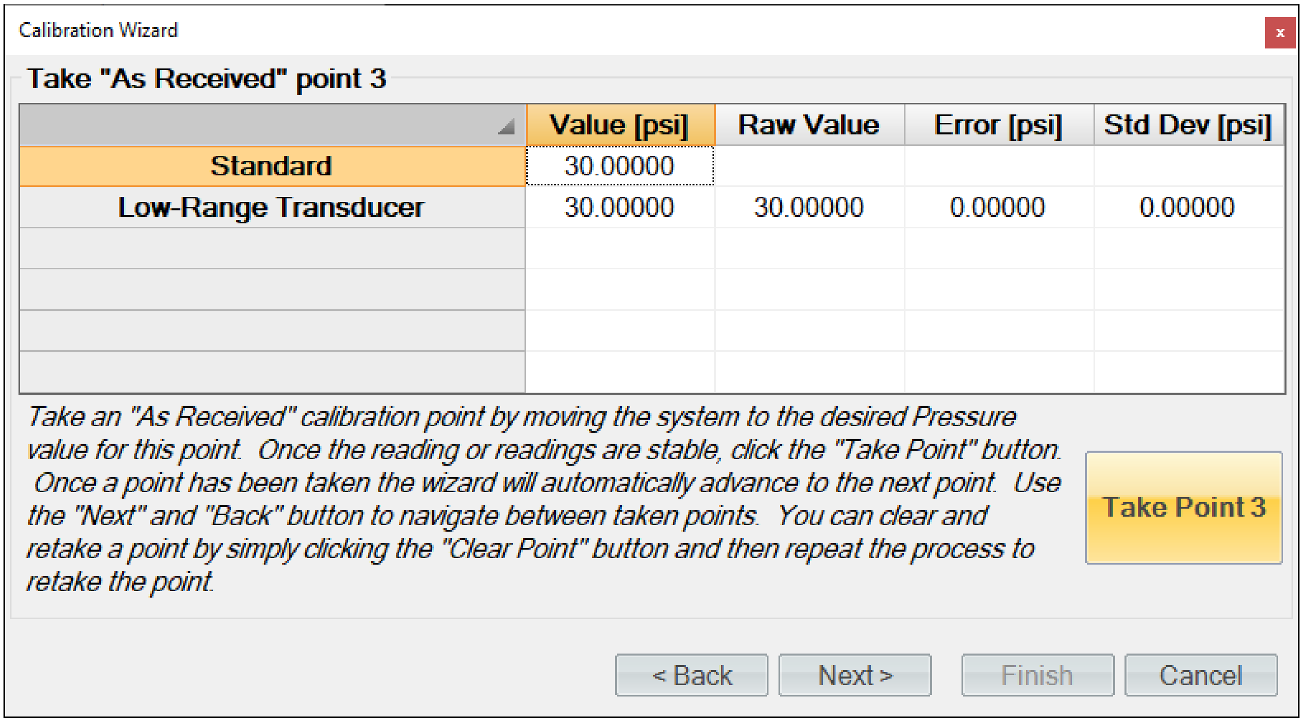
Tip - *Use the "Next" and "Back" buttons to navigate between taken points. You can clear and retake a point by simply clicking the "Clear Point" button and then repeating the process to retake the point.*



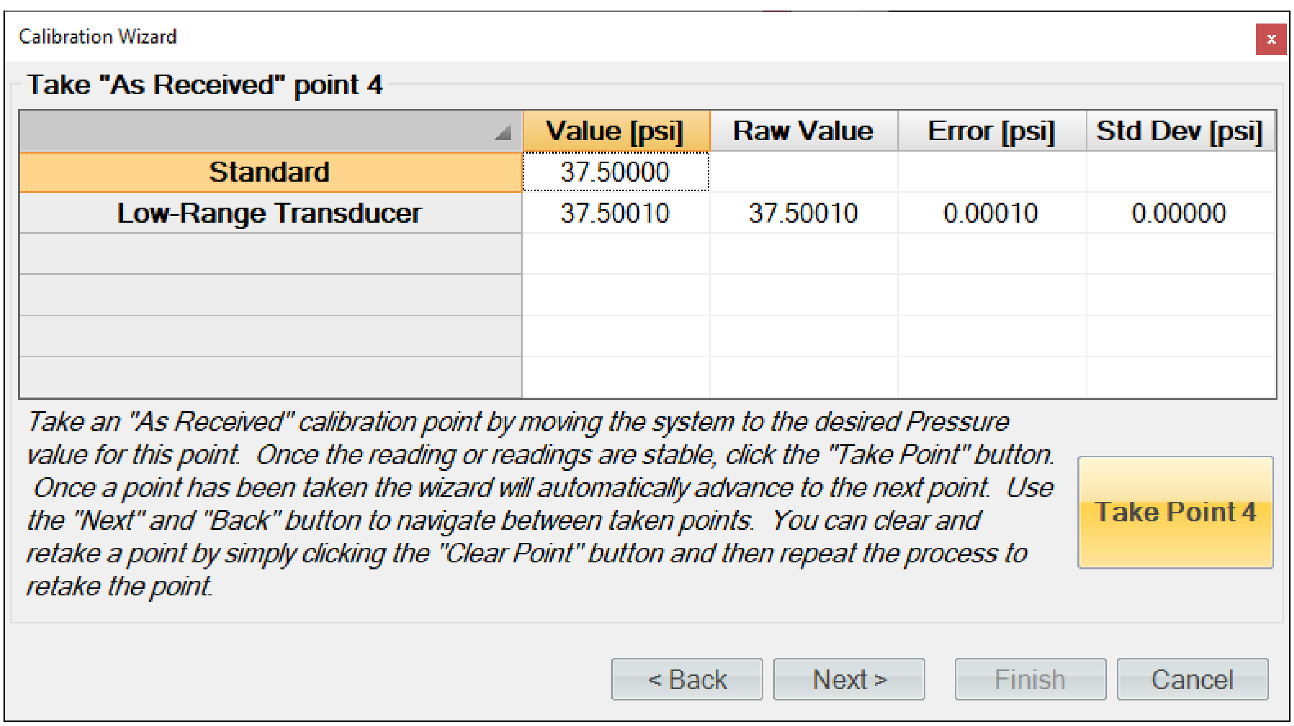
Using the pressure standard, generate and measure the next pressure point (22.5 psi). Once the readings are stable, enter the value of the standard and click the "Take Point" button.



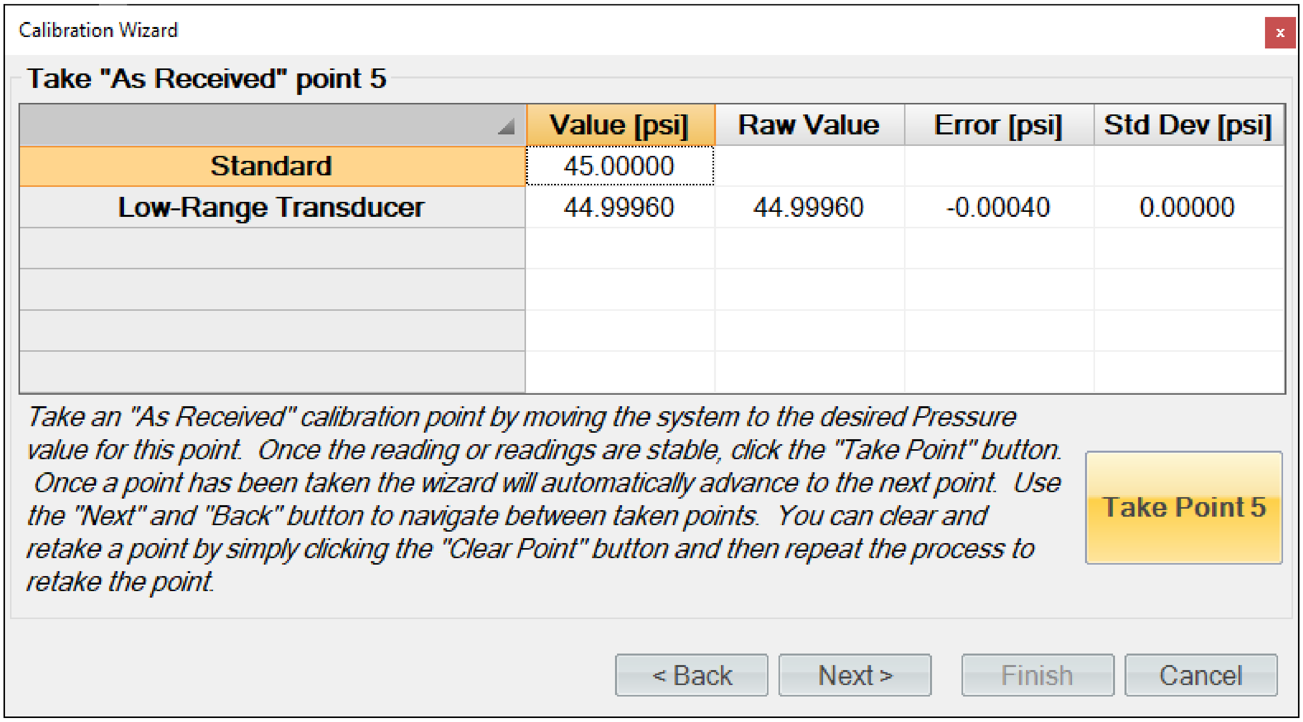
Using the pressure standard, generate and measure the next pressure point (30 psi). Once the readings are stable, enter the value of the standard and click the “Take Point” button.



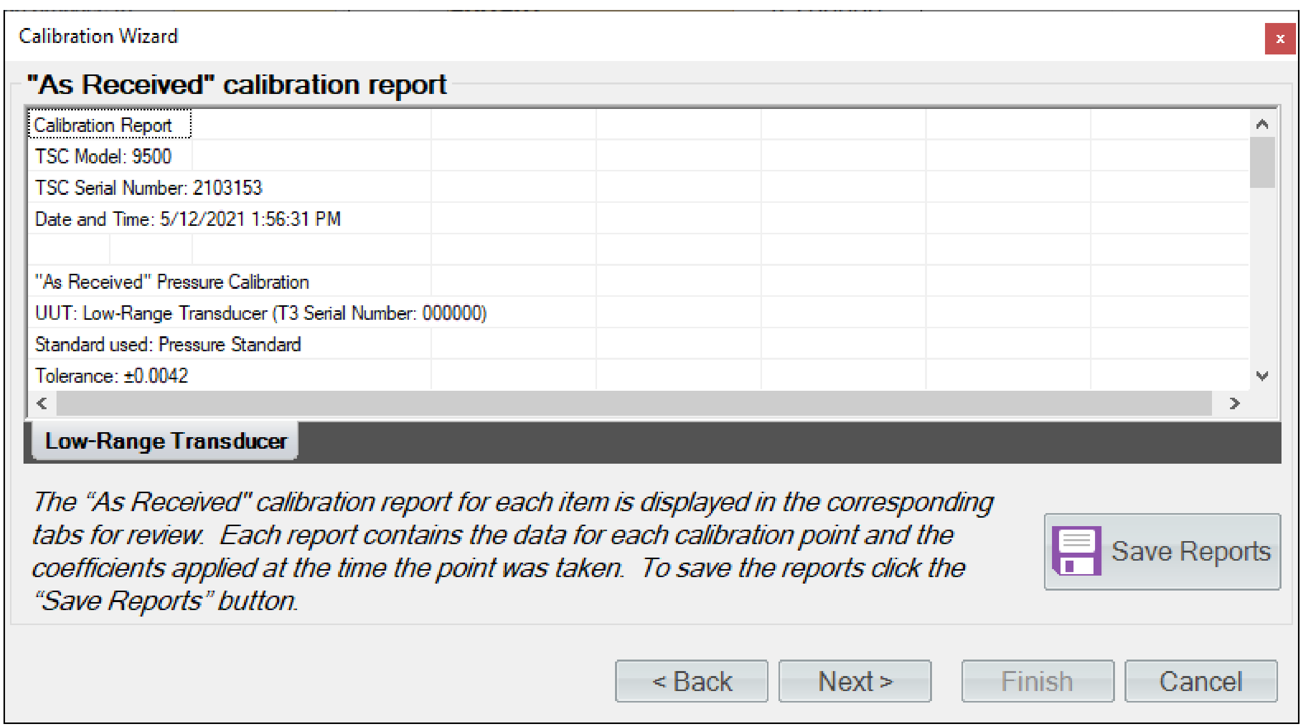
Using the pressure standard, generate and measure the next pressure point (37.5 psi). Once the readings are stable, enter the value of the standard and click the “Take Point” button.



Using the pressure standard, generate and measure the last pressure point (45 psi). Once the readings are stable, enter the value of the standard and click the “Take Point” button.

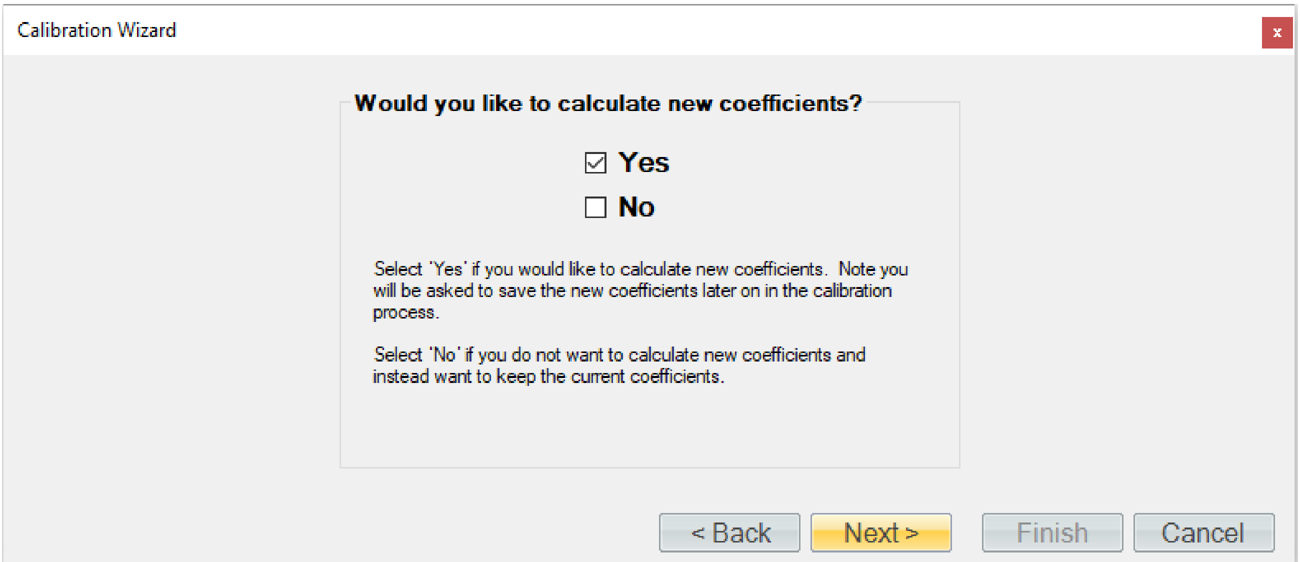


ControLog advances to the “As Received” calibration report when all pressure points have been entered. The transducer appears in its own tab that contains the data for each calibration point, and the coefficients used when the points were taken.

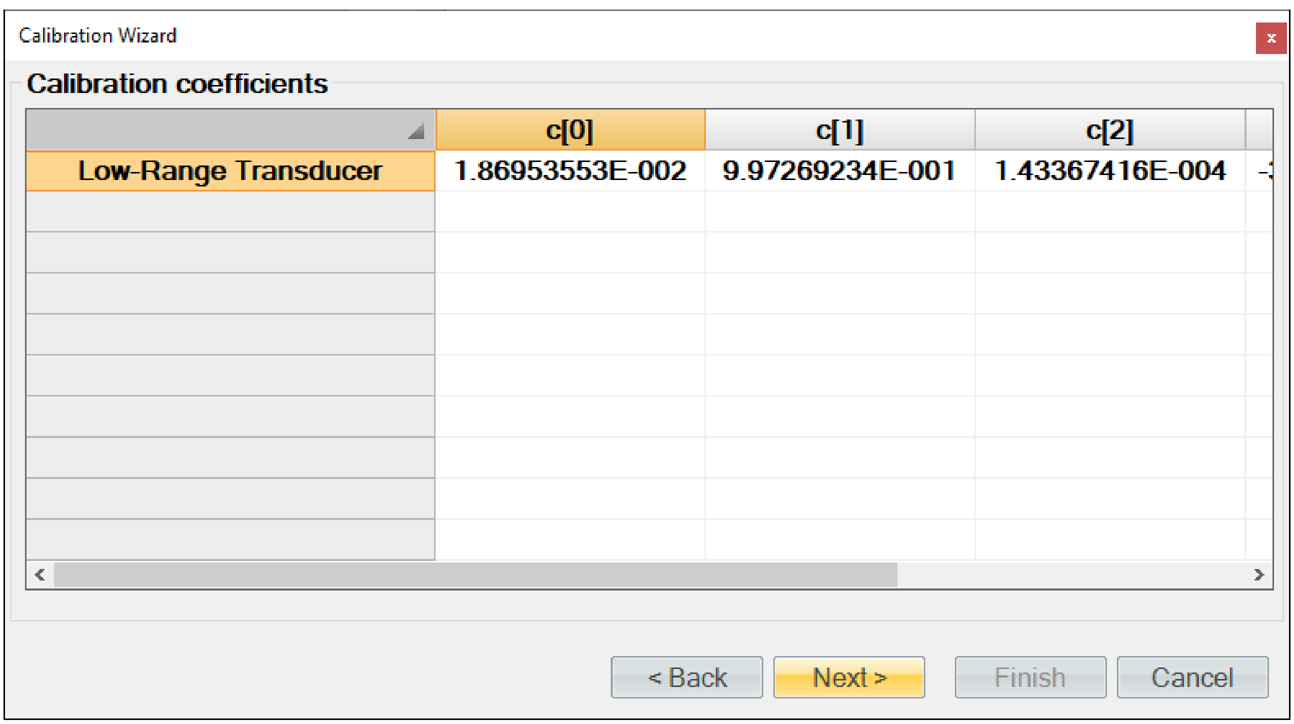


The "Save Reports" button opens a file dialog to save the report. The default file location is ...Documents\Thunder Scientific\9500 ControLog\Reports\.

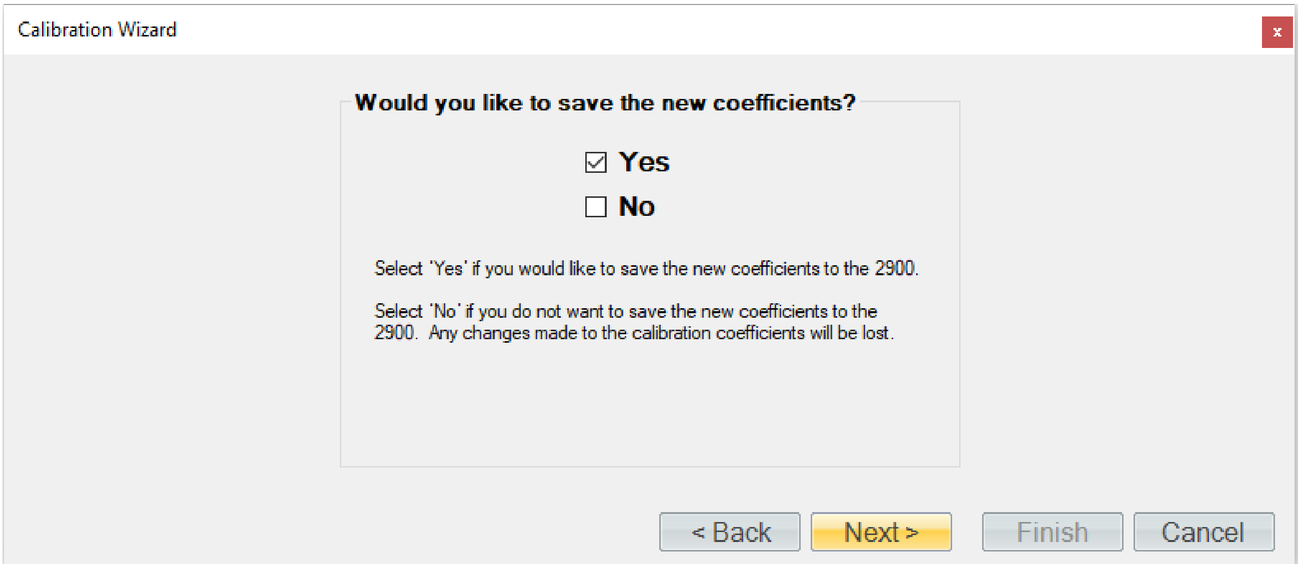
Clicking "Next," asks the user if they want to calculate new coefficients using the as received data points just taken.



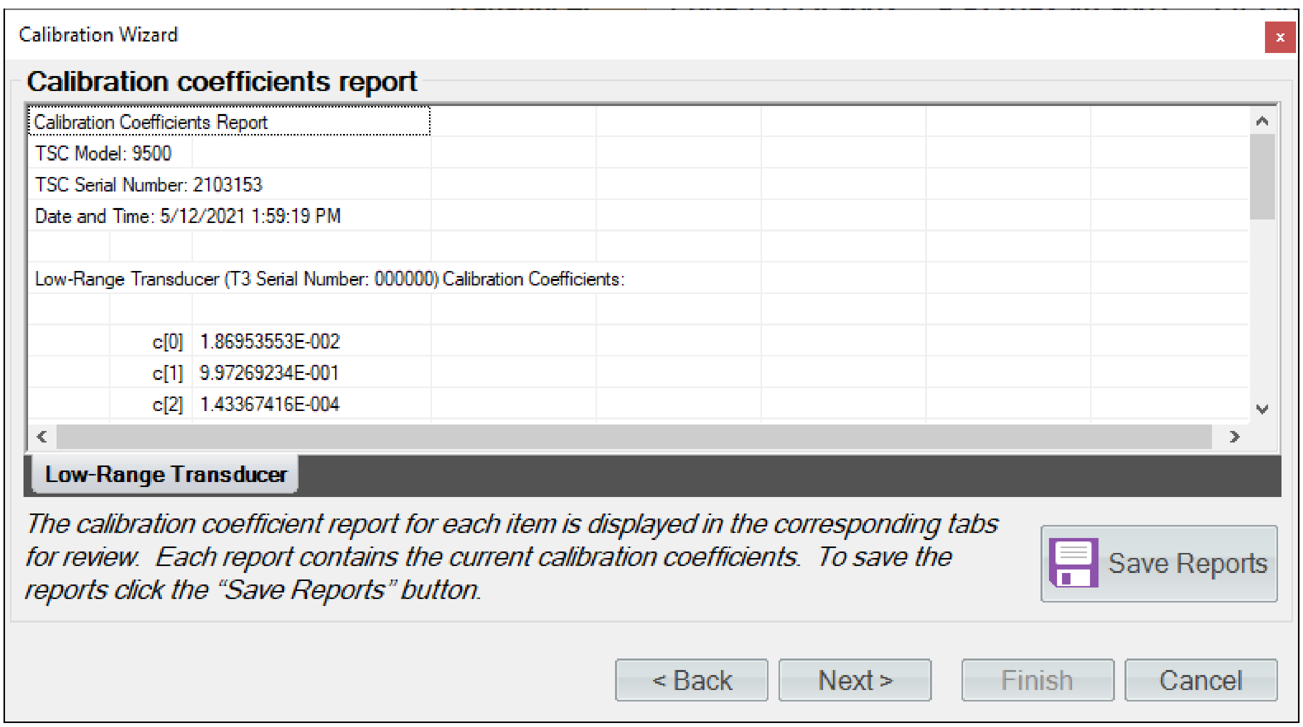
If the user selects to calculate new coefficients, they are calculated and displayed. ControLog issues a message telling the user that the coefficients cannot be calculated if a problem occurs during the calculation.



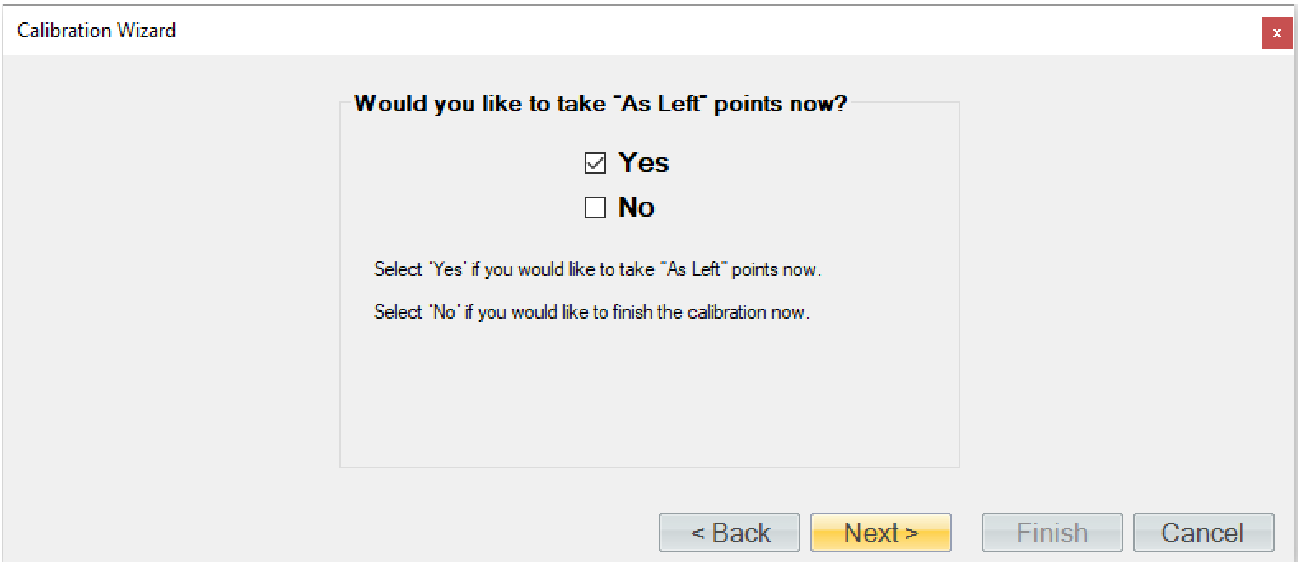
Next, the user is asked to save the new coefficients to the system. Selecting "Yes" results in the current coefficient being over-written by the newly calculated coefficients.



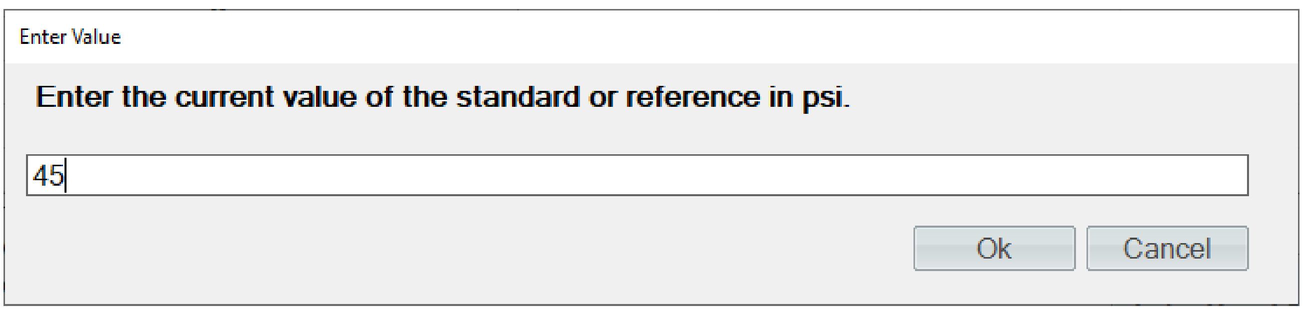
Next, the user can view and save the calibration coefficients report for the transducer.



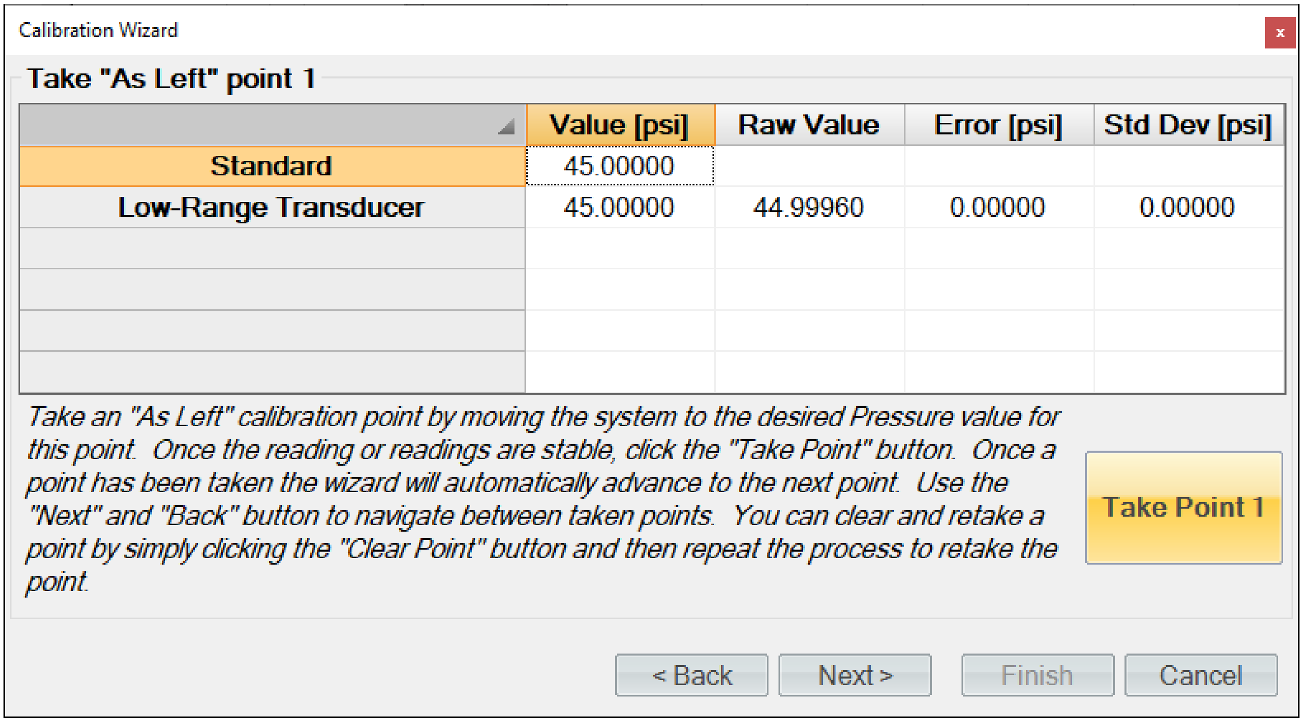
Next, the user can complete the calibration or can choose to take “As Left” points.



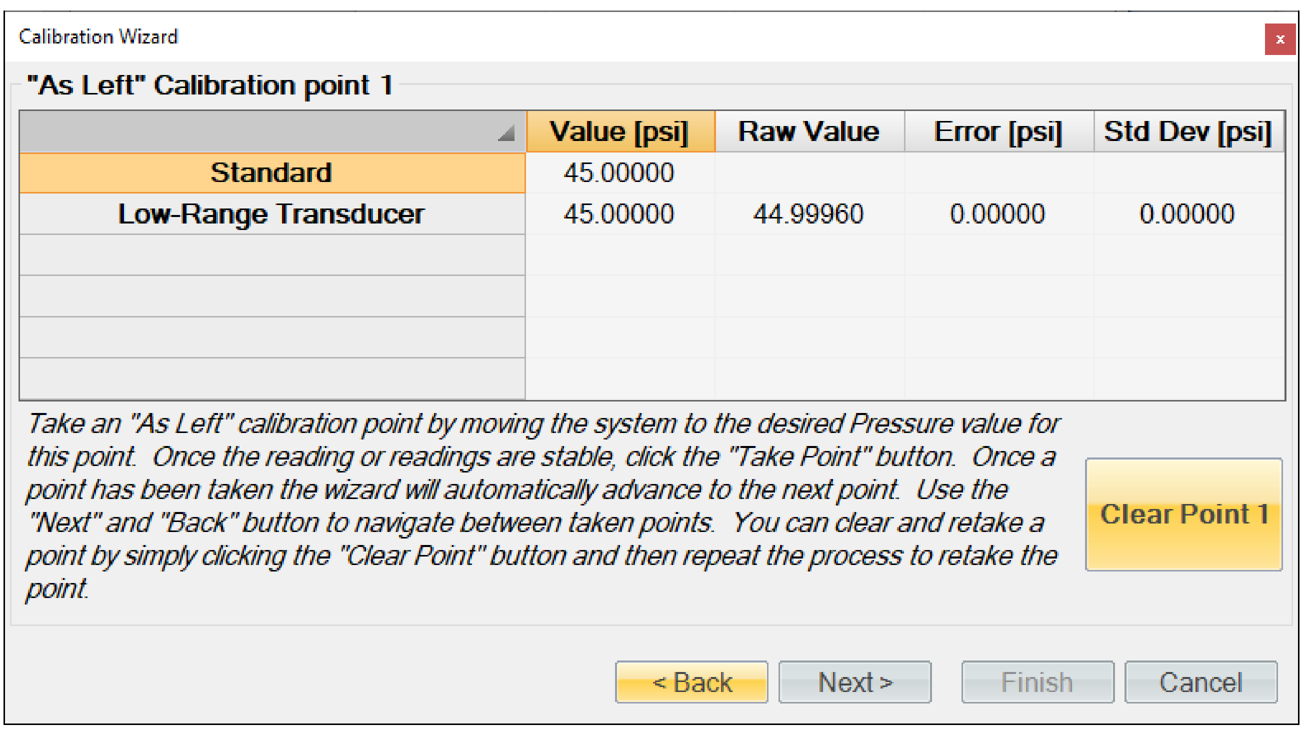
ControLog allows users to take as many “As Left” points as they want. In this example, we check every 5 psi, starting at 45 psi and ending at atmospheric pressure. If the standard is not a connected device, then ControLog asks for the value before taking the point. You can also enter a standard or reference value before taking a point by clicking the cell in the “Standard” and “Value” columns. This is useful for seeing error values before a point is taken.



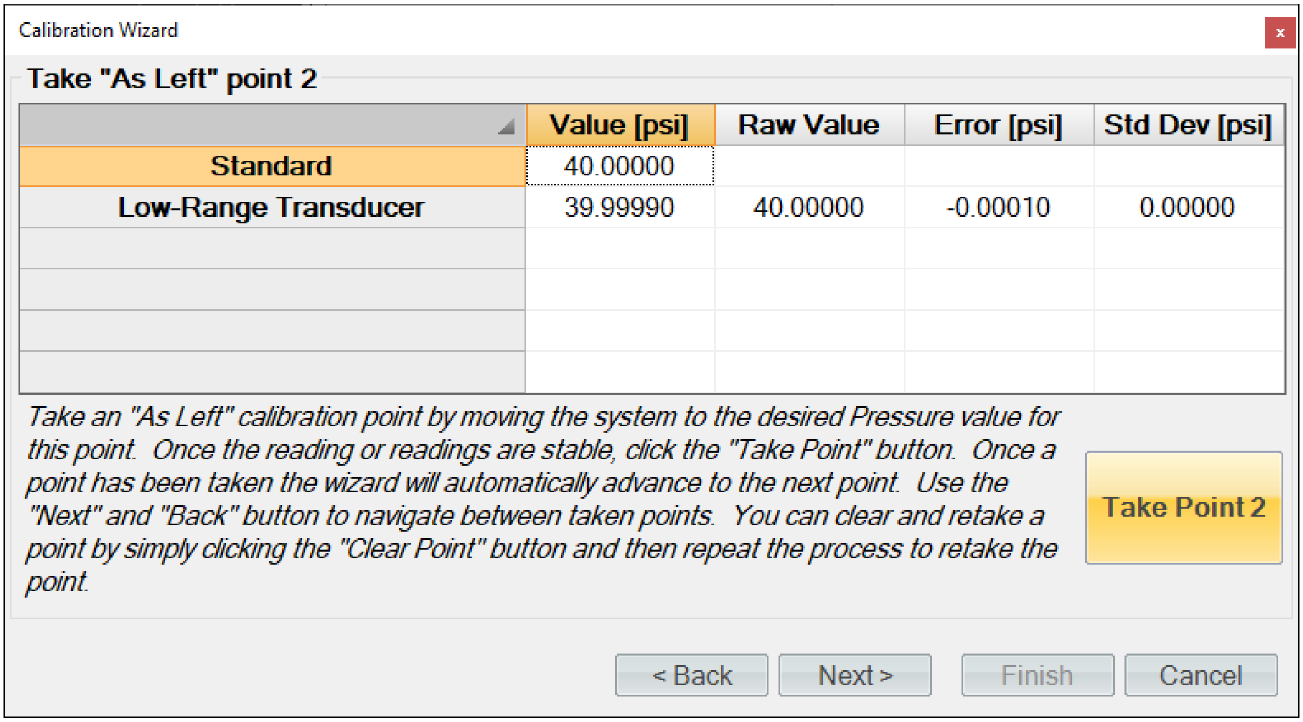
Once the readings are stable, enter the value of the standard and click the “Take Point” button. Once a point has been taken, the wizard automatically advances to the next point.



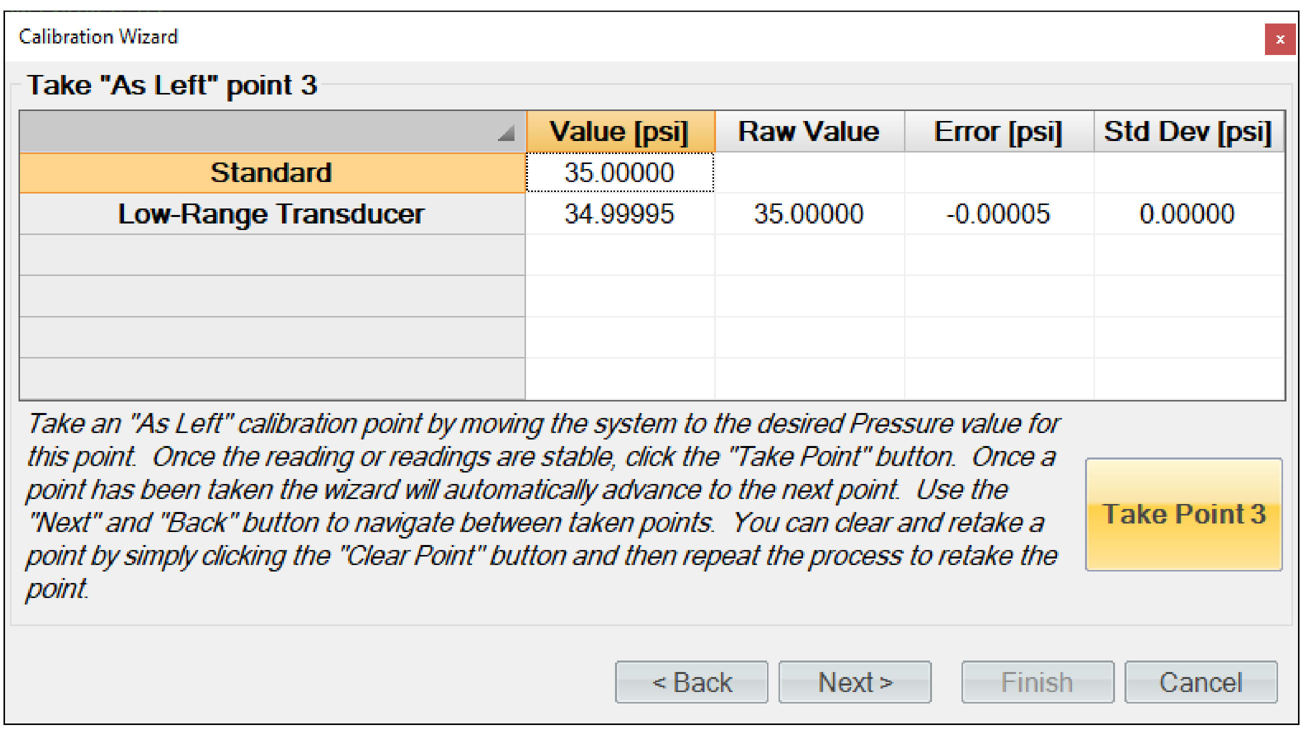
Tip - *Use the “Next” and “Back” buttons to navigate between taken points. You can clear and retake a point by simply clicking the “Clear Point” button and then repeating the process to retake the point.*



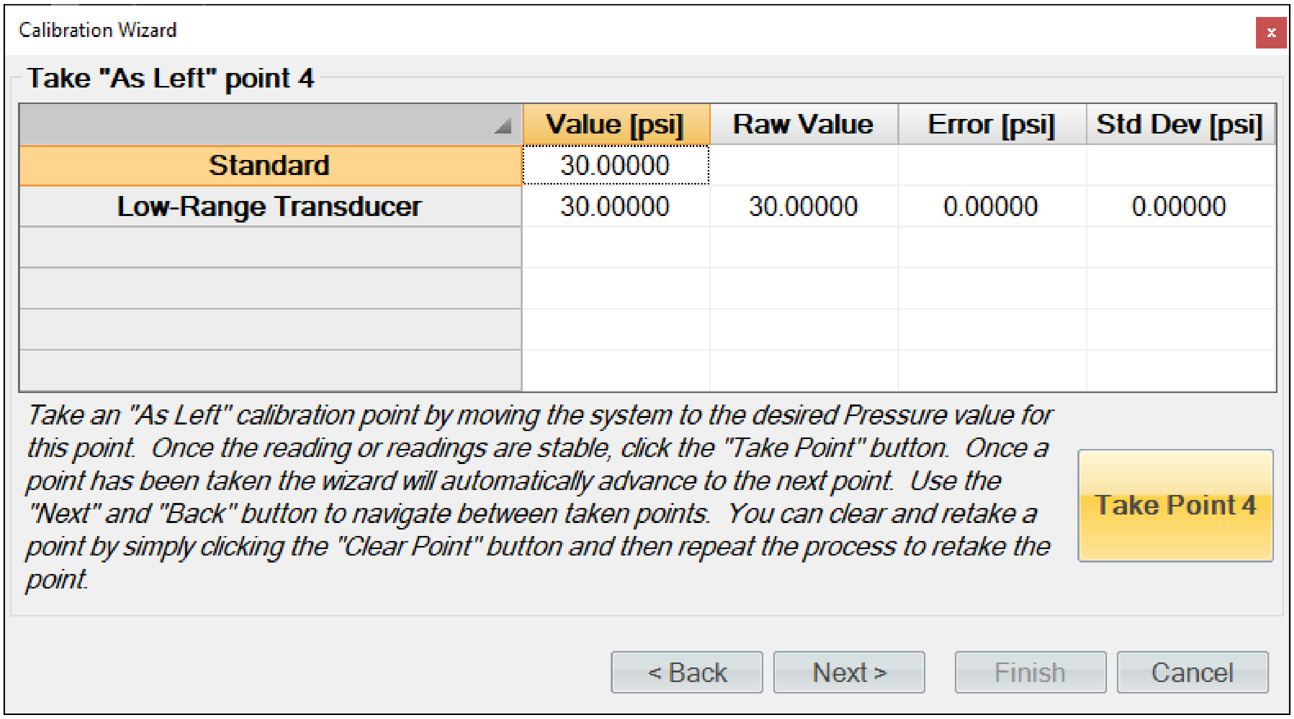
Using the pressure standard, generate and measure the next pressure point (40 psi). Once the readings are stable, enter the value of the standard and click the "Take Point" button.



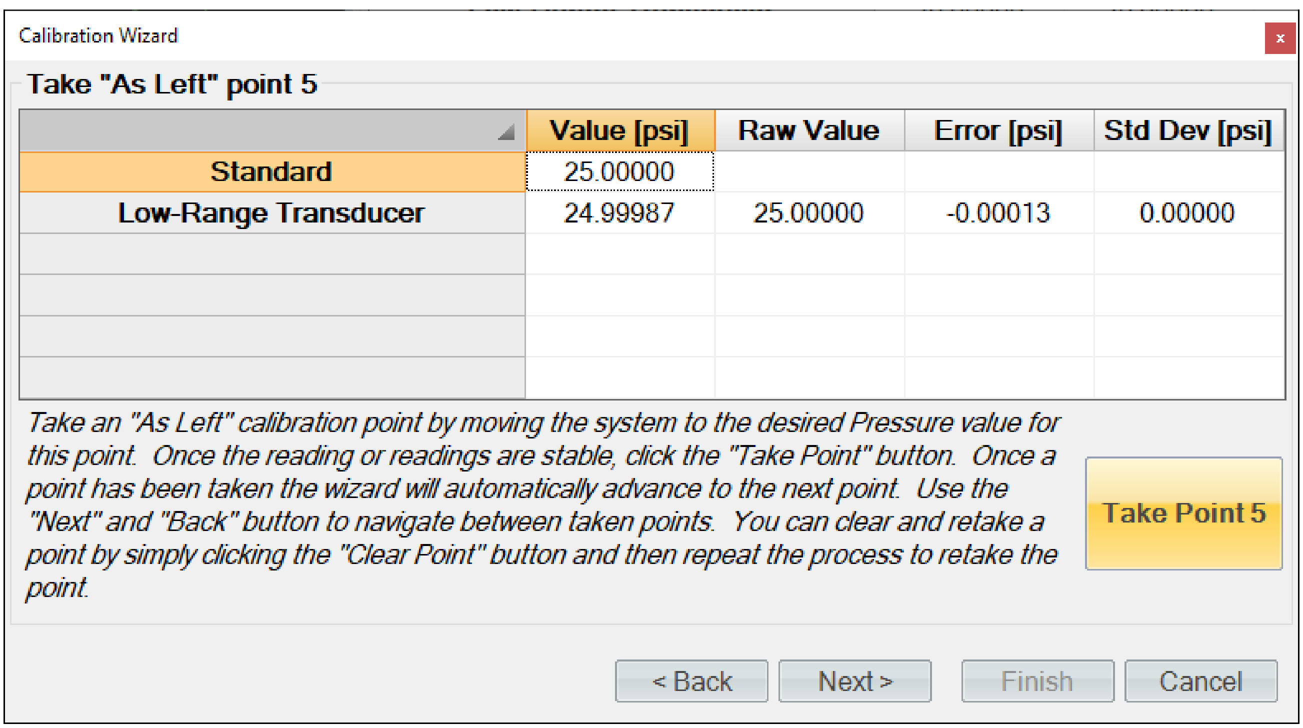
Using the pressure standard, generate and measure the next pressure point (35 psi). Once the readings are stable, enter the value of the standard and click the "Take Point" button.



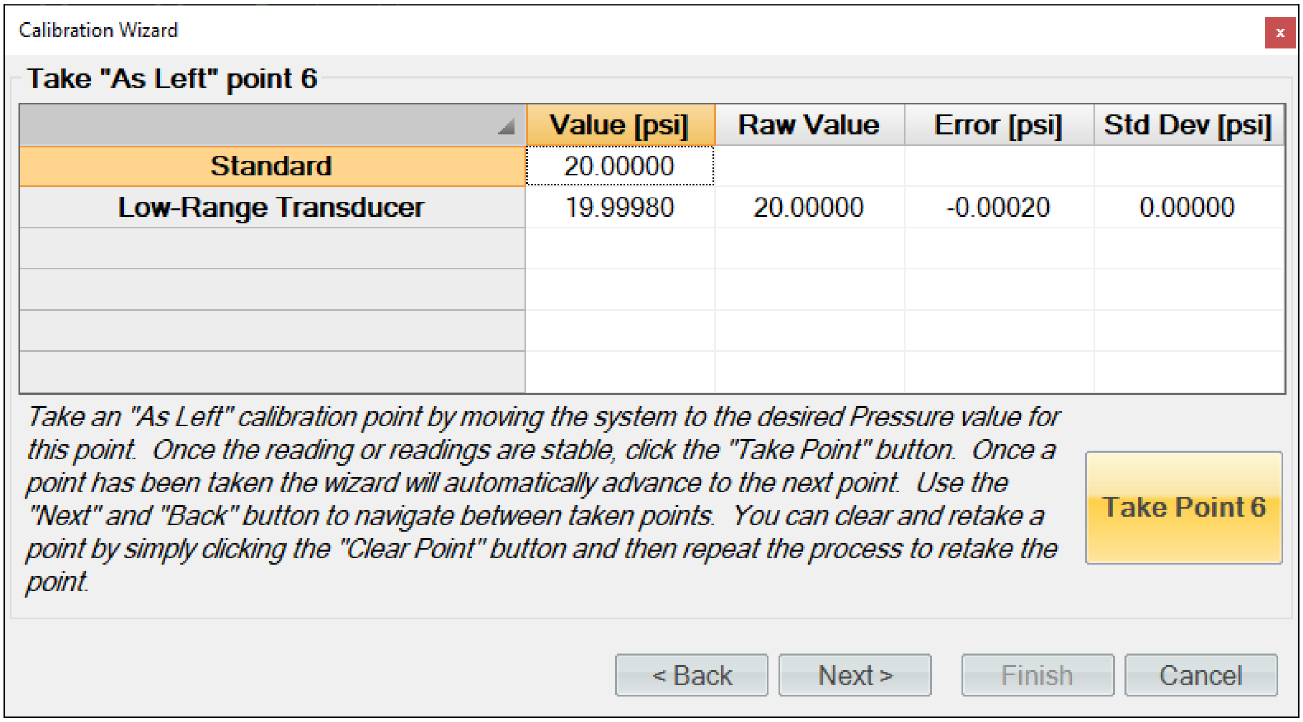
Using the pressure standard, generate and measure the next pressure point (30 psi). Once the readings are stable, enter the value of the standard and click the “Take Point” button.



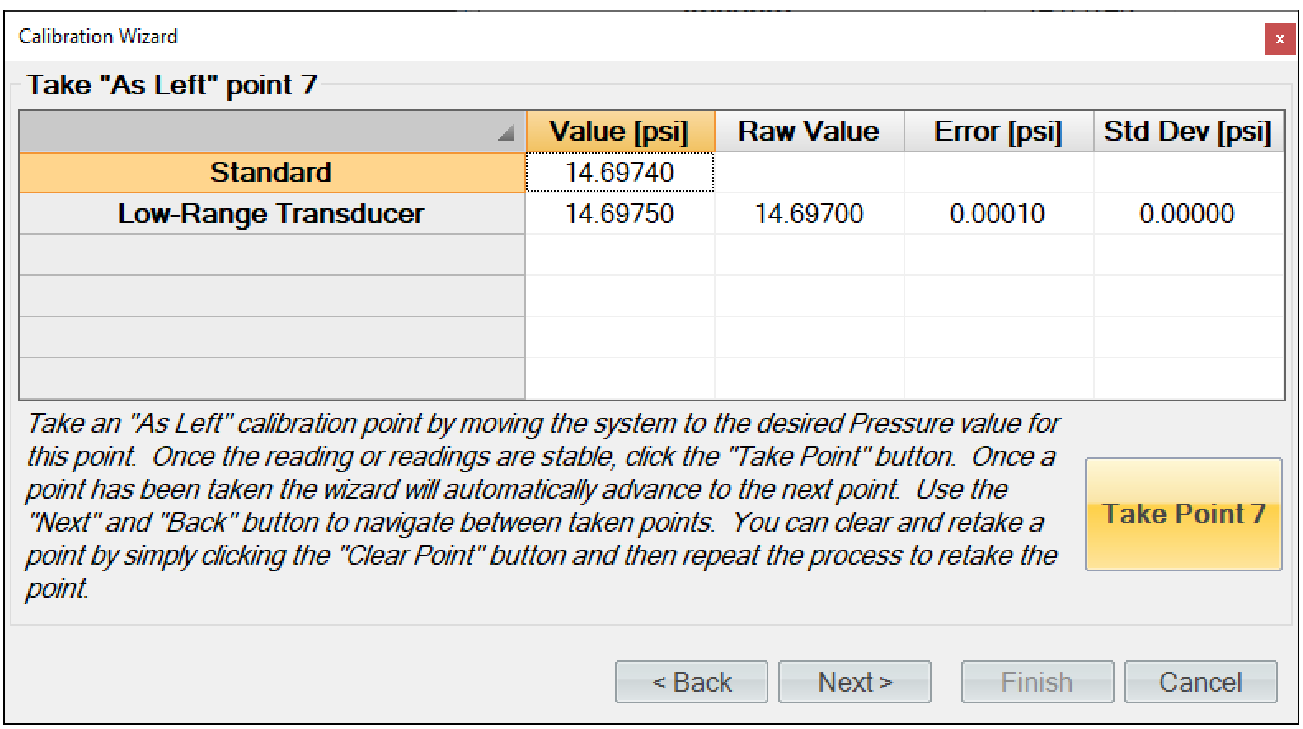
Using the pressure standard, generate and measure the next pressure point (25 psi). Once the readings are stable, enter the value of the standard and click the “Take Point” button.



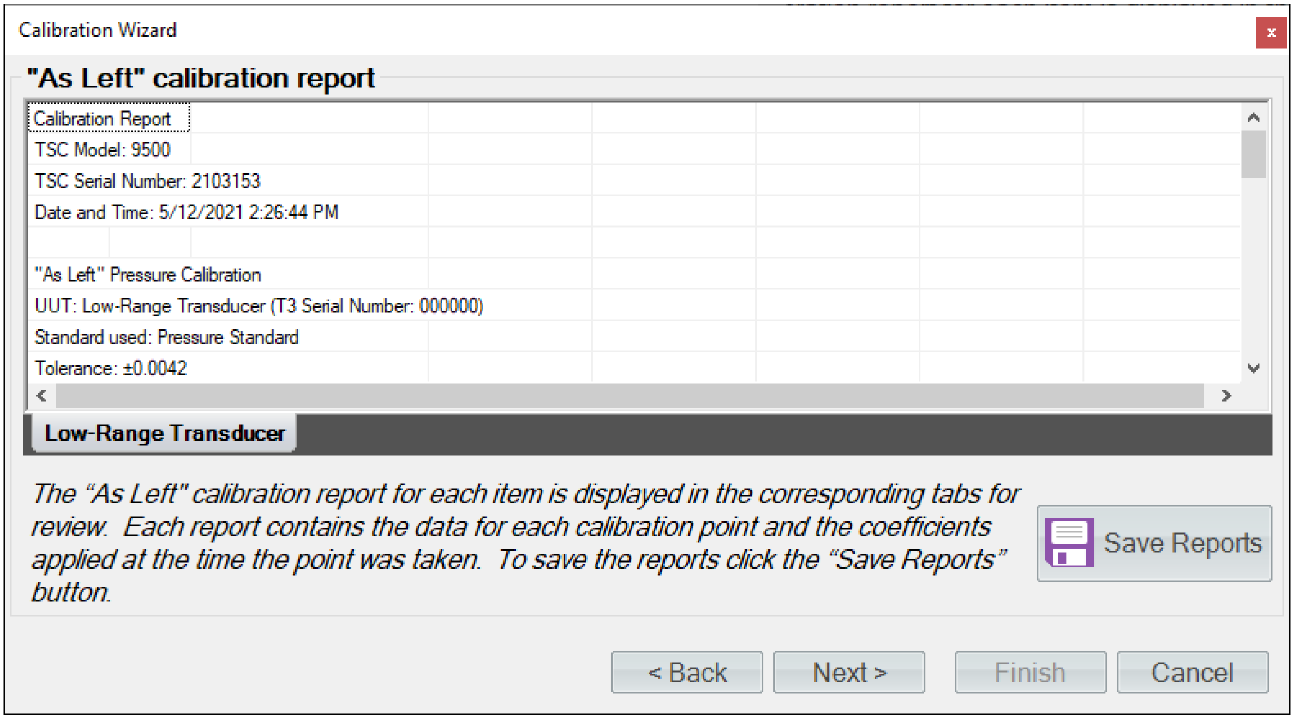
Using the pressure standard, generate and measure the next pressure point (20 psi). Once the readings are stable, enter the value of the standard and click the “Take Point” button.



Using the pressure standard, generate and measure the last pressure point (atmospheric pressure). Once the readings are stable, enter the value of the standard and click the “Take Point” button.

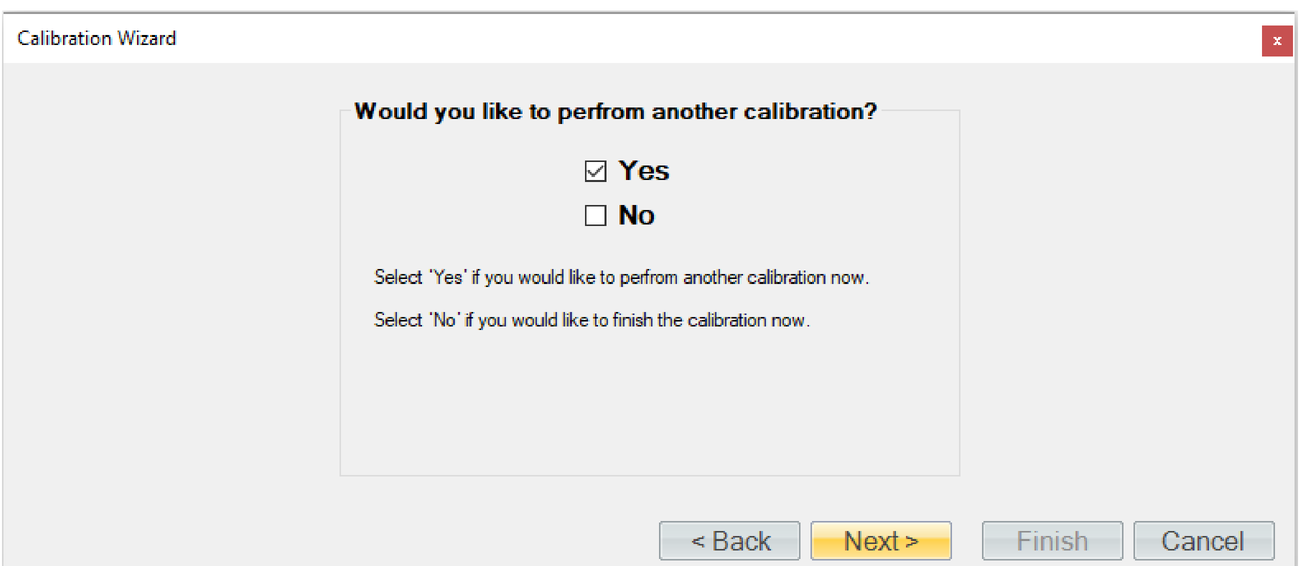


When you have taken the desired amount of “As Left” pressure points, click the “Next” button to view the “As Received” calibration report. The transducer appears in its own tab that contains the data for each calibration point, and the coefficients used when the points were taken.



The “Save Reports” button opens a file dialog to save the report. The default file location is …Documents\Thunder Scientific\9500 ControLog\Reports\.

Repeat this same procedure for each transducer to calibrate them to their specific range.



Reinstall the pressure transducer in the system:

- After all the pressure transducers have been calibrated, close the Pressure Calibration window, and reinstall the pressure transducers, tightening nut 1/8 turn past finger tight.
- Replace console panels when all pressure transducer calibrations have been performed, and the transducers have been reinstalled.

6.2.4 Supply Pressure

While indicated on the screen, the supply pressure is not critical to the accuracy of the generated humidity and is not used in the humidity calculations. Therefore, supply pressure calibration requirements depend upon the needs of the user. The procedure to calibrate the supply pressure is the same as the previous pressure calibration procedure. Calibrate over the range of 0 to 350 psiG. Example points are (0, 175, and 350 psiG) but they can be any sequence of numbers within the range. Just use best metrology practices when determining which points to take. For more details, refer to section 6.2.3 *Internal Calibration Procedure*.

Note – *The supply pressure transducer must be calibrated in gauge pressure.*

6.3 Mass Flow Meter Calibration

While indicated on the screen, the mass flow rate measurement is not critical to the accuracy of the generated humidity and is not used in the humidity calculations. Therefore, flow calibration requirements depend upon the needs of the user.

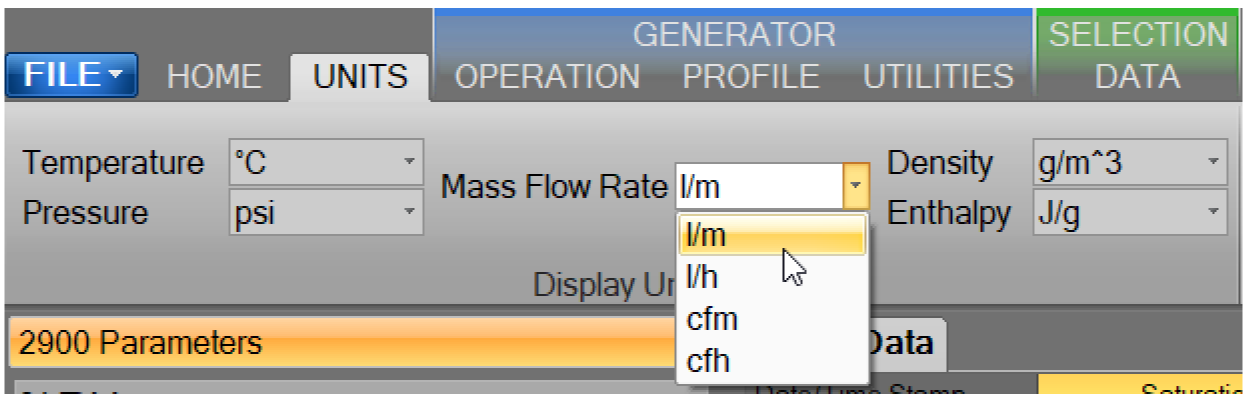
6.3.1 Equipment Required

1. Standard or Reference flow meter.

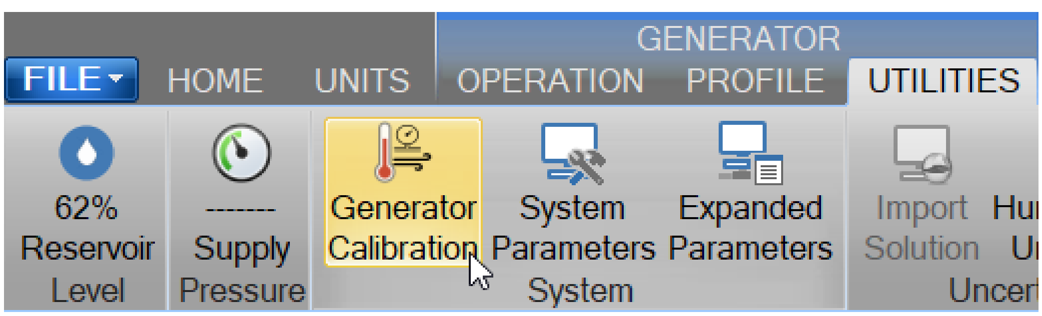
6.3.2 Calibration Procedure

Connect the reference flow meter to the gas supply inlet inside the test chamber.

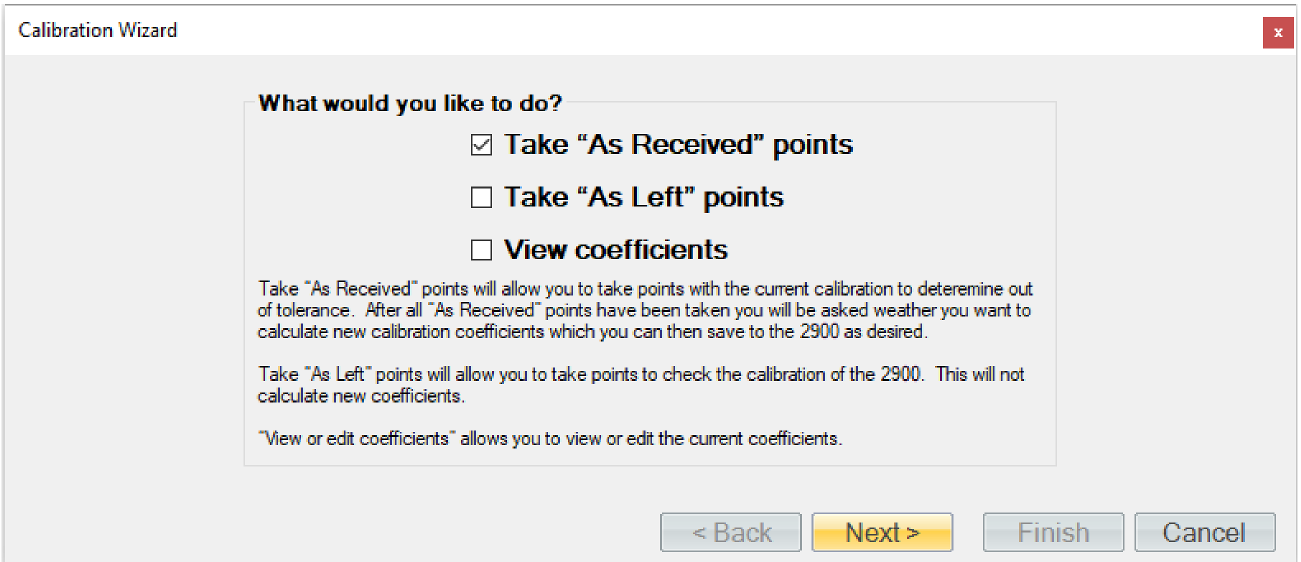
From the Units menu tab, select the desired mass flow rate units for calibration (l/m is recommended). Once calibration has begun, the units should not be changed again until the calibration is complete.



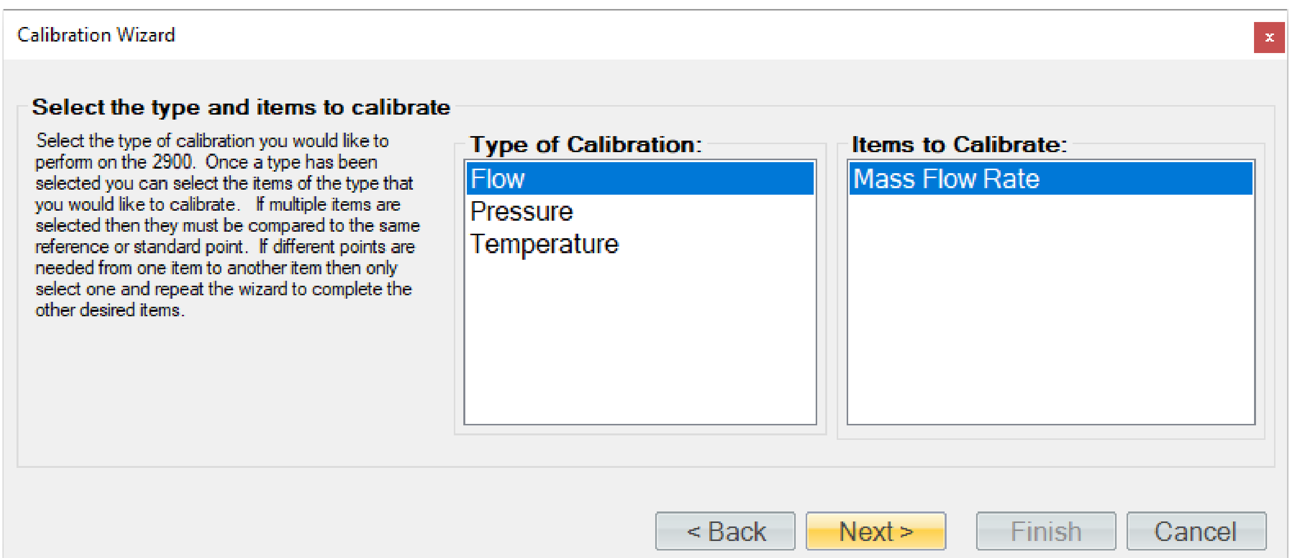
Select Generator Calibration from the Utilities menu tab to open the Calibration Wizard.



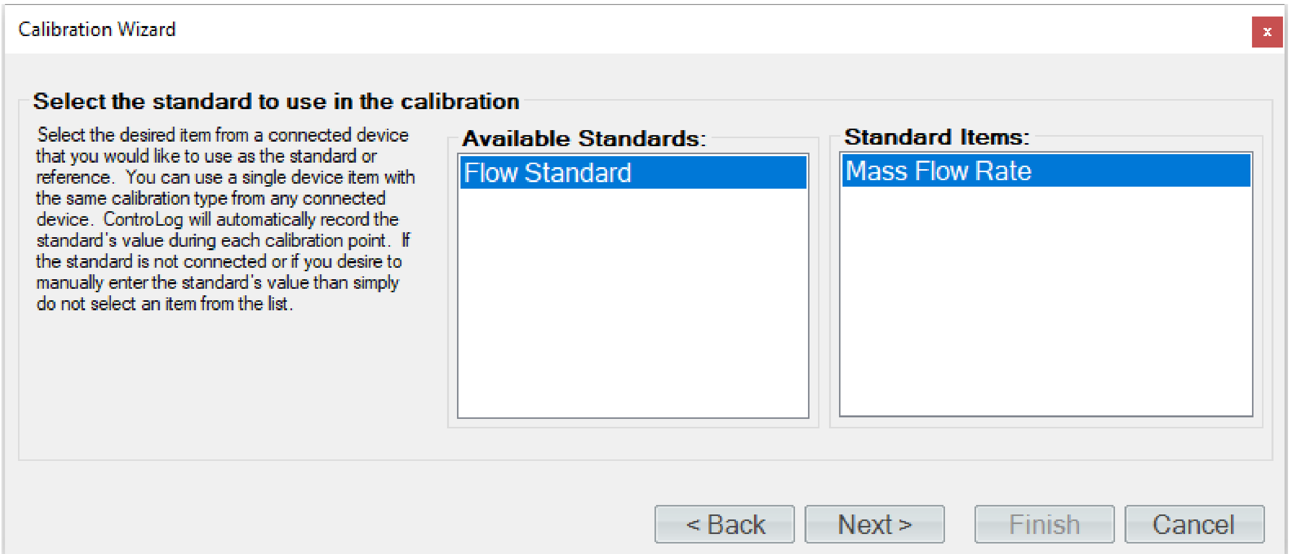
Select "Take "As Received" points." This allows the user to take points with the current calibration to determine out of tolerance. After all "As Received" points have been taken, users are asked whether they want to calculate new calibration coefficients.



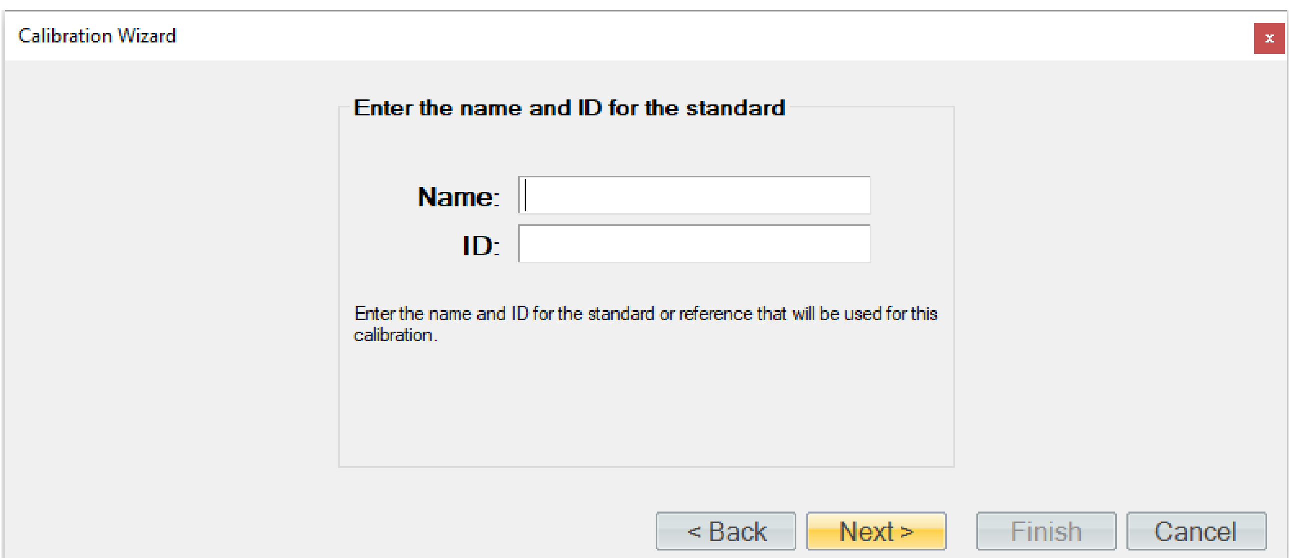
Set the type of calibration to Flow and select the Mass Flow Rate as the item to calibrate.



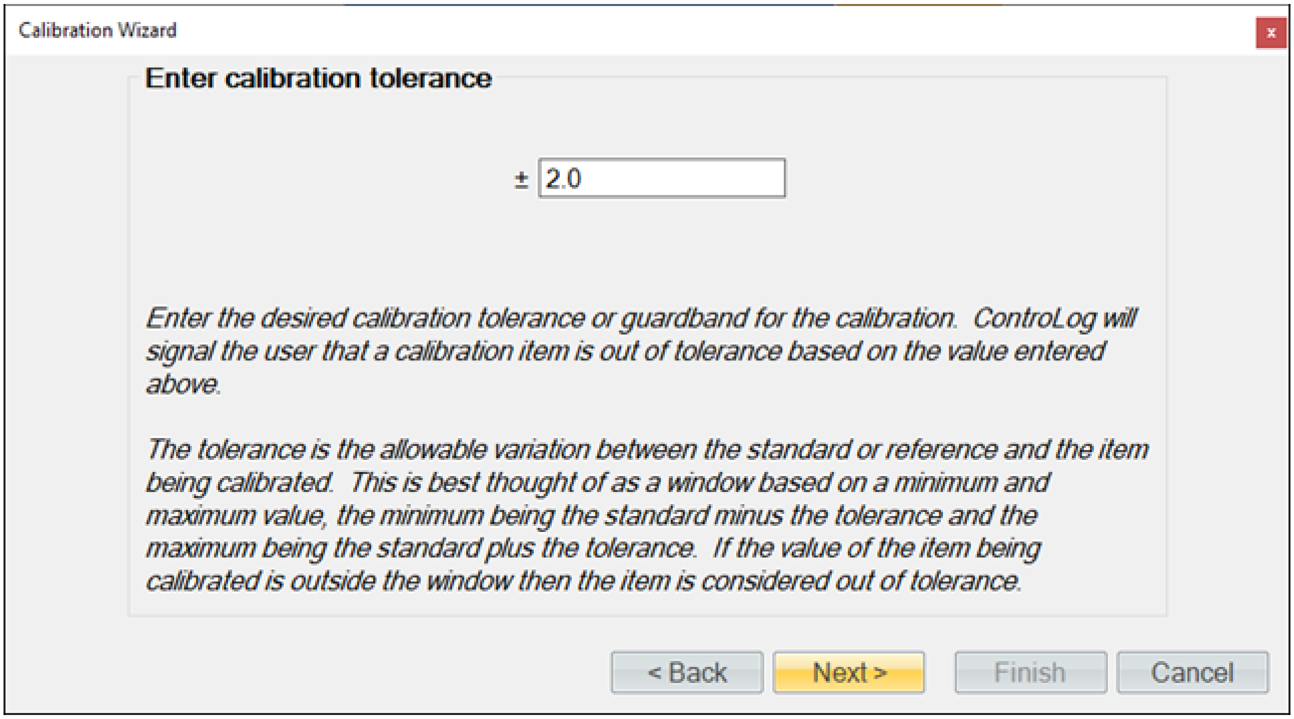
If the mass flow rate standard is a connected device (refer to section 10 Connections), you may select it for calibration. You can use a single device item with the same calibration type from any connected device. ControLog automatically records the standard's value during each calibration point. If the standard is not a connected device or you want to enter the standard's value manually, do not select an item from the list.



Enter the Name and ID of the standard being used. This information is populated on the calibration report. Selecting "Next" without entering a Name results in ControLog giving the standard a generic name.

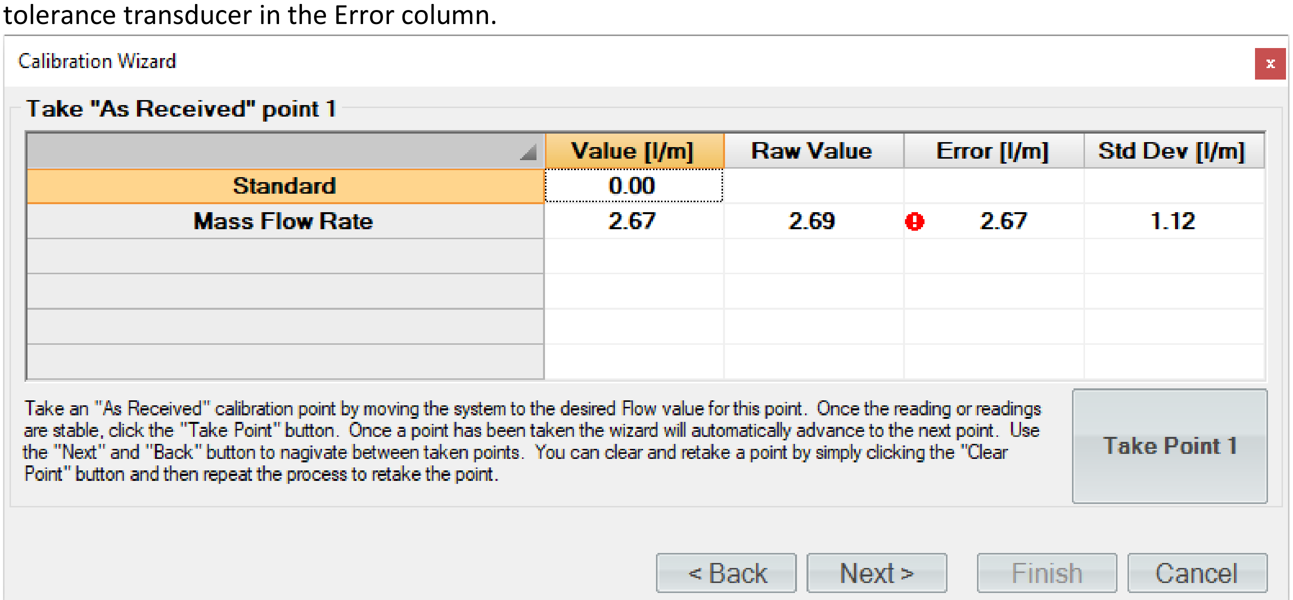


Enter the desired calibration tolerance or guard band for the calibration. ControLog signals the user that a calibration item is out of tolerance based on the entered value.



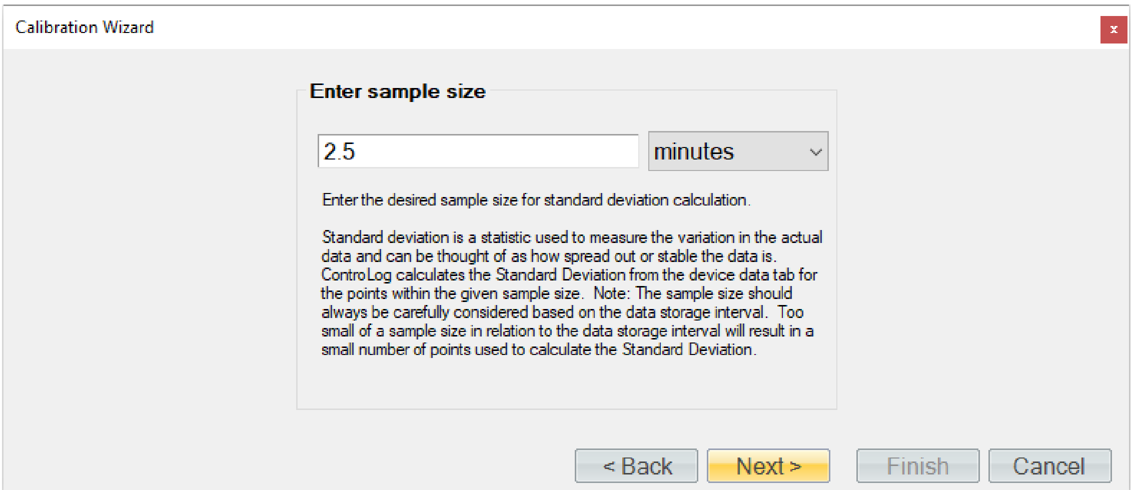
The tolerance is the allowable variation between the standard or reference and the calibrated item. This is best thought of as a window based on a minimum and maximum value, the minimum being the standard minus the tolerance and the maximum being the standard plus the tolerance. If the value of the item being calibrated is outside the window, then the item is considered out of tolerance.

An out-of-tolerance condition is indicated by a red circle with an exclamation point for the out-of-tolerance transducer in the Error column.



Enter the sample size used to perform the standard deviation calculation. The sample size is the given time that ControLog uses to determine which data points to use to determine the standard deviation of each probe.

> **Note** – *The number of points used is based on the selected data storage rate and the desired sample size. For example, if the data storage rate is every 30 seconds, a sample size of 2.5 minutes results in 5 points being used to calculate the standard deviation.*

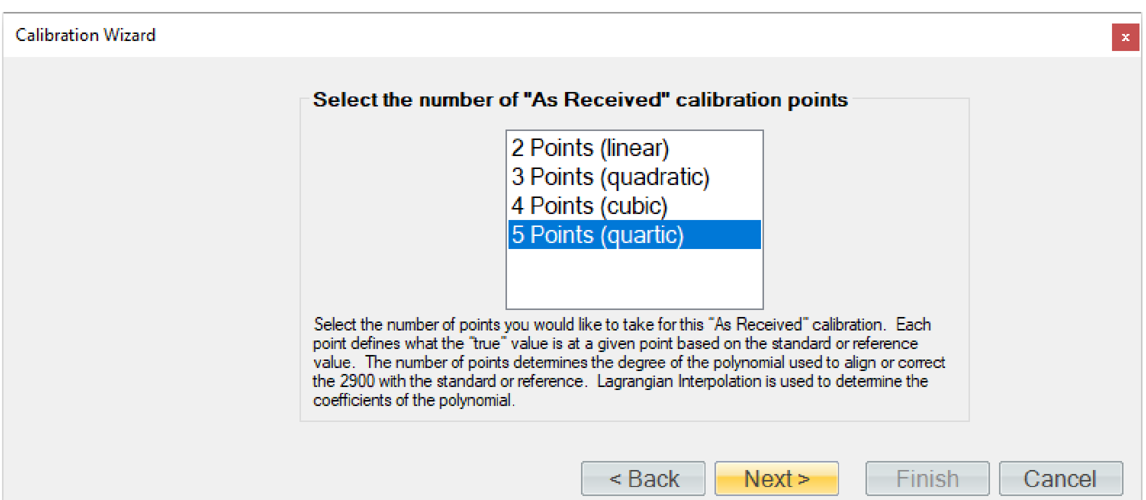


Select the number of points you would like to take for this "As Received" calibration. Each point defines the "true" value at a given point based on the standard or reference value. The number of points determines the degree of the polynomial used to align or correct the generator with the standard or reference.

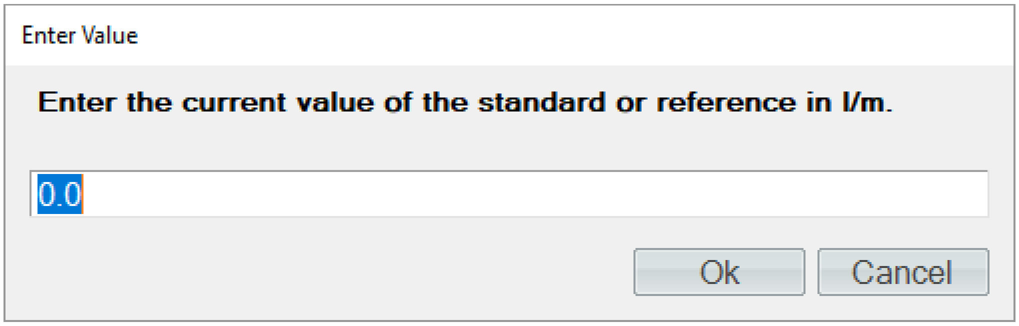
Five calibration points are recommended using the following mass flow rates:

- 0, 25, 50, 75, and 100 l/m

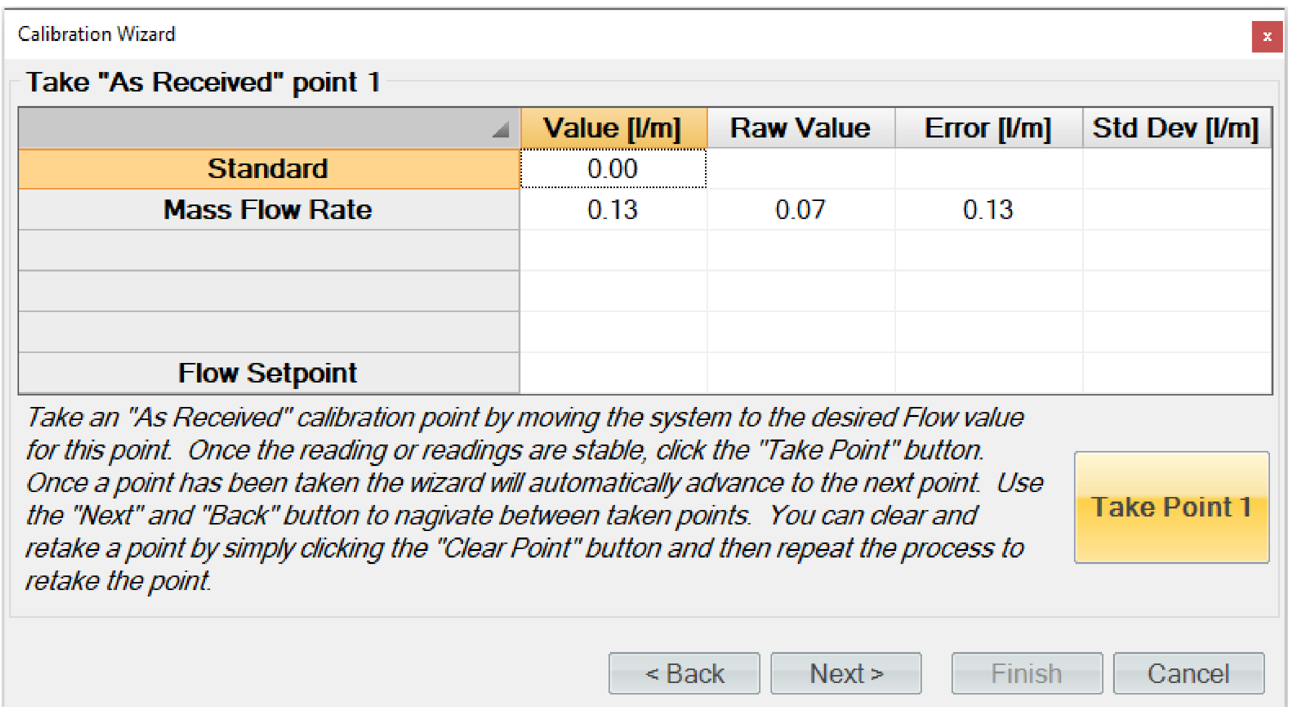
Note – *The specific points can be different from those listed above. Use best metrology practices when determining which points to take.*

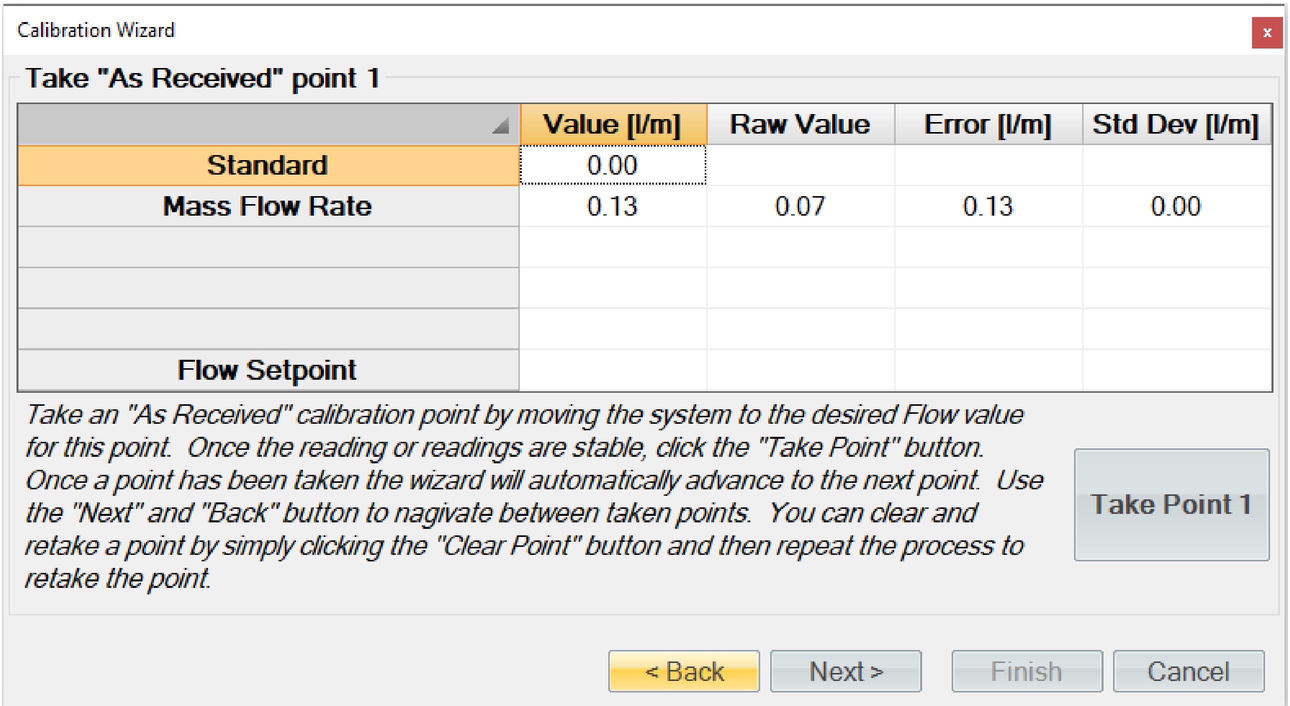


With the generator shutdown, take a zero-flow point. If the standard is not a connected device, then ContoLog asks for the value before taking the point. You can also enter a standard or reference value before taking a point by clicking the cell in the “Standard” and “Value” columns. This is useful for seeing error values before a point is taken.



Once the reading is stable, click the “Take Point” button. Once a point has been taken, the wizard automatically advances to the next point.





Calibration Wizard

Take "As Received" point 1

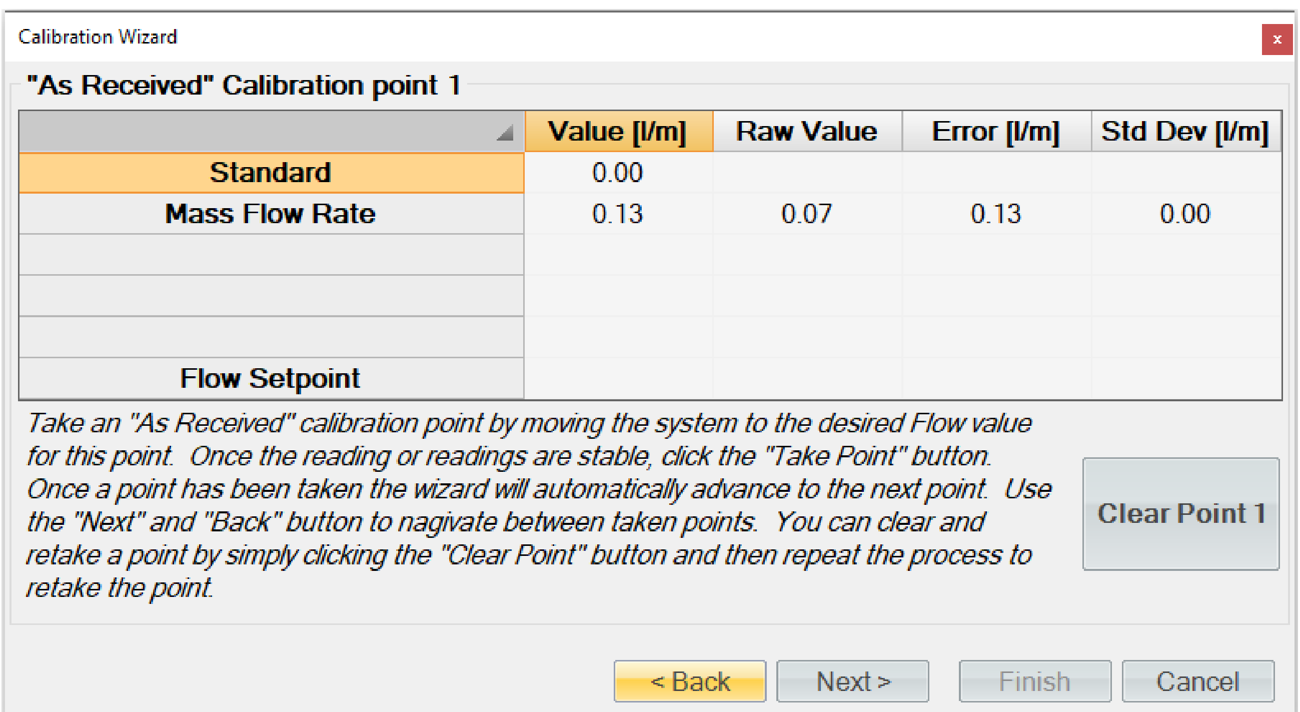
	Value [l/m]	Raw Value	Error [l/m]	Std Dev [l/m]
Standard	0.00			
Mass Flow Rate	0.13	0.07	0.13	0.00
Flow Setpoint				

Take an "As Received" calibration point by moving the system to the desired Flow value for this point. Once the reading or readings are stable, click the "Take Point" button. Once a point has been taken the wizard will automatically advance to the next point. Use the "Next" and "Back" button to nagivate between taken points. You can clear and retake a point by simply clicking the "Clear Point" button and then repeat the process to retake the point.

Take Point 1

< Back | Next > | Finish | Cancel

Tip – *Use the "Next" and "Back" buttons to navigate between taken points. You can clear and retake a point by simply clicking the "Clear Point" button and then repeating the process to retake the point.*



Calibration Wizard

"As Received" Calibration point 1

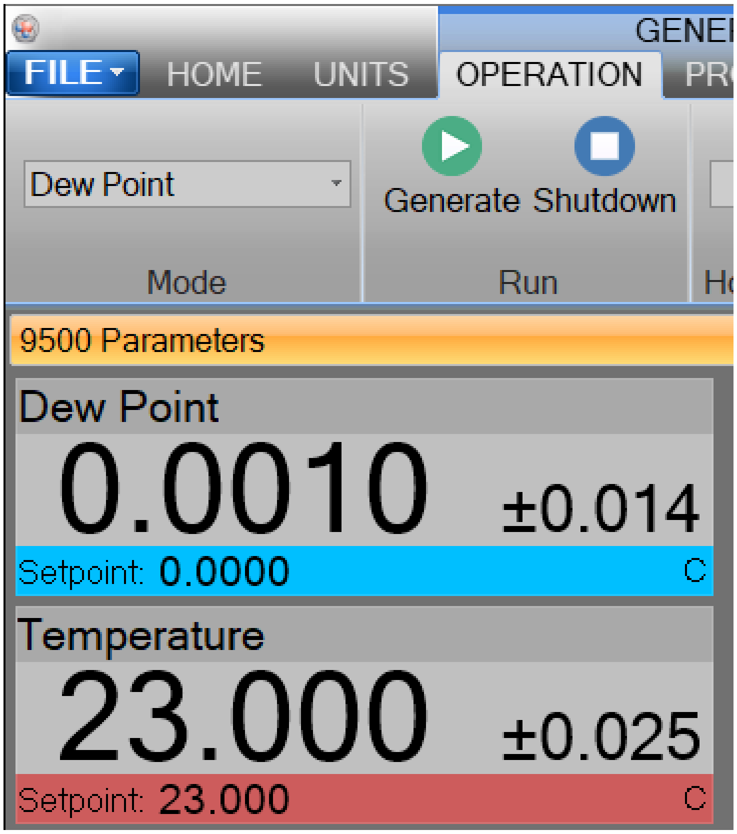
	Value [l/m]	Raw Value	Error [l/m]	Std Dev [l/m]
Standard	0.00			
Mass Flow Rate	0.13	0.07	0.13	0.00
Flow Setpoint				

Take an "As Received" calibration point by moving the system to the desired Flow value for this point. Once the reading or readings are stable, click the "Take Point" button. Once a point has been taken the wizard will automatically advance to the next point. Use the "Next" and "Back" button to nagivate between taken points. You can clear and retake a point by simply clicking the "Clear Point" button and then repeat the process to retake the point.

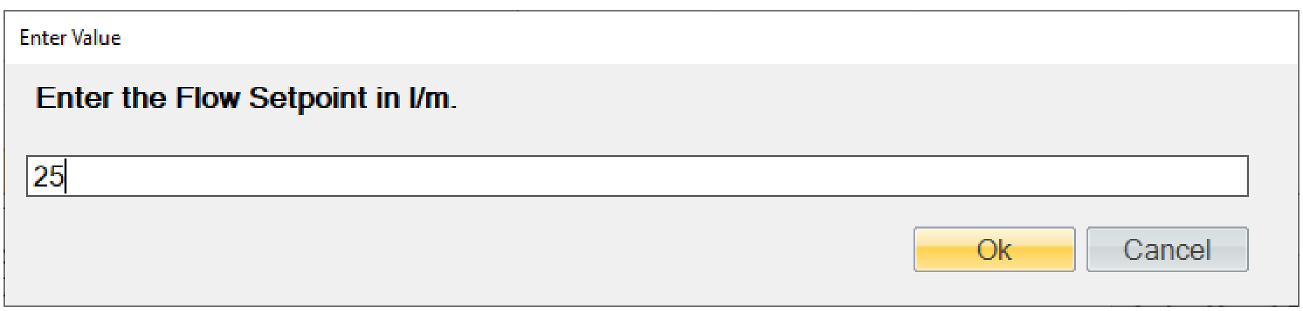
Clear Point 1

< Back | Next > | Finish | Cancel

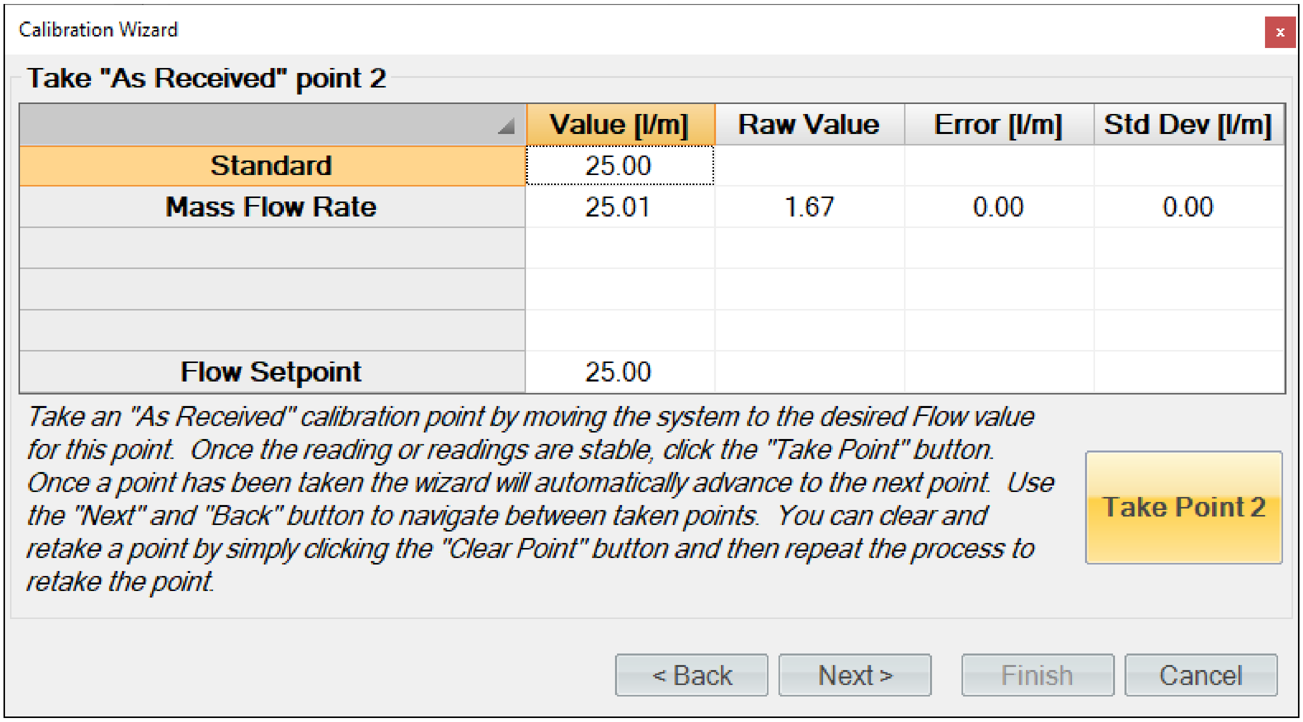
Set the Mode to Dew Point under the Operation Tab and change the Dew Point setpoint to 0 °C. Change the Temperature setpoint to around 21 °C to 25 °C.



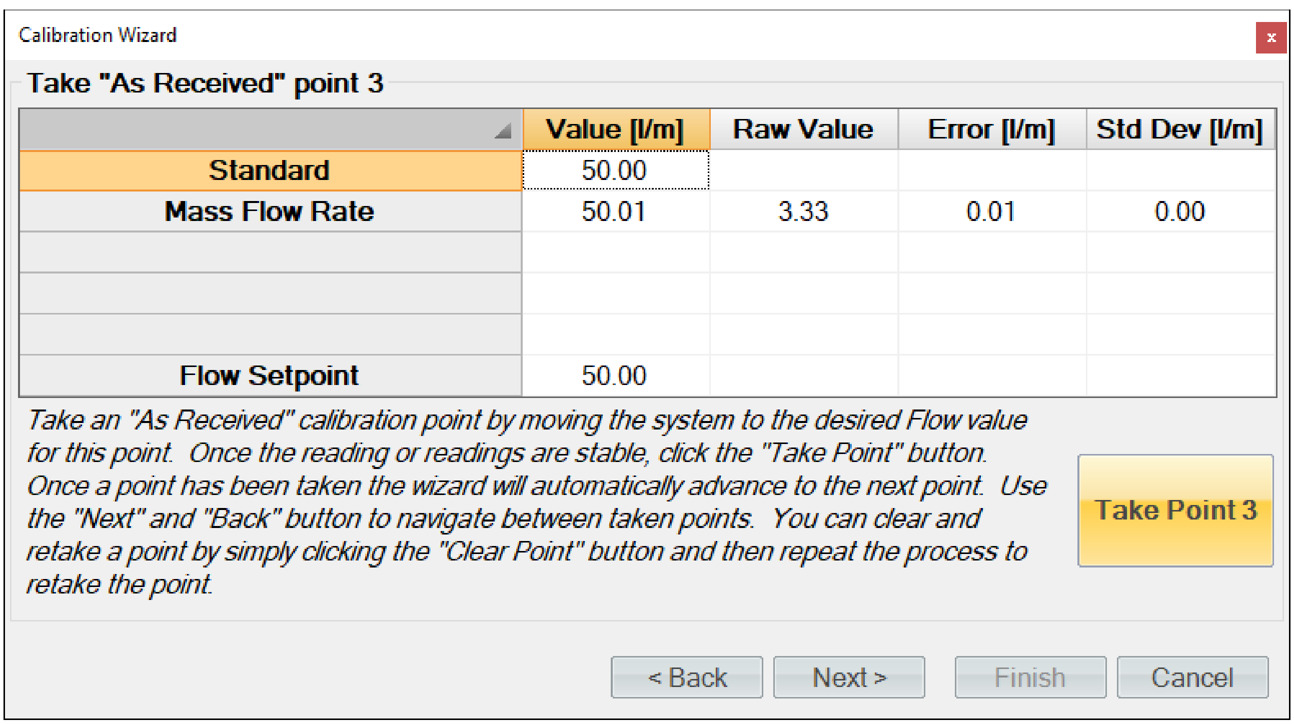
Enter the next flow rate (25 l/m) in the Flow Setpoint "Value" cell. This starts the 9500, generating a 0 °C dew at the current temperature setpoint. Wait for the system to become stable at the 0 °C dew point.



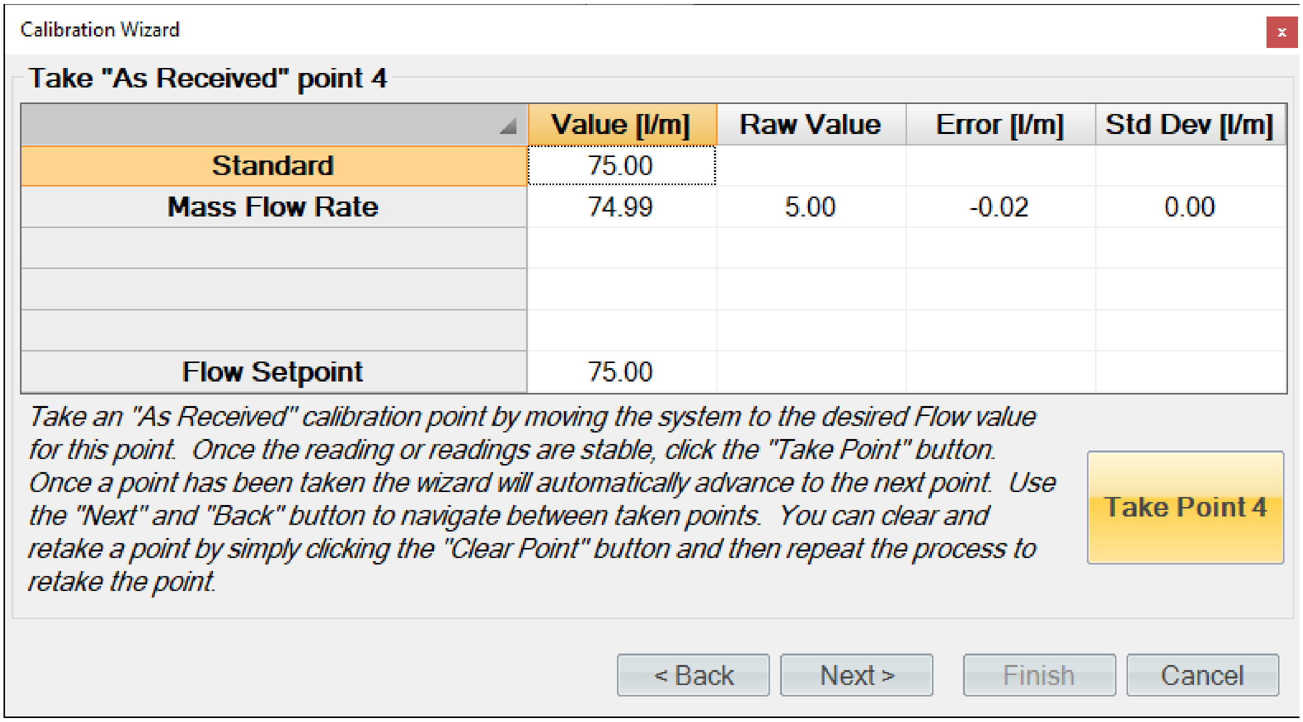
Using the flow standard, measure the next point. Once the readings are stable, enter the value of the standard and click the "Take Point" button.



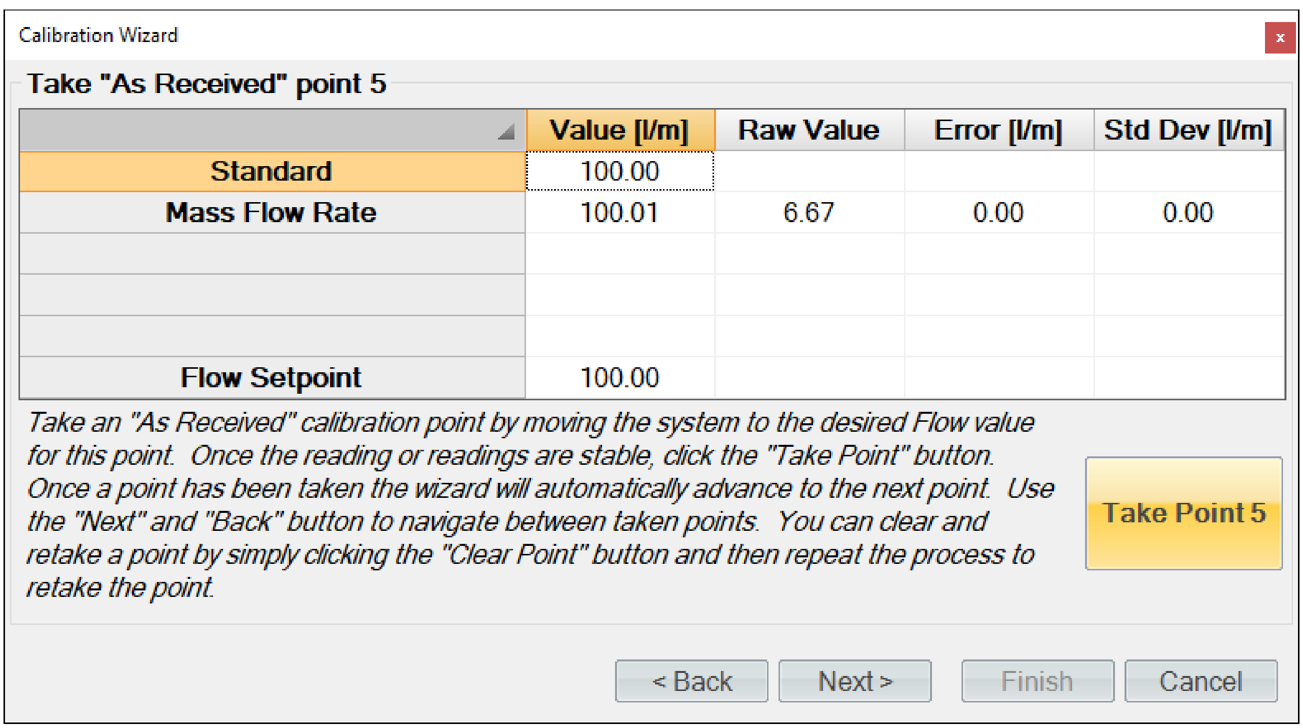
Continue generating a 0 °C dew point but advance the flow rate to the next point (50 l/m). Using the flow standard, measure the point and once the readings are stable, enter the standard's value and click the “Take Point” button.



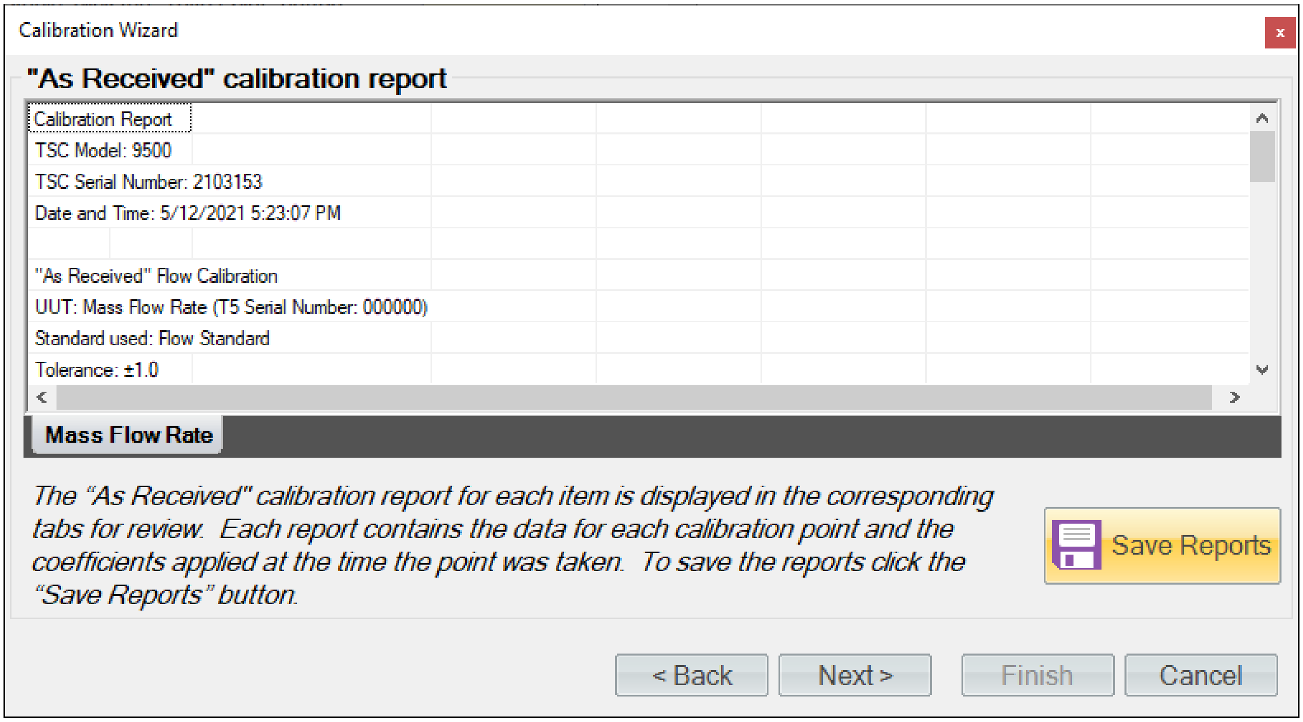
Continue generating a 0 °C dew point but advance the flow rate to the next point (75 l/m). Using the flow standard, measure the point and once the readings are stable, enter the standard's value and click the “Take Point” button.



Continue generating a 0 °C dew point but advance the flow rate to the last point (100 l/m). Using the flow standard, measure the point and once the readings are stable, enter the standard's value and click the “Take Point” button.

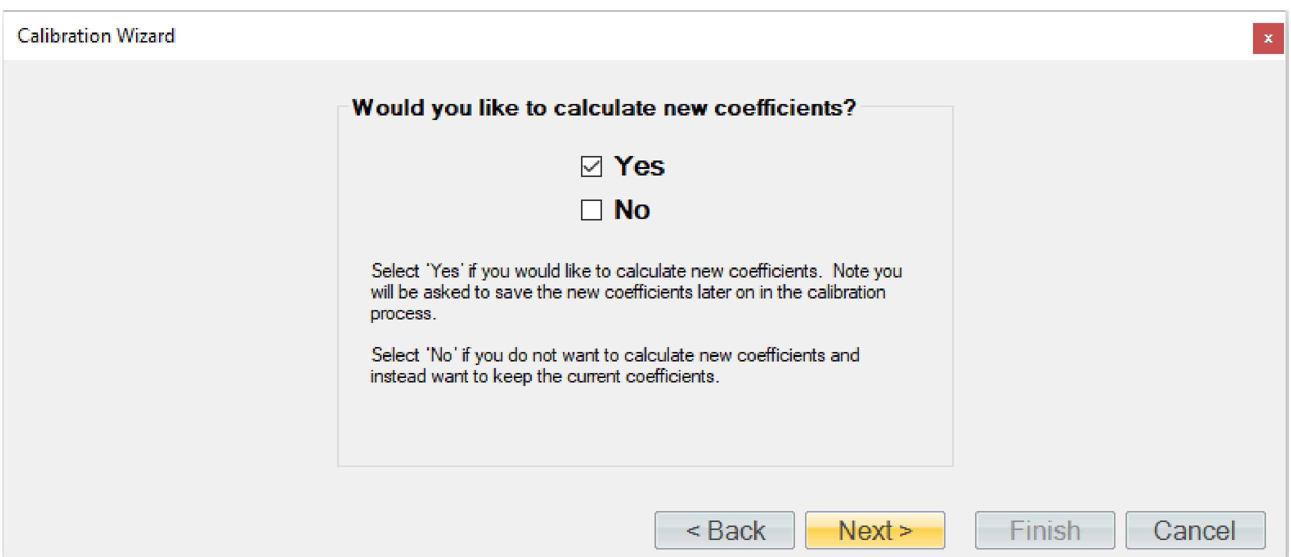


ControLog advances to the “As Received” calibration report when all flow points have been entered. The flow meter appears in its own tab that contains the data for each calibration point, and the coefficients used when the points were taken.

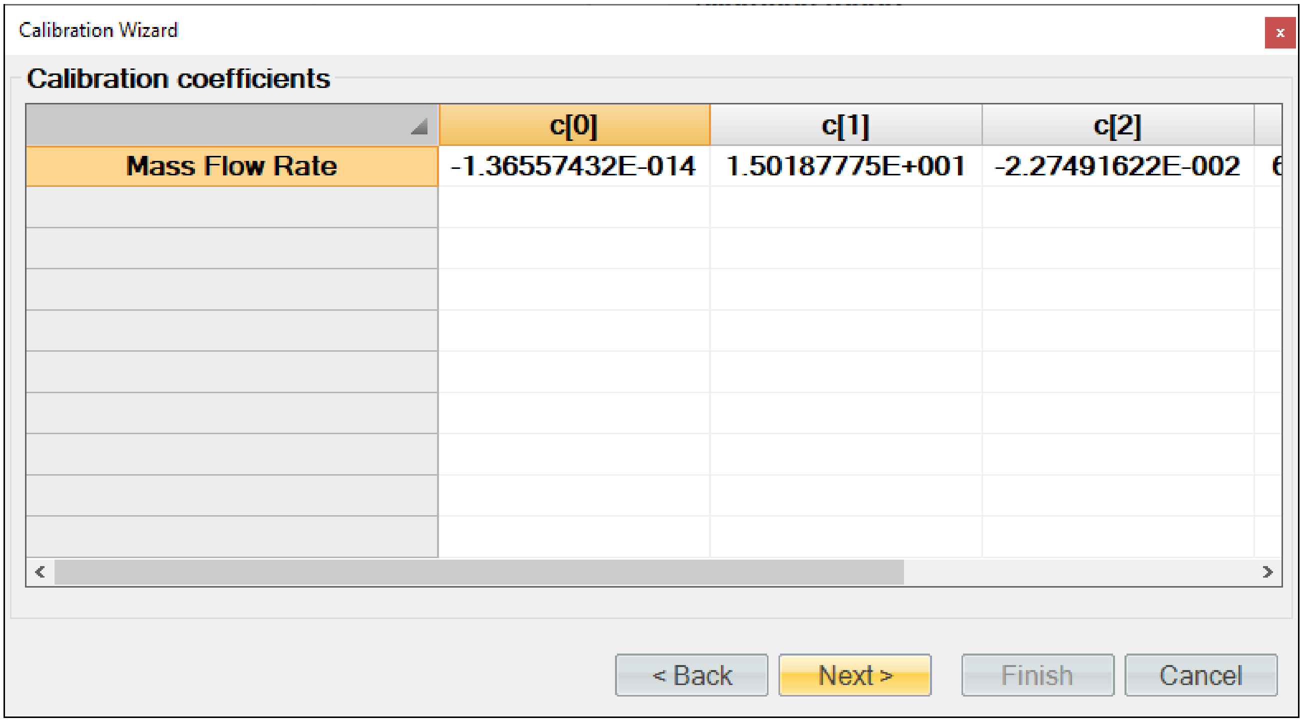


The "Save Reports" button opens a file dialog to save the report. The default file location is …Documents\Thunder Scientific\9500 ControLog\Reports\.

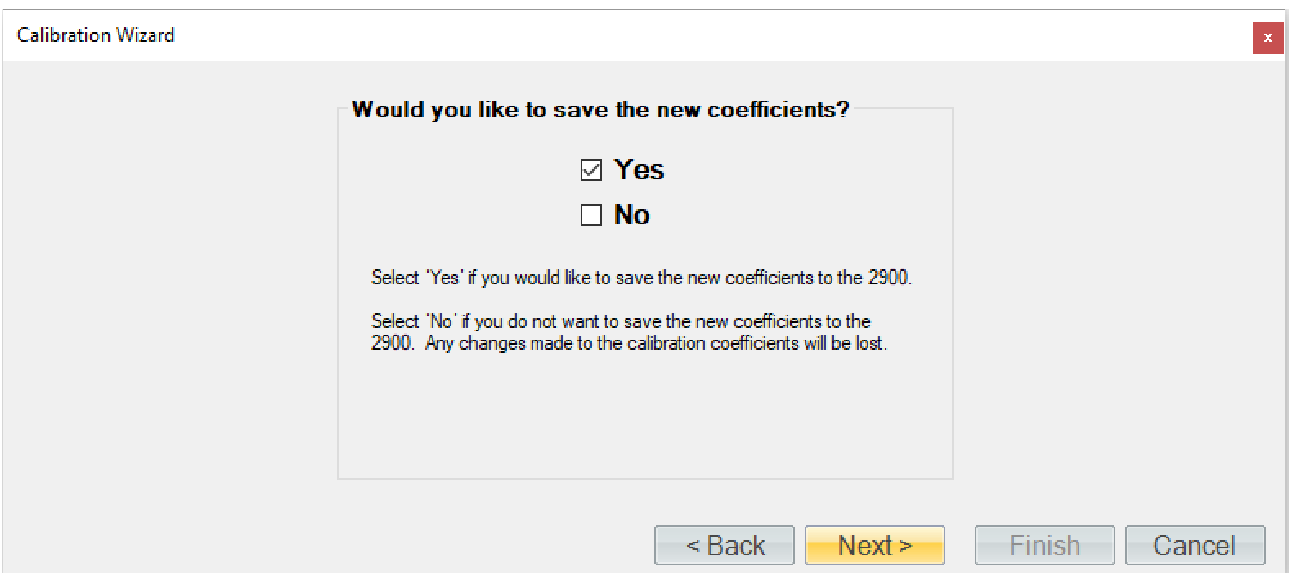
Clicking "Next," asks the user if they want to calculate new coefficients using the as received data points just taken.



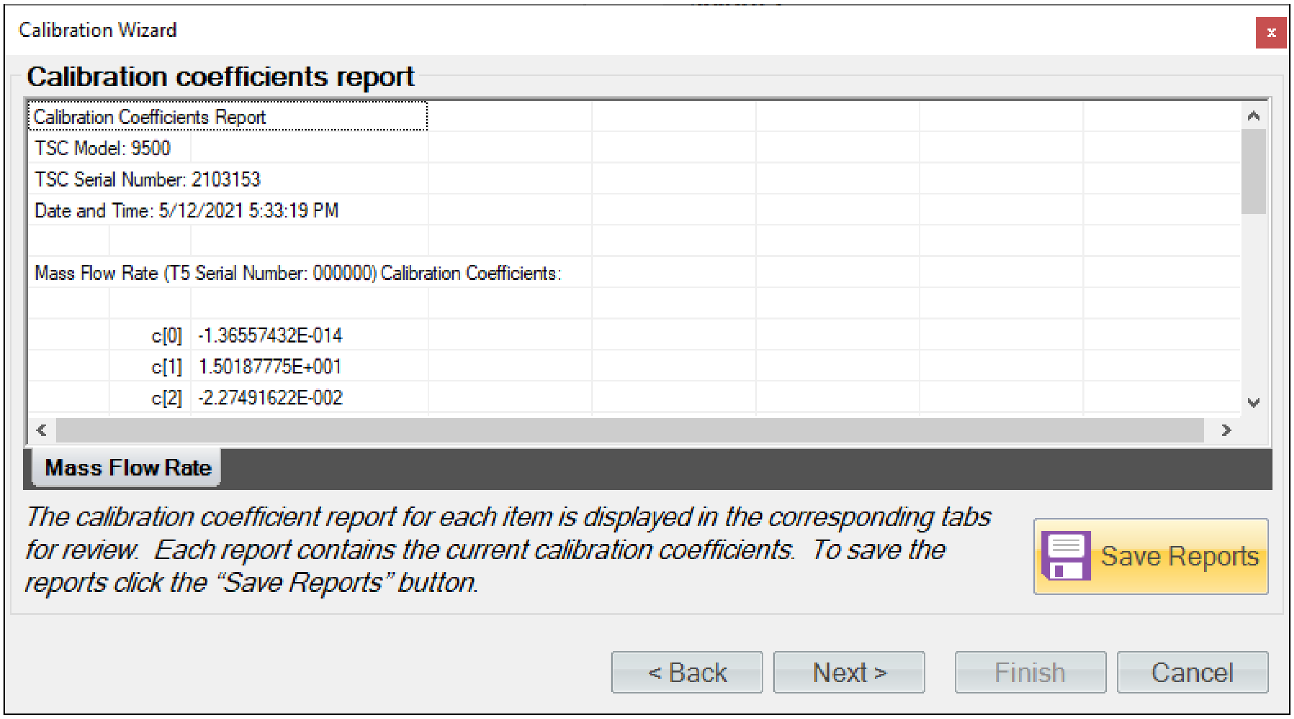
If the user selects to calculate new coefficients, they are calculated and displayed. ControLog issues a message telling the user that the coefficients cannot be calculated if a problem occurs during the calculation.



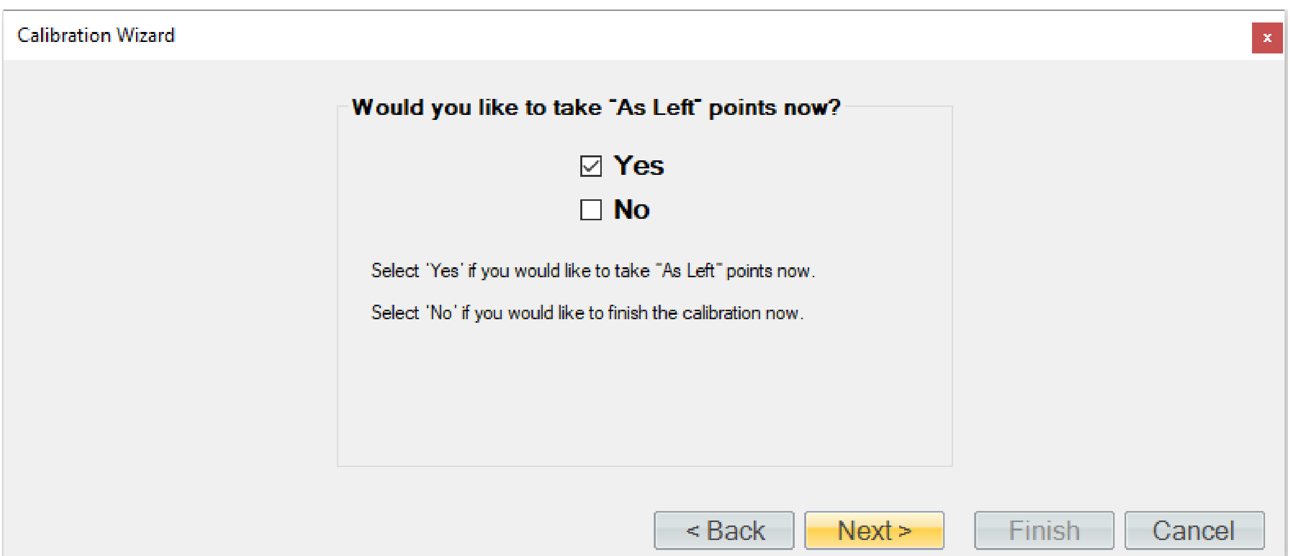
Next, the user is asked to save the new coefficients to the system. Selecting "Yes" results in the current coefficient being over-written by the newly calculated coefficients.



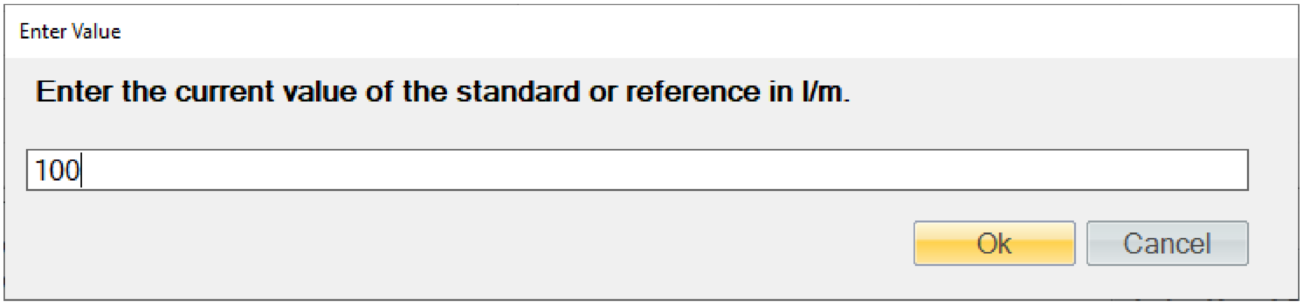
Next, the user can view and save the calibration coefficients report for the flow meter.



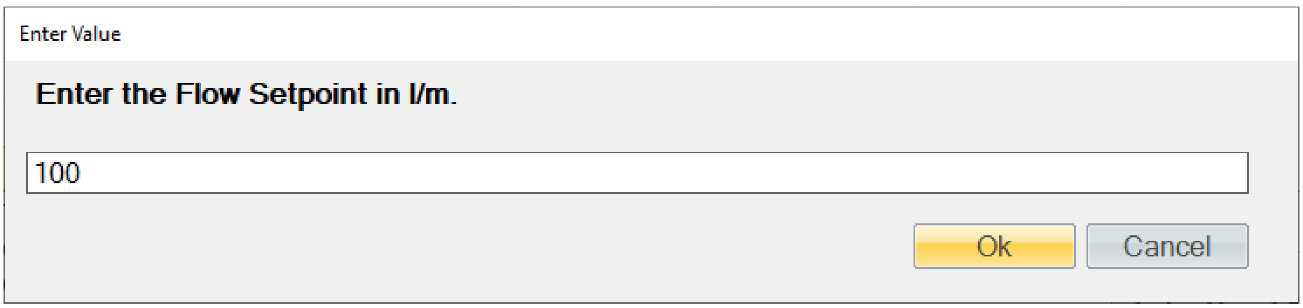
Next, the user can complete the calibration or choose to take "As Left" points.



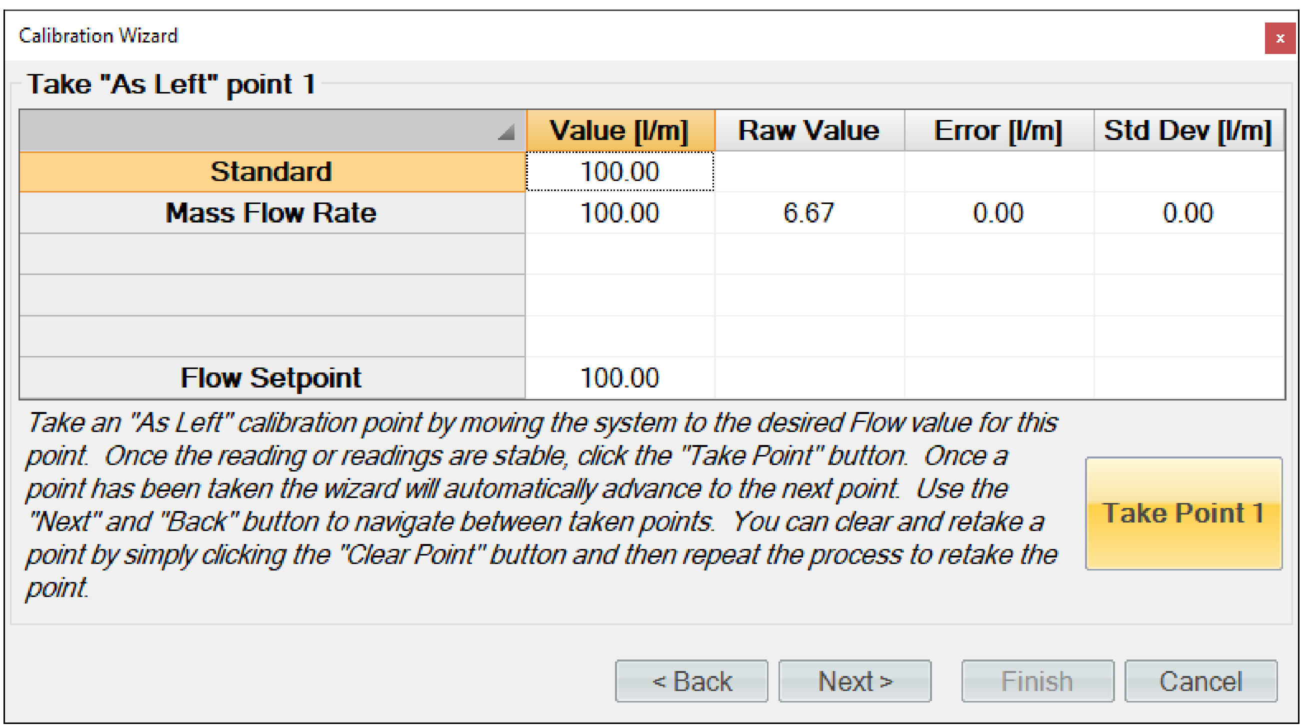
ControLog allows users to take as many “As Left” points as they want. In this example, we check three points. If the standard is not a connected device, then ControLog asks for the value before taking the point. You can also enter a standard or reference value before taking a point by clicking the cell in the “Standard” and “Value” columns. This is useful for seeing error values before a point is taken.



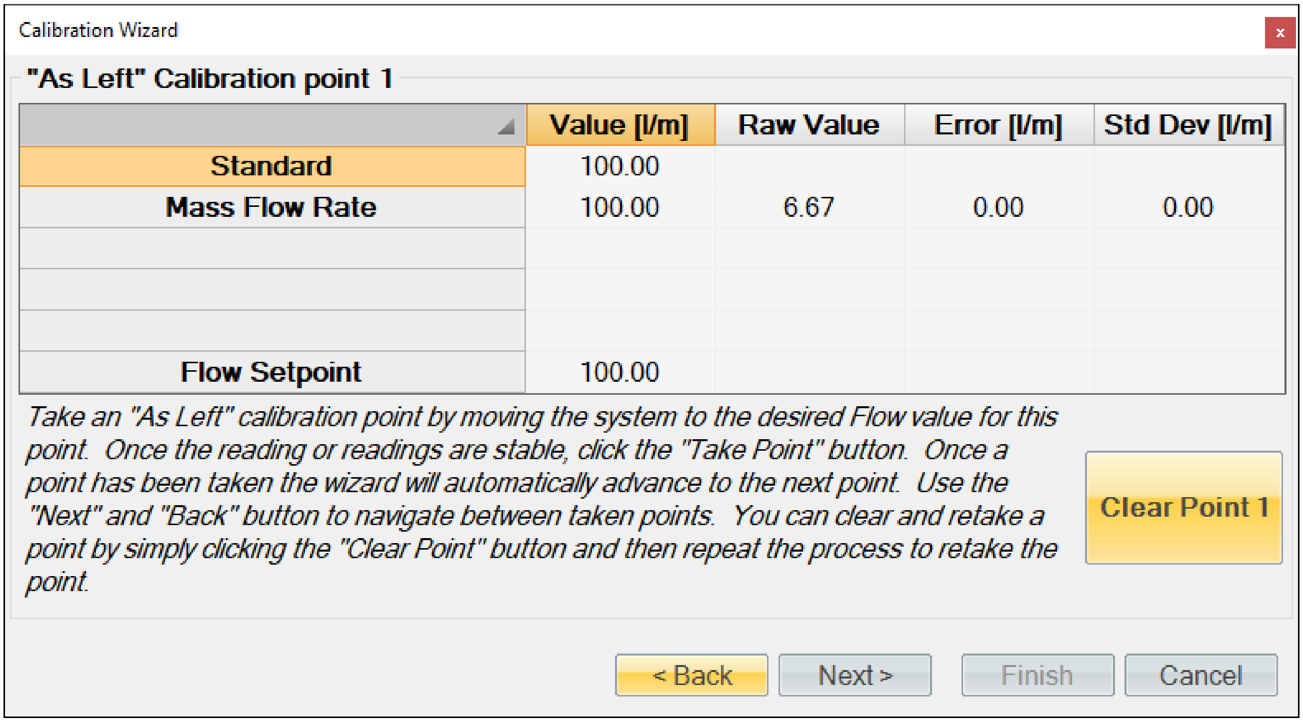
Enter the first flow rate (100 l/m) in the Flow Setpoint “Value” cell to continue generating a 0 °C dew point.



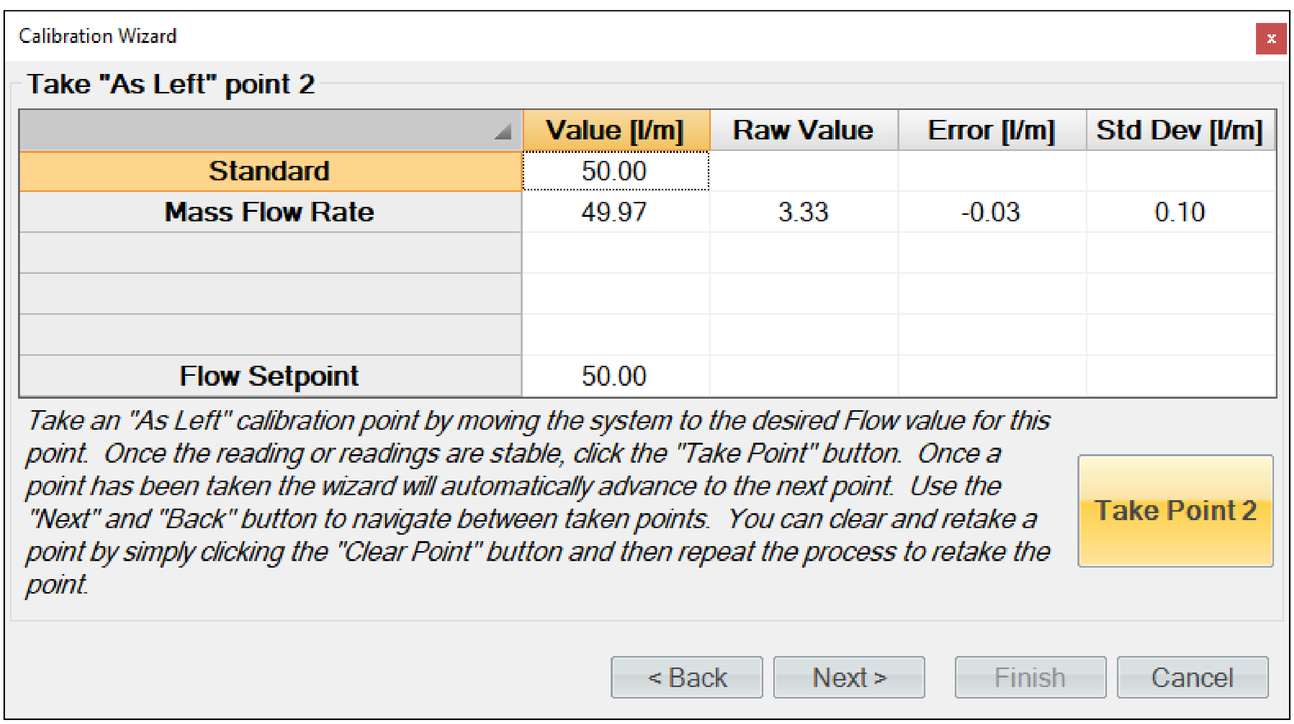
Using the flow standard, measure the point and once the readings are stable, enter the standard's value and click the “Take Point” button.



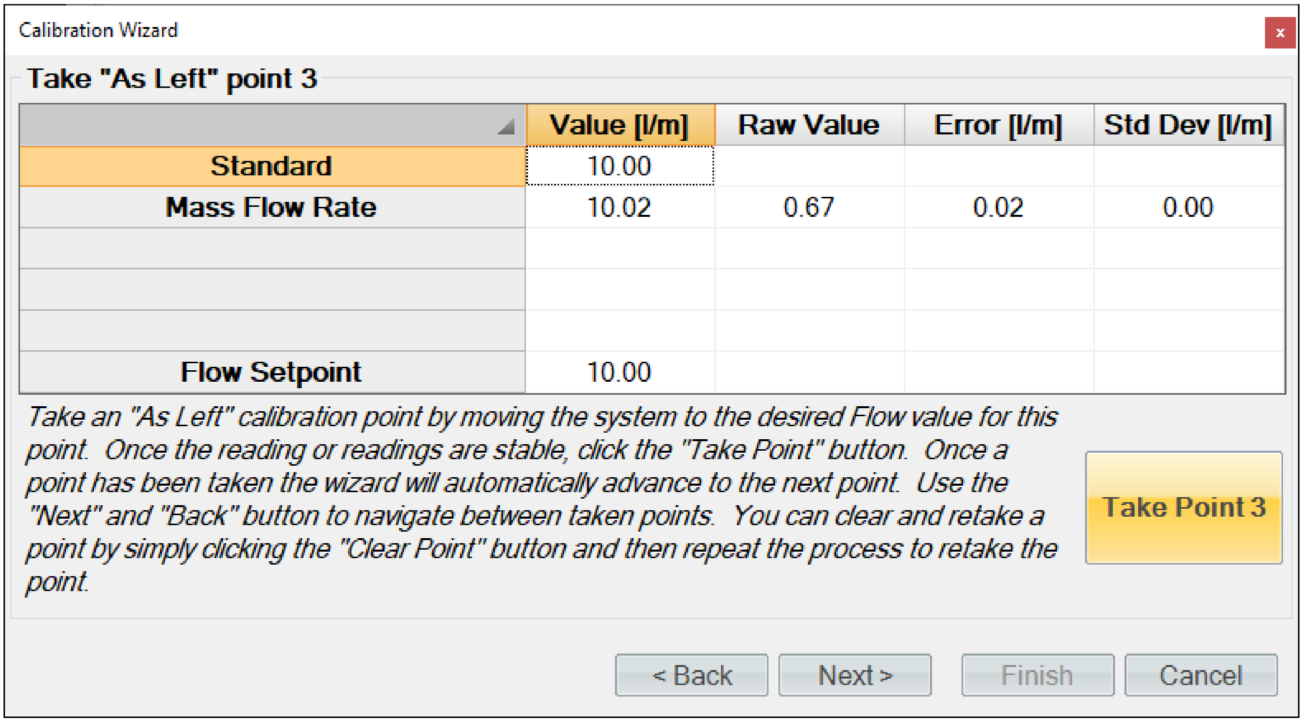
Tip – *Use the "Next" and "Back" buttons to navigate between taken points. You can clear and retake a point by simply clicking the "Clear Point" button and then repeating the process to retake the point.*



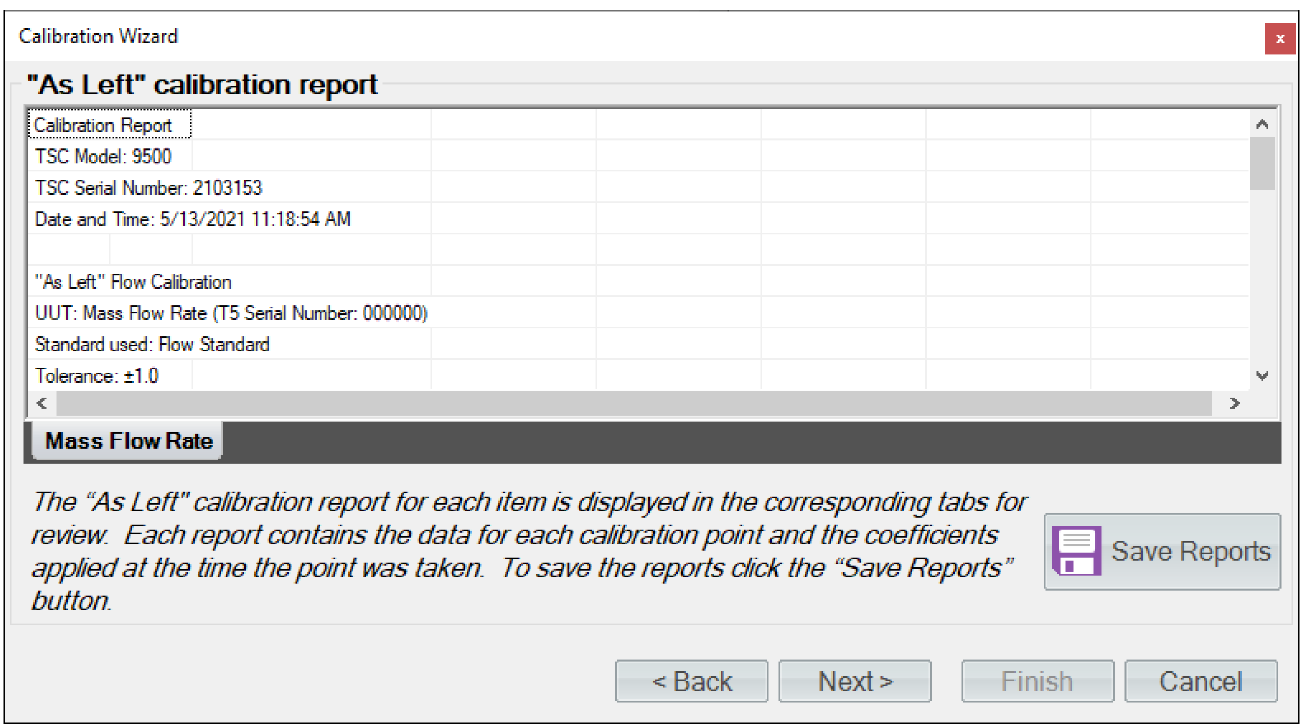
Continue generating a 0 °C dew point but advance the flow rate to the next point (50.0 l/m). Using the flow standard, measure the point and once the readings are stable, enter the standard's value and click the "Take Point" button.



Continue generating a 0 °C dew point but advance the flow rate to the next point (10.0 l/m). Using the flow standard, measure the point and once the readings are stable, enter the standard's value and click the “Take Point” button.

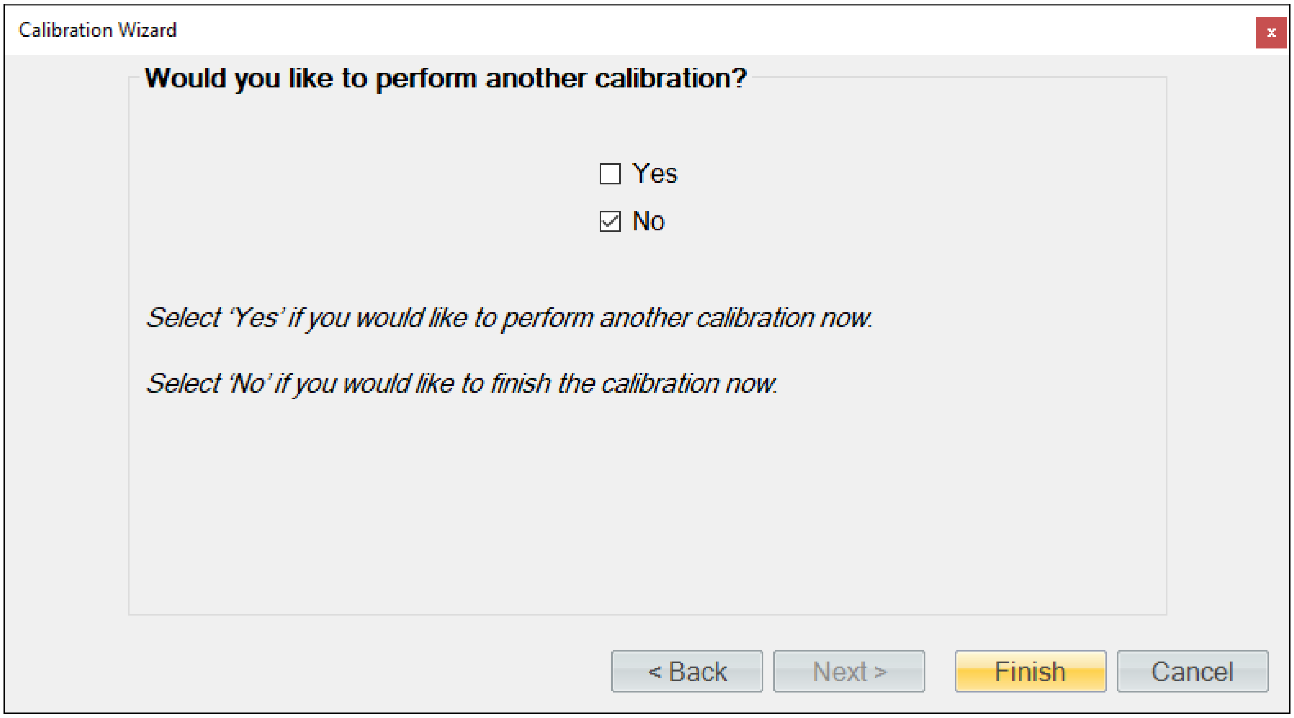


When you have taken the desired amount of “As Left” flow points, click the “Next” button to view the “As Received” calibration report. The flow meter appears in its own tab that contains the data for each calibration point, and the coefficients used when the points were taken.



The "Save Reports" button opens a file dialog to save the report. The default file location is ...Documents\Thunder Scientific\9500 ControLog\Reports\.

When finished, close the Mass Flow Calibration window by selecting "No" and then Finish.



6.4 Viewing and Editing Calibration Coefficients

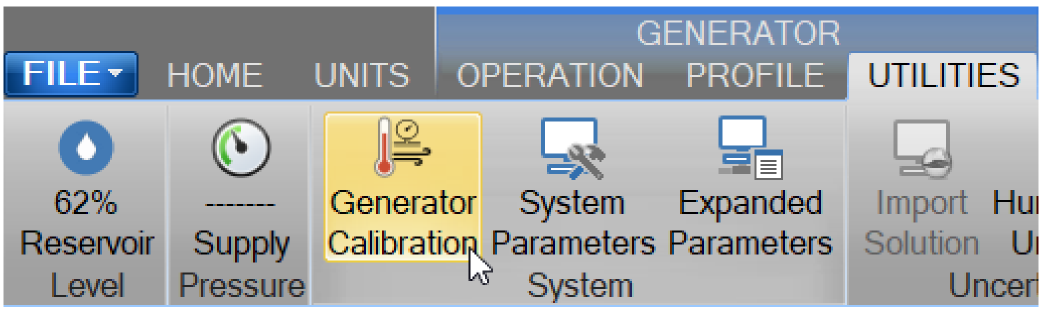
The calibration coefficients for any calibration item can be viewed and or edited using the Calibration Wizard. ControLog uses the following equation to apply calibration coefficients:

$$f(x) = c_4x^4 + c_3x^3 + c_2x^2 + c_1x + c_0$$

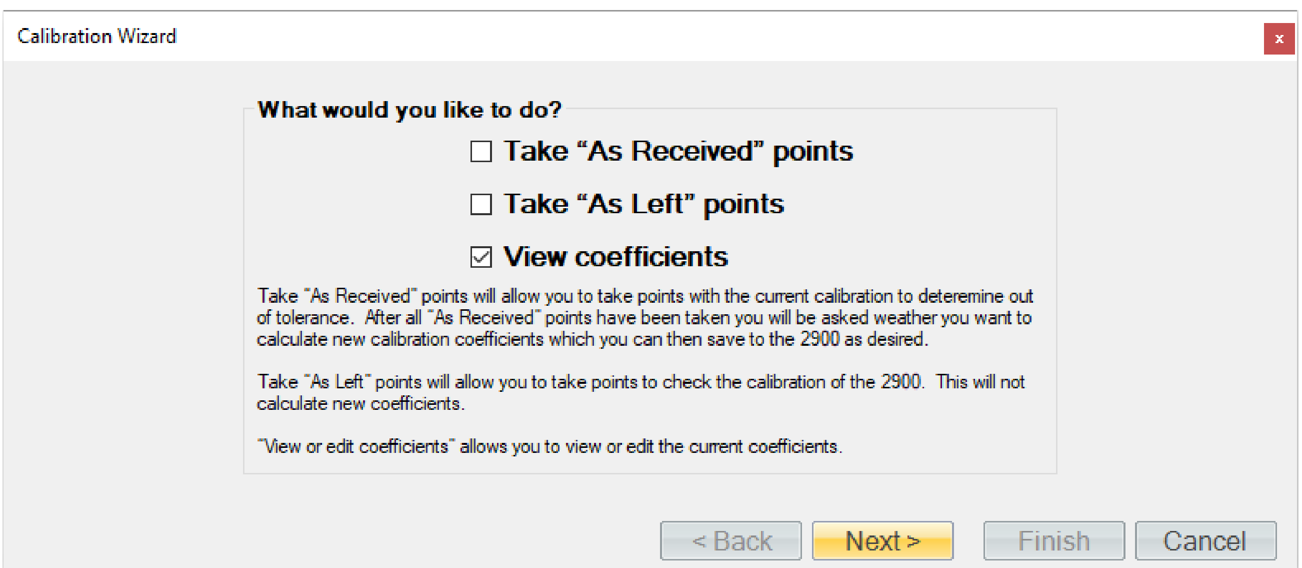
Where x is the raw value, c0, c1, c2, c3, and c4 are the coefficients, and f(x) is the calibrated value for the given coefficients and raw value.

> **Note –** *Editing calibration coefficients requires Manager Access Level or above (see section 4.1.6.8 Access Control for more information on changing Access Levels).*

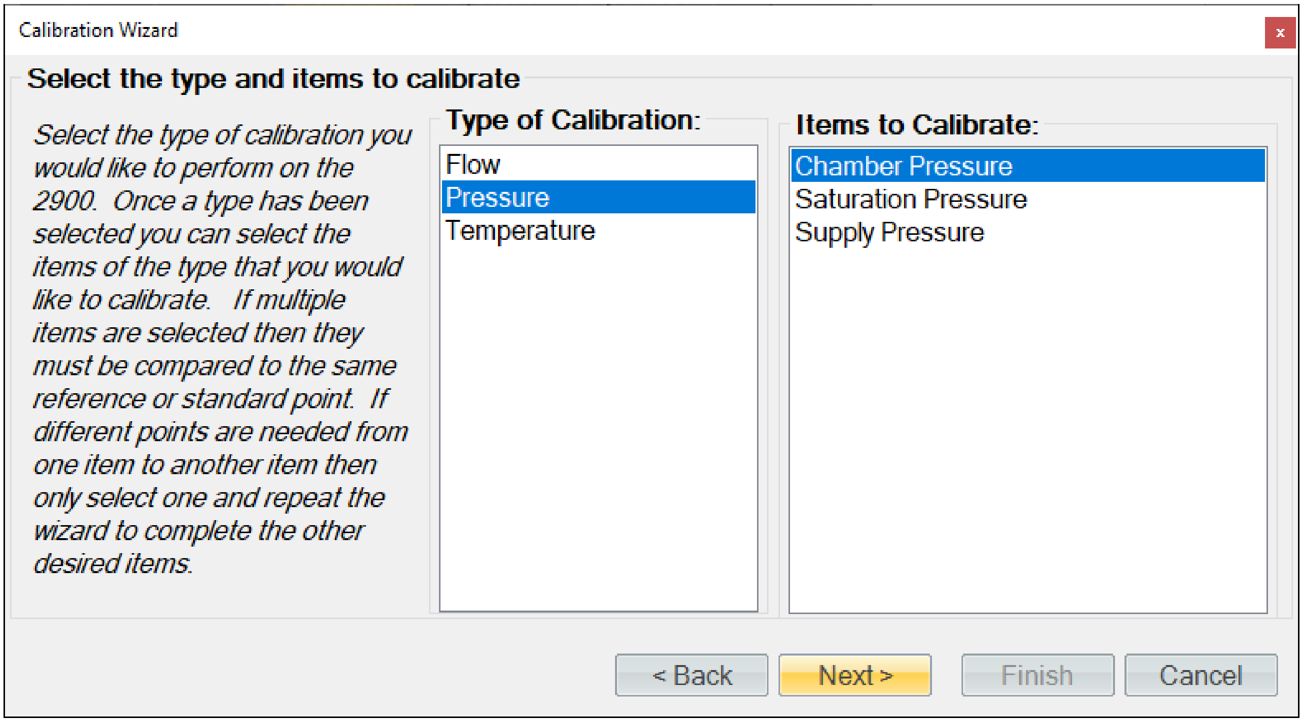
Select Generator Calibration from the Utilities menu tab to open the Calibration Wizard.



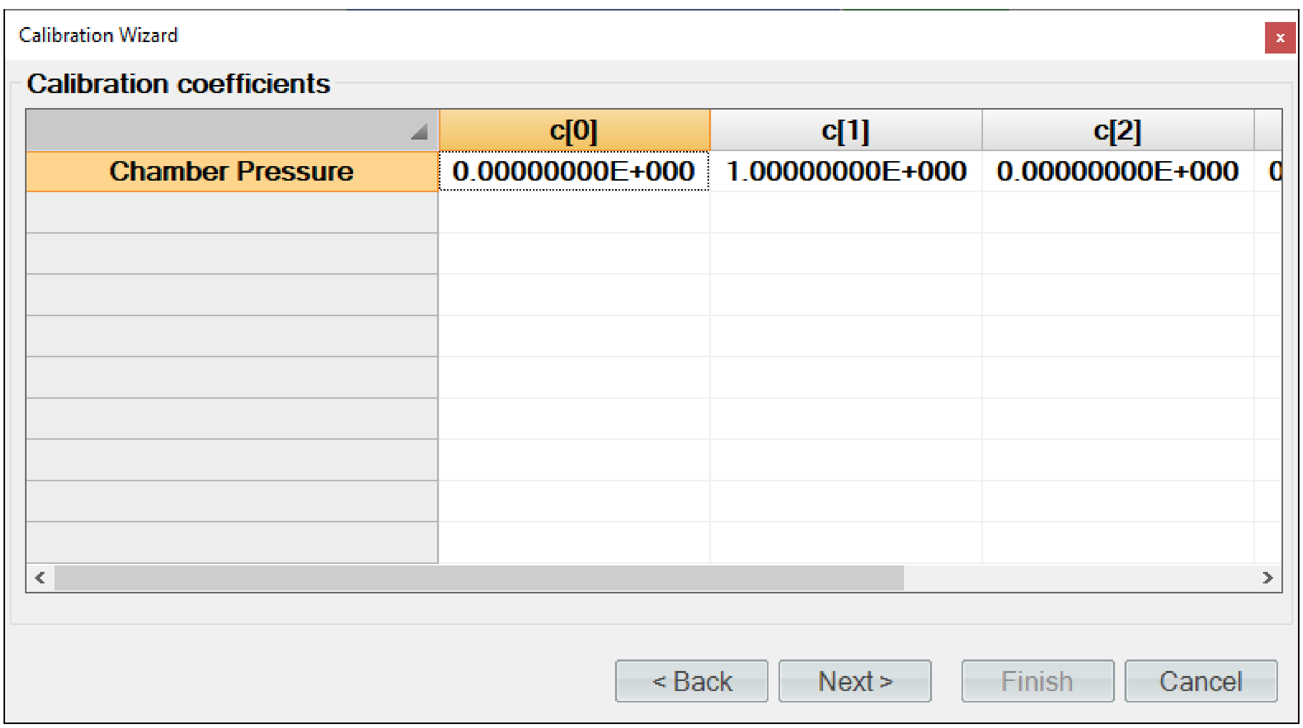
Select View or edit coefficients.



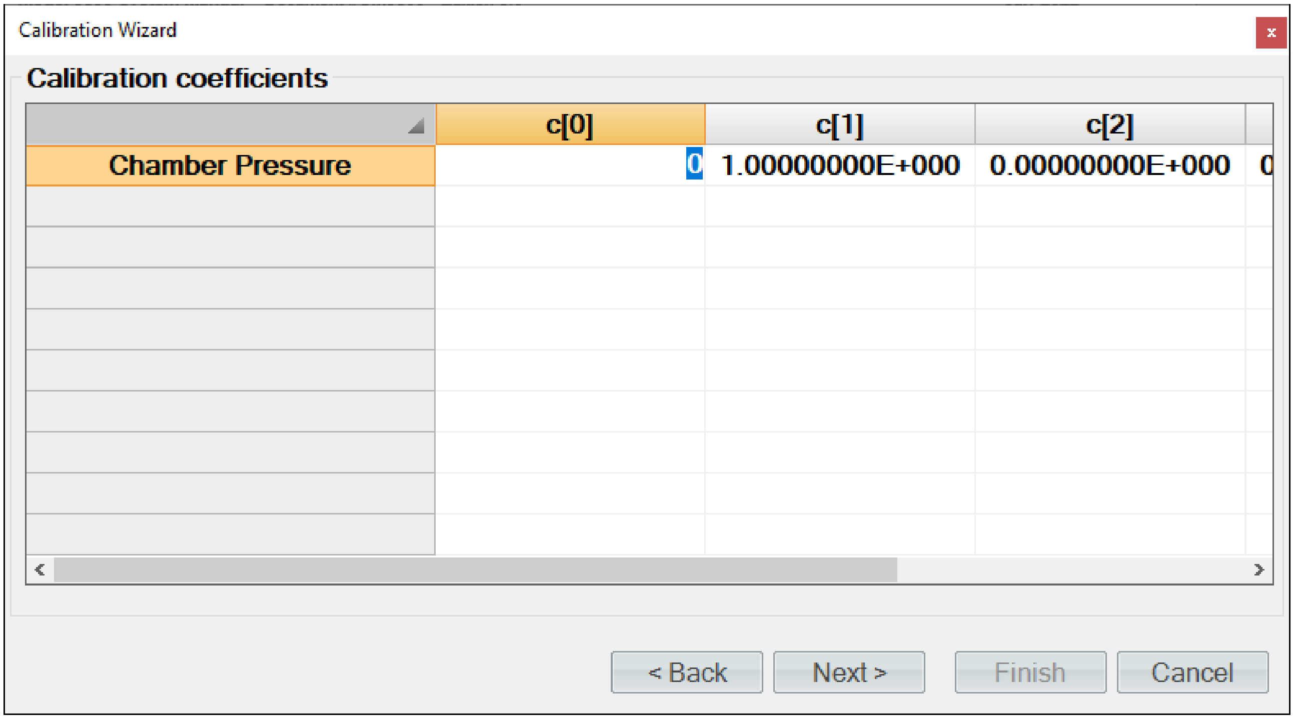
Select the type of calibration and the items for which you wish to view or edit coefficients.



The calibration coefficients are then shown for the selected items.

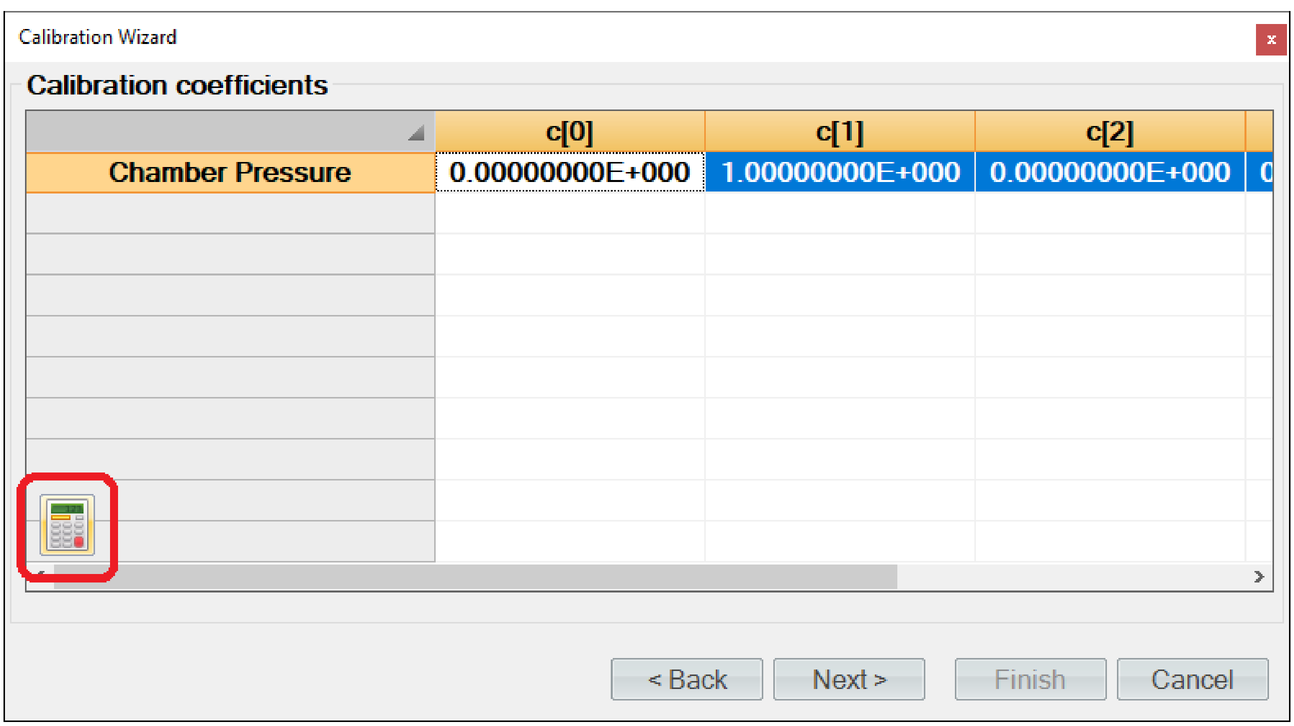


To edit the coefficients, click on the cell of the coefficient you wish to edit and enter a new value using the keyboard.

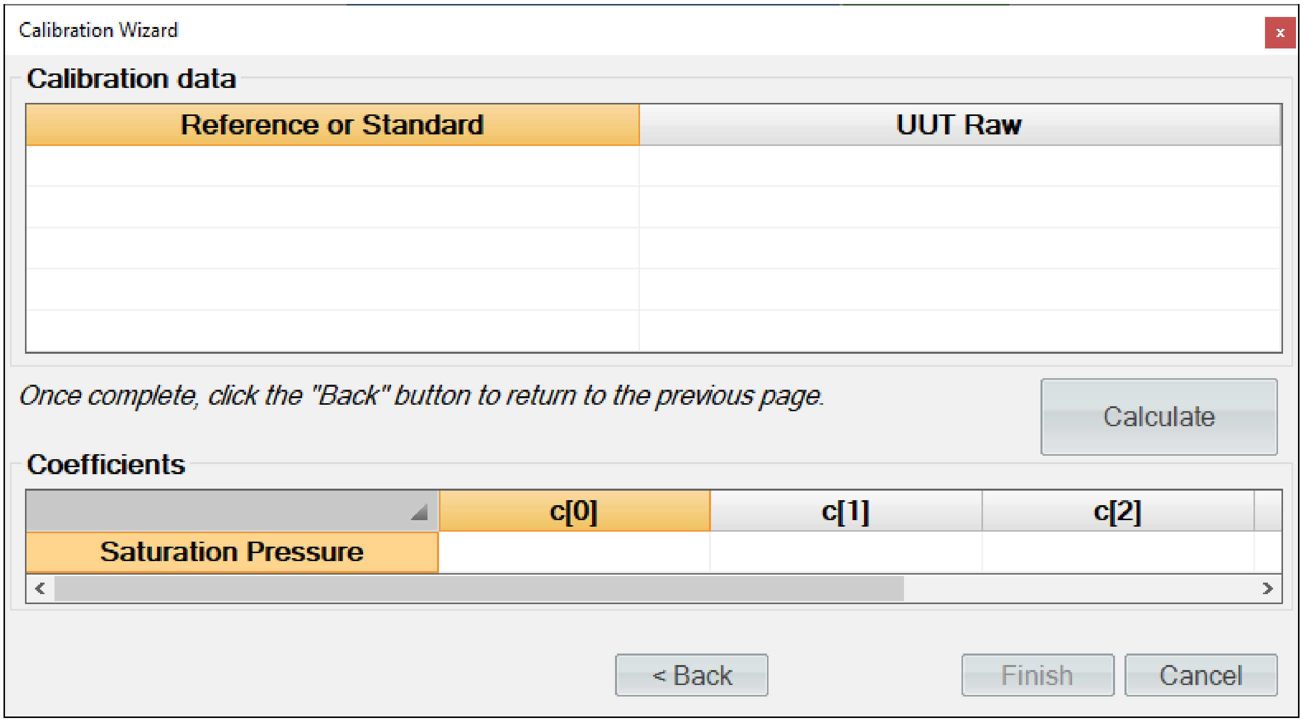


6.4.1 Coefficient Calculator

A Coefficients Calculator is available to help the user generate new coefficients from external calibration data or other calibration data. To open the calculator, select the name of the item you want to calculate coefficients for, and then press the calculator icon in the lower left corner.

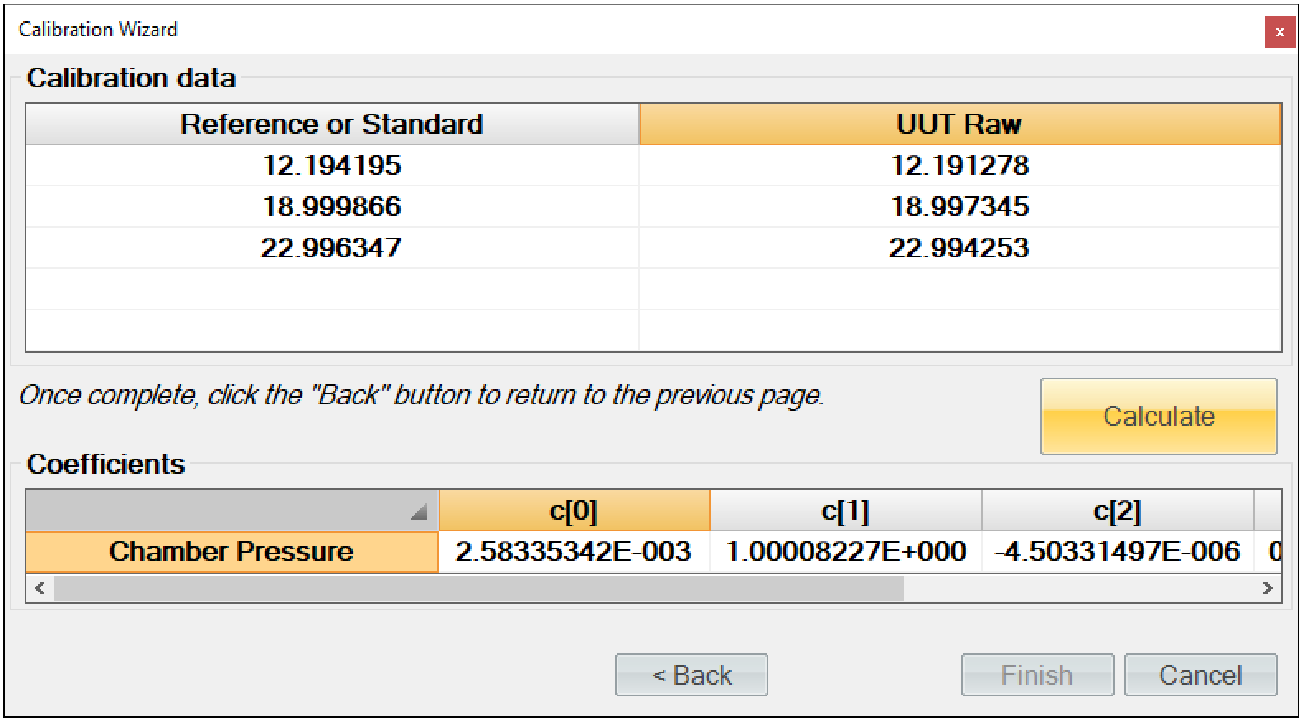


Enter the standards or reference values in the left column and the raw values from the unit under test (UUT) in the right column.

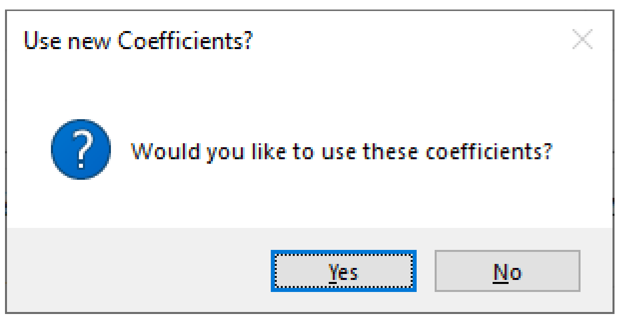


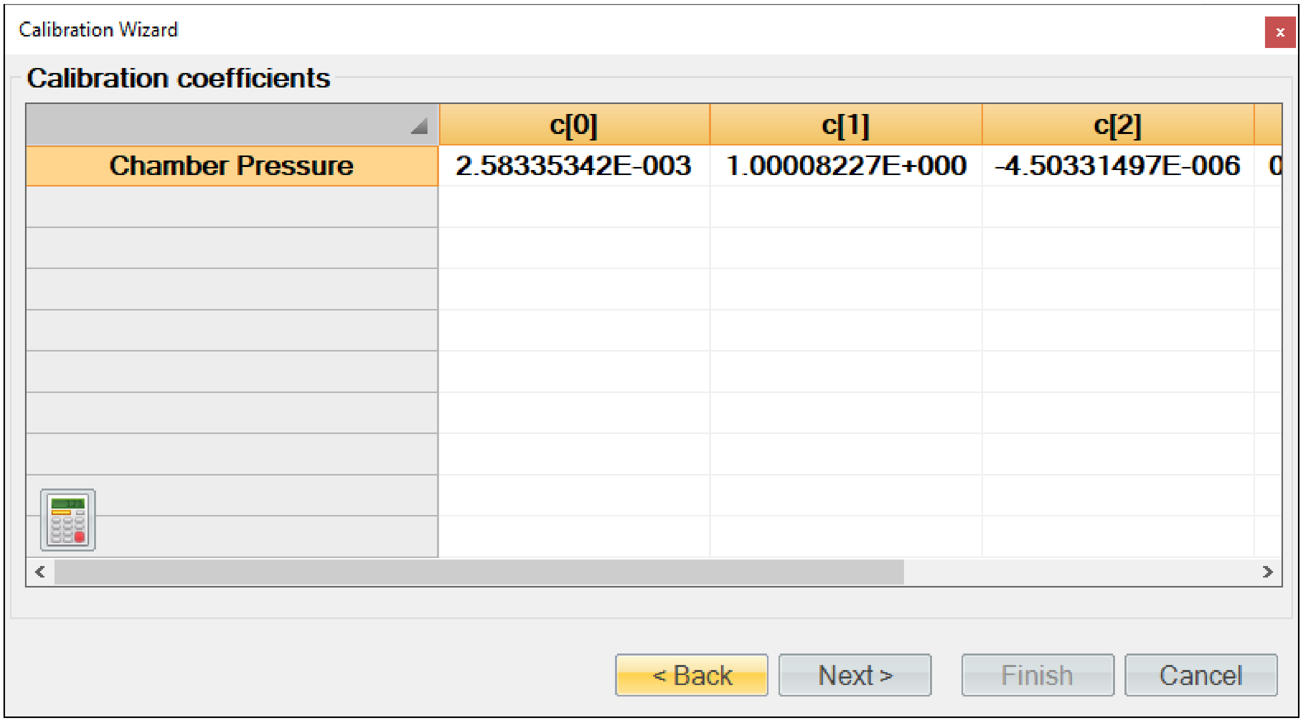
Once the data has been entered, press the "Calculate" button to calculate new coefficients. The system will calculate new coefficients to best match the entered data and will display them at the bottom of the calculator.

> **Note –** *The number of coefficients calculate will be directly proportional to the number of data points entered.*

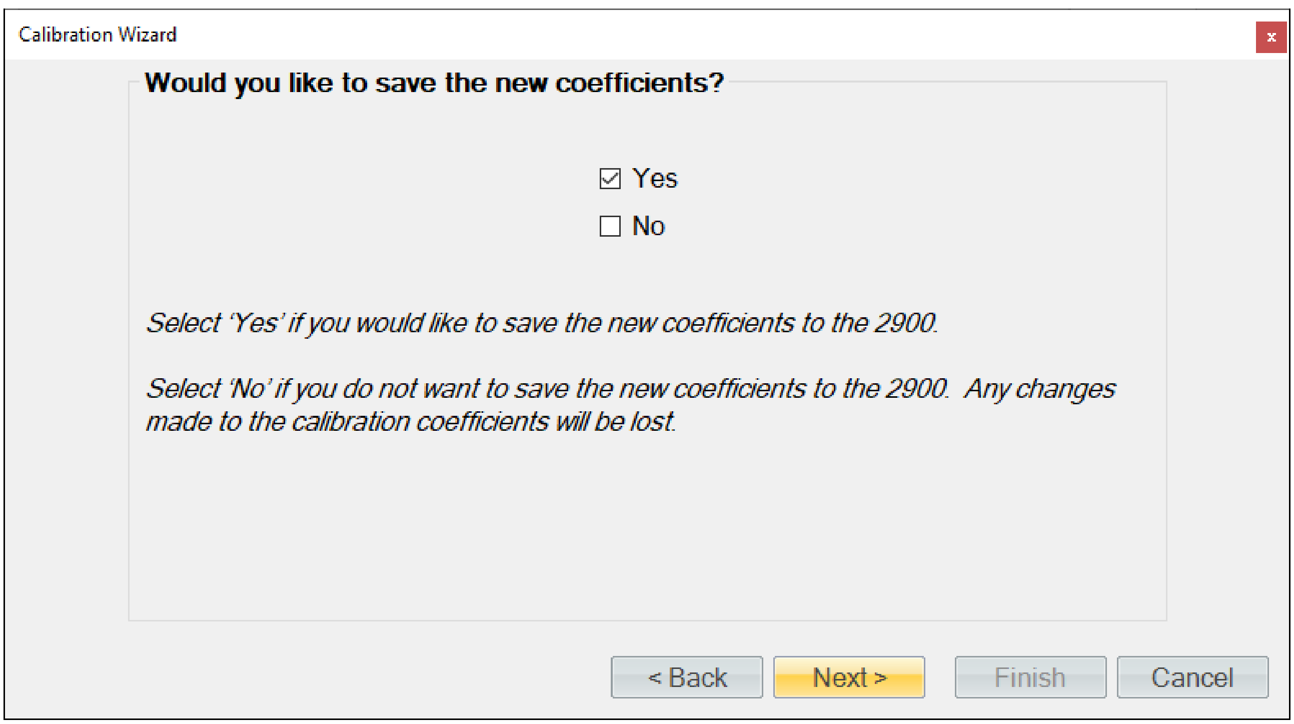


Once satisfied with the calculated coefficient, press the "Back" button. The system will ask if you want to use the newly calculated coefficients. Selecting "Yes" will copy the new coefficients, overwriting the current ones. Choosing "No" will leave the current coefficients unchanged.

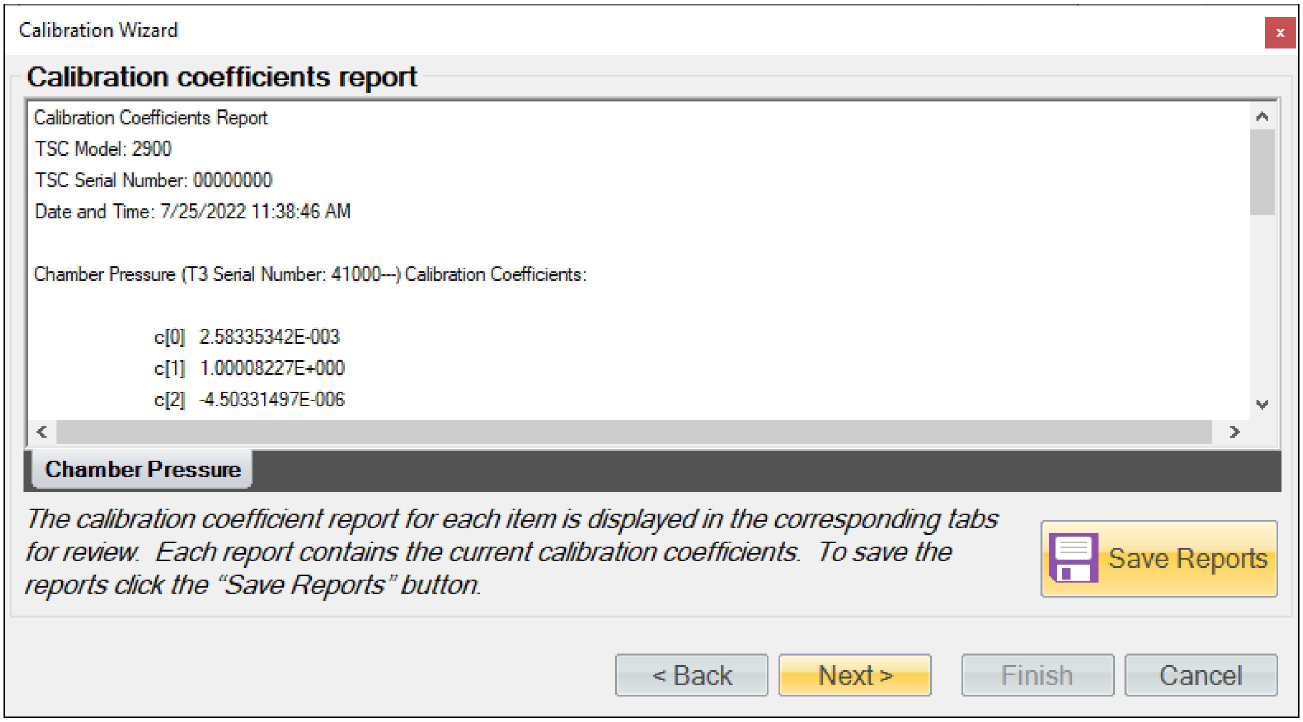




Next, the user is asked to save the new coefficients to the system. Selecting "Yes" results in the current coefficient being over-written by the newly entered or calculated coefficients.



A new calibration coefficients report is generated.



The "Save Reports" button opens a file dialog to save the report. The default file location is …Documents\Thunder Scientific\9500 ControLog\Reports\. If the report is saved in an Excel format, then each probe or transduce appears in its own tab within the workbook. If the report is saved in a pdf or text-based format, then a file for each probe or transducer is created.

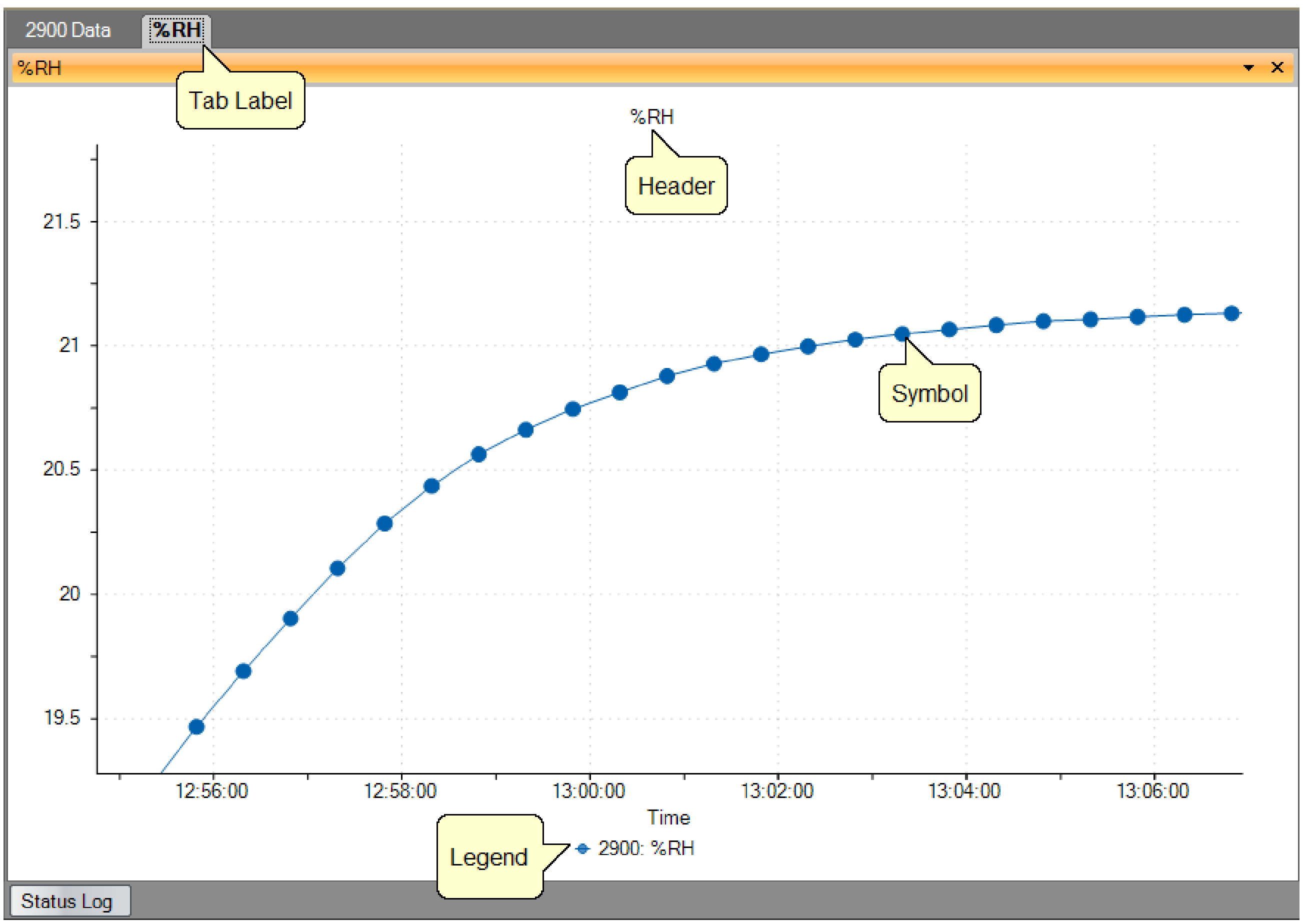
7 GRAPHING

Graphing is a powerful tool for viewing recorded data or monitoring current data in real-time. The graph works hand in hand with the data tabs. While the generator is operating, data tabs store the most recent data points from the connected devices at the desired interval. A graph can be used to create a visual picture of this stored data.

Graph operations can be accessed by two means, either by selecting the desired command from the graph menu at the top or by long-pressing or right-clicking a graph tab and opening a context menu. The functionality of the commands is the same regardless of which method is used, but remember that the menu commands are dynamic and reflect operations that can be performed on the selected graph tab.

> **Note –** *ControLog has a limit of twelve graph tabs opened at any given time.*

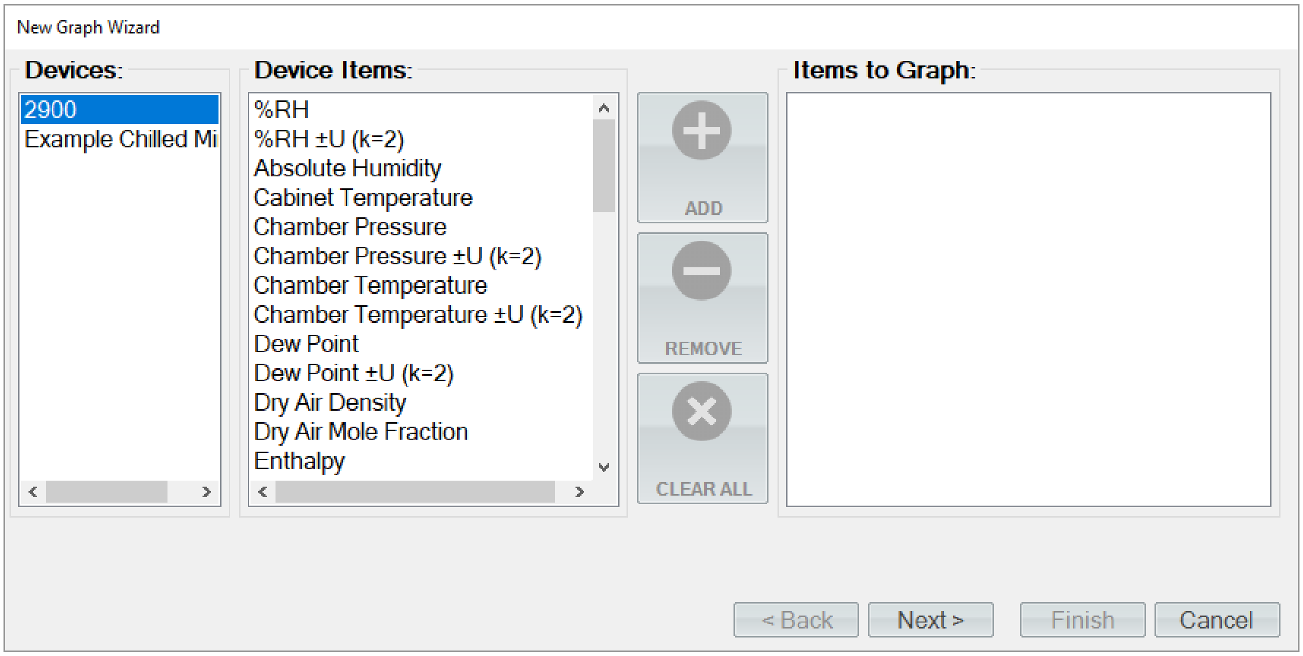
Each graph tab consists of a two-dimension plot across an X and Y-Axis. The graph can be customized to display different point symbols, various line colors, a legend, and a header.



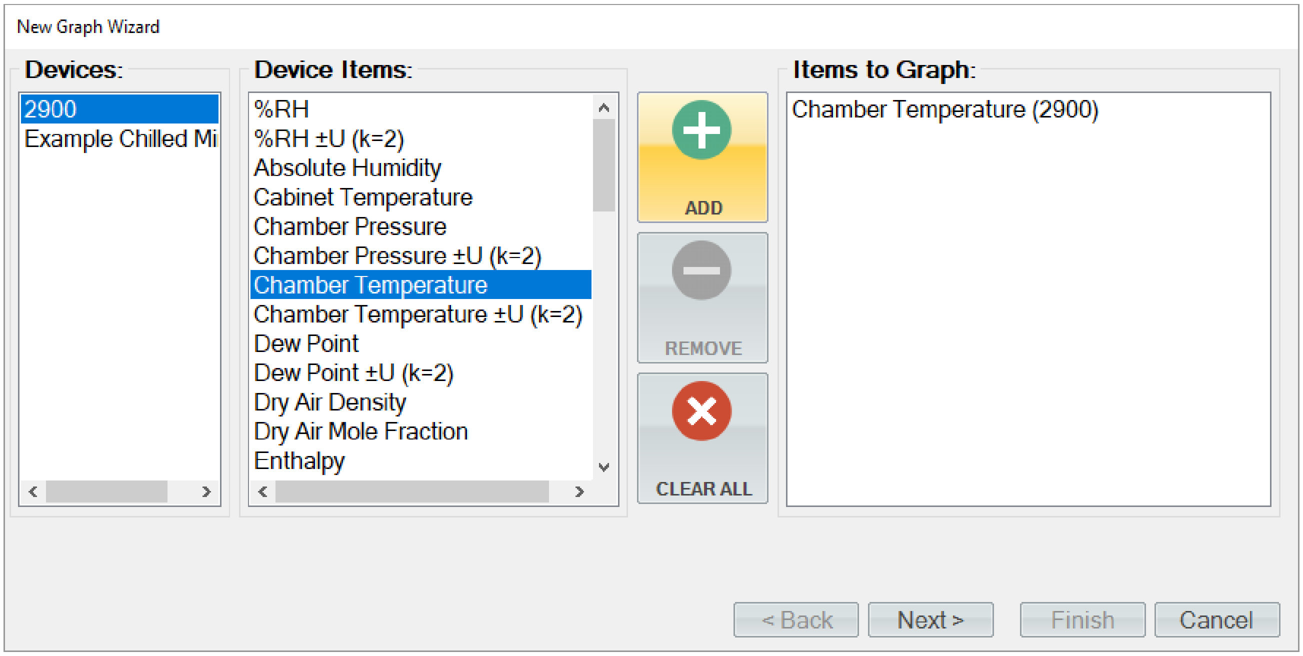
7.1 Creating a New Graph

A new graph can be created using the New Graph Wizard dialog. The wizard walks the user through the selection process of what data they would like to include in the new graph and how it should look. To create a new graph, select “New” from the Home Menu Tab, Graph Menu Tab, or right-click any graph tab and select “New” from its context menu.

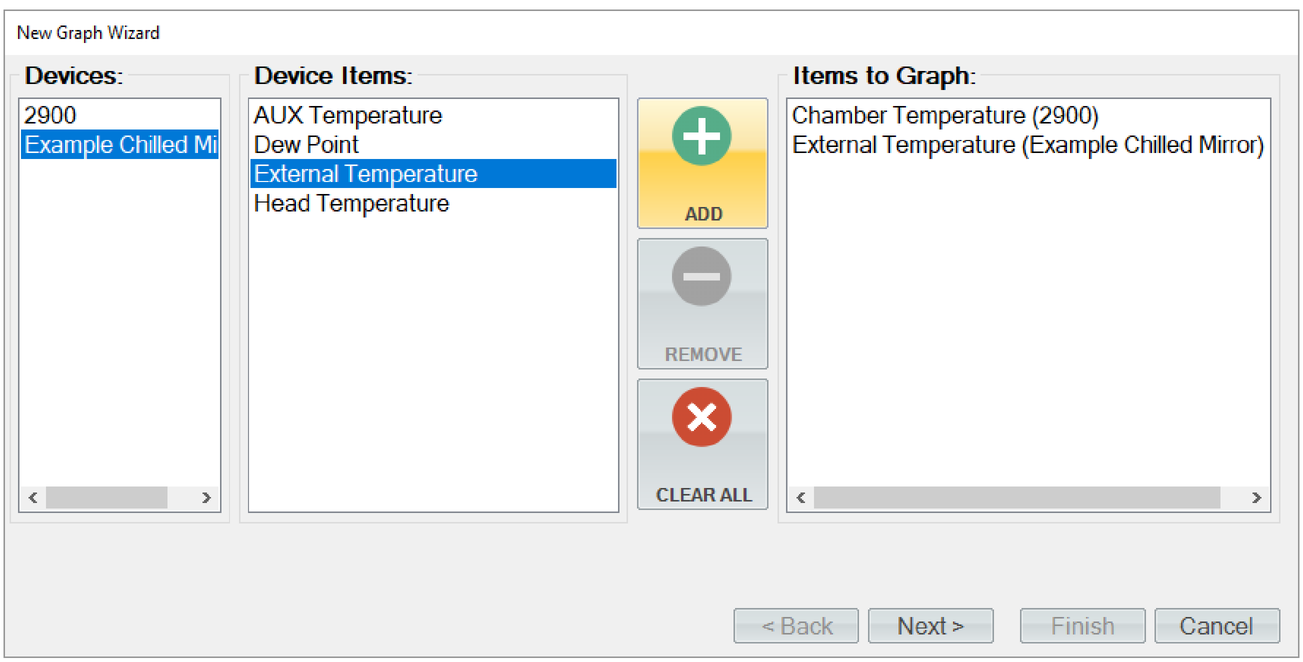
A “New Graph Wizard” dialog appears.



The first page of the New Graph Wizard is where the user selects which device items they would like to include in the graph. On the left-hand side is a list of all available devices. Selecting a device results in the "Device Items" lists being updated to reflect the available items for the selected device. To add an item, highlight the desired item or items in the "Device Items" list and click the "Add" button.

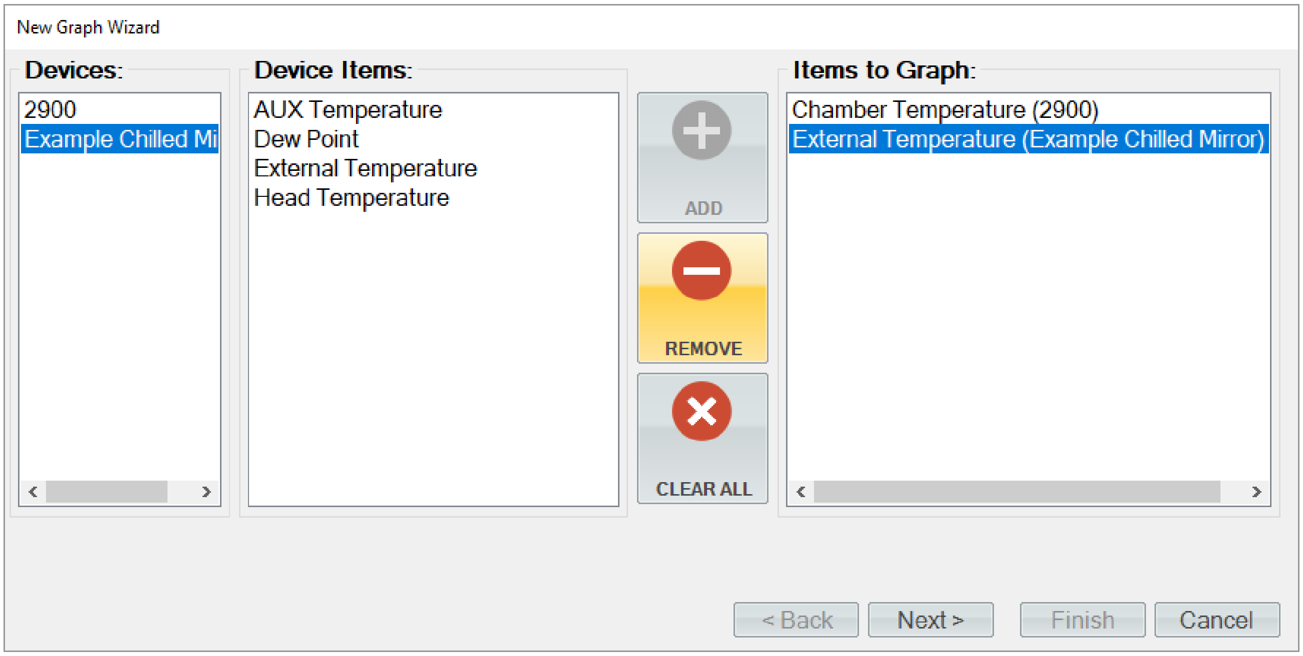


Repeat this process until all the desired items are listed on the right side.

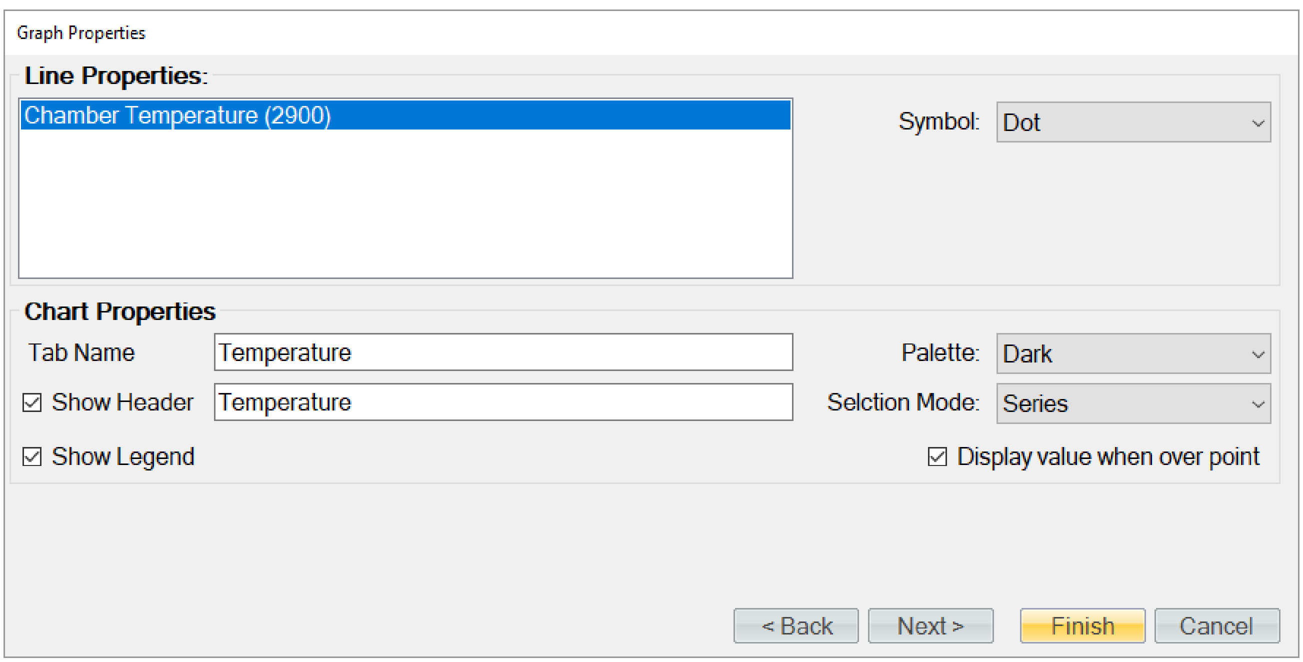


Note – *The user can invert any selection by right-clicking. This highlights all items that are not currently highlighted and removes the highlight from any items that are currently highlighted.*

To remove an item from the list of items to graph, the user can either click the “Clear All” button to remove all items or select the desired item from the “Items to Graph” list and click the “Remove” button.



Once complete, clicking the “Next” button brings up the Properties page. From the properties page, the user can customize the look of each graphed line along with the chart itself.



7.1.1 Line Properties

Line Properties define the color and point symbol for the selected line. Select the desired line from the selection box and set the Color, Symbol, whether to smooth the line or show data labels and how often to show them.

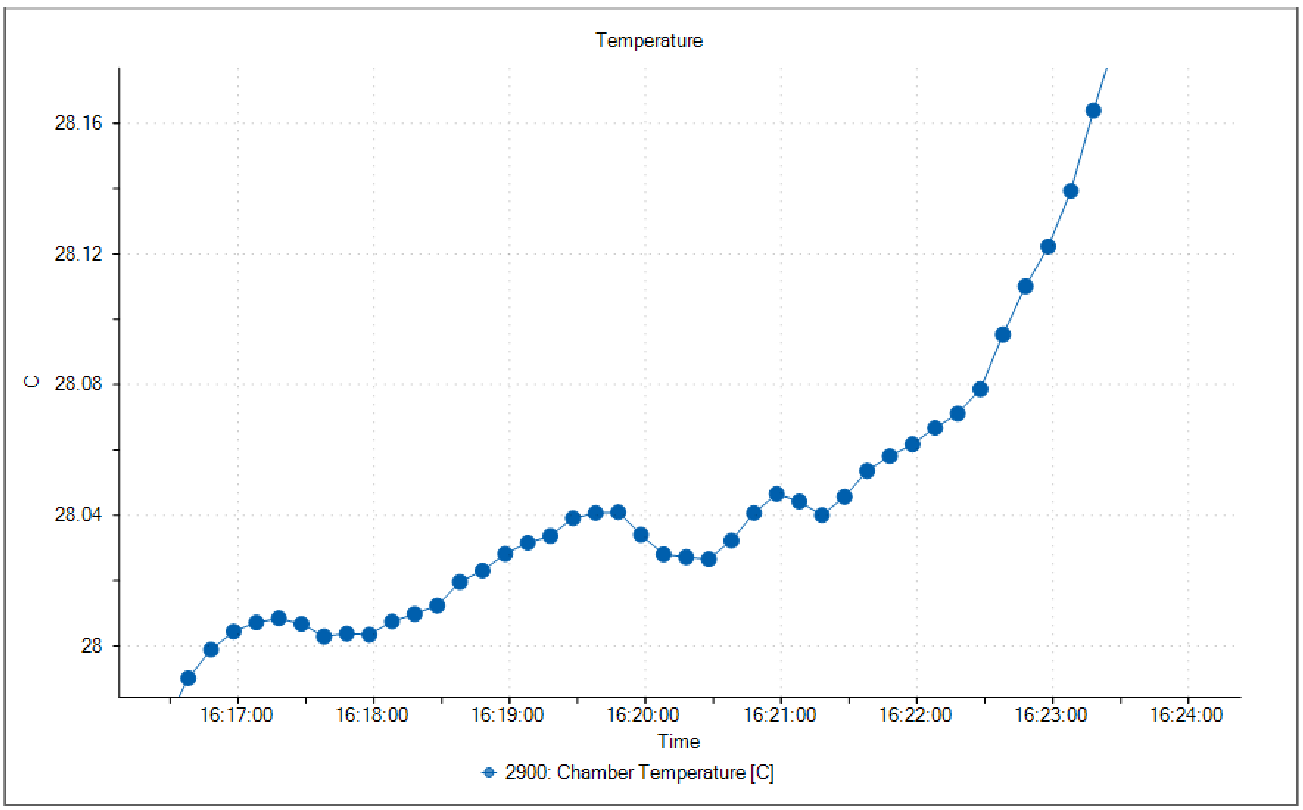
- Symbol defines the symbol drawn at each point. The symbol is the same color as the line and is shown at each data point. To change the symbol, select the desired symbol from the drop-down list.

7.1.2 Chart Properties

Chart Properties define the name of the graph tab, indicate whether to show a header on the graph, and whether to show a legend of the lines plotted.

- Tab Name defines the name of the graph tab. The name the user sees appears in the Data and Graph Tab Group.
- Show Header defines the header that appears at the top of the graph. To add a header to the graph, check the checkbox and enter the desired text description for the header.
- Show Legend defines whether a legend is displayed on the right-hand side of the graph, indicating which colored line is which data item.
- Palette defines the color palette in which the lines are drawn. Select the desired color palette from the drop-down list to change the palette.
- Selection Mode allows the user to highlight different lines within the graph.

Once complete, clicking the “Finish” button displays the new graph in the Data and Graph Tab Group.

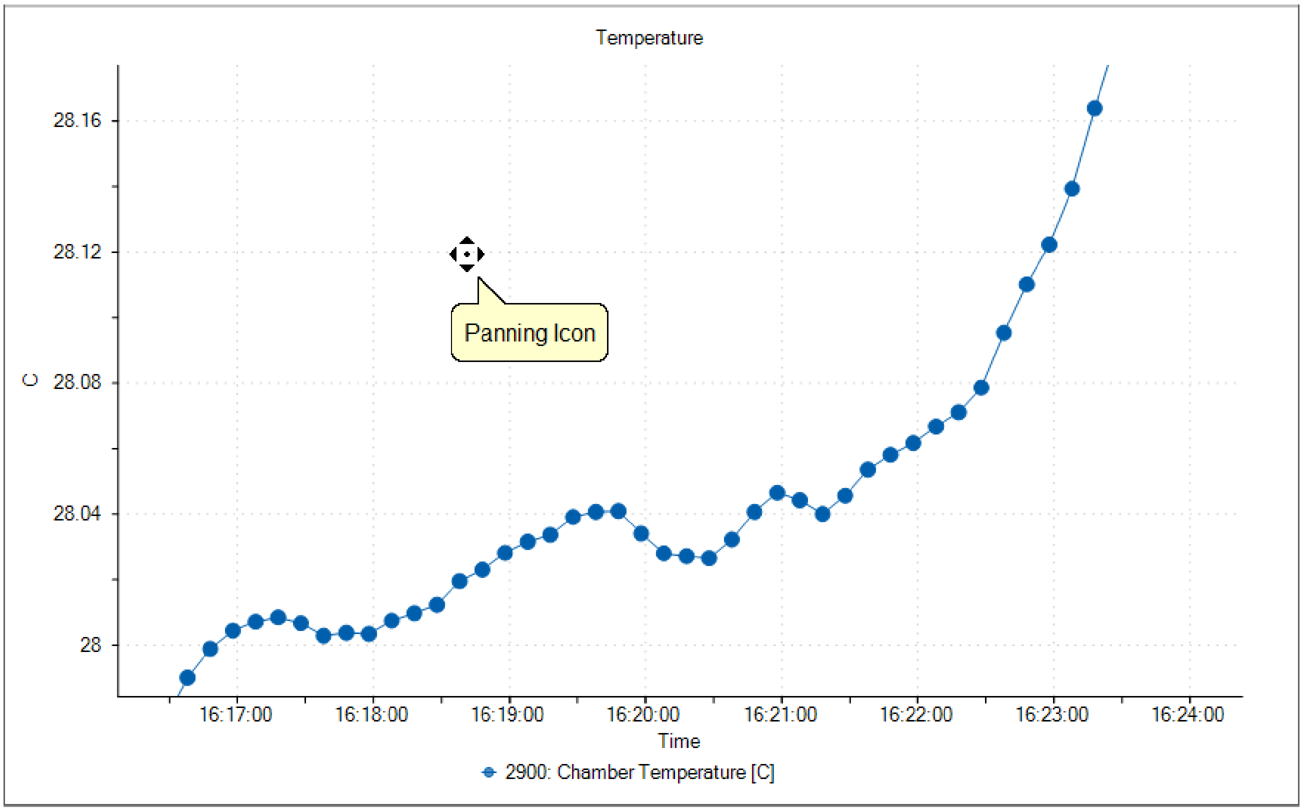


7.2 Customizing a Graph

Each graph tab can be customized to display the data in different means. The user can Pan, Zoom and Scale the graph to the desired appearance.

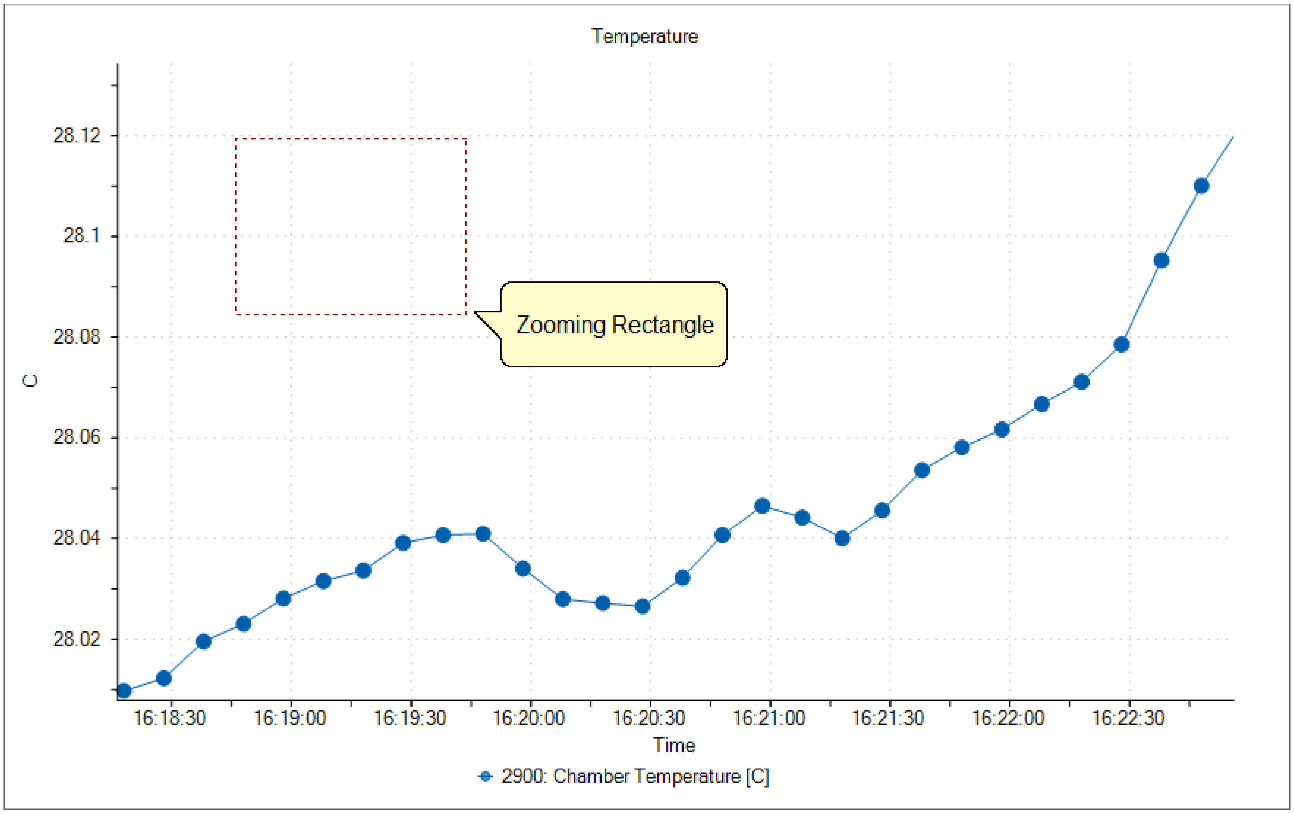
7.2.1 Pan

The graph can be panned up and down and left and right using a left click and hold of the mouse button or a touch gesture while the user moves the cursor around. Panning is useful when you have zoomed in on the graph and want to view different parts of the data without changing the scaling.



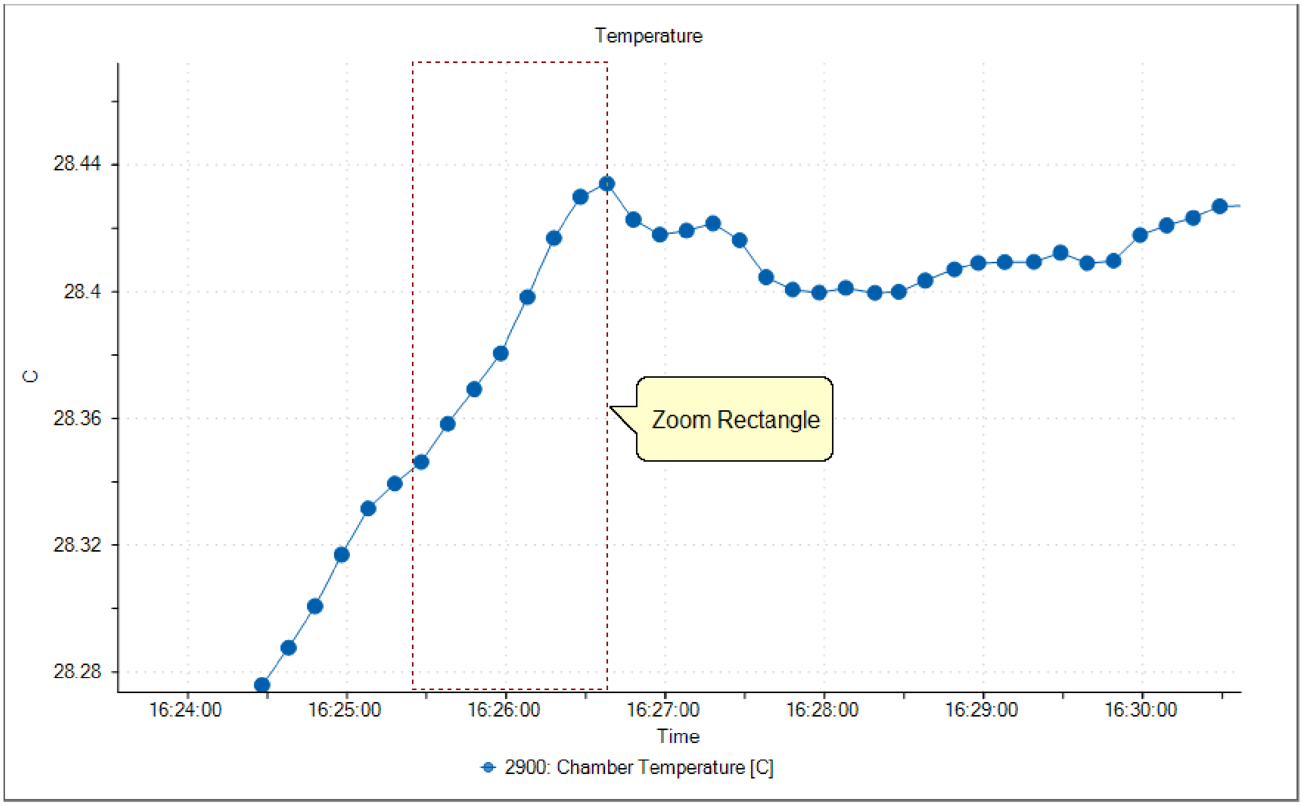
7.2.2 Zoom

The user can select to zoom the graph from the Graph Menu Tab or by using a "pinch" gesture. Using the cursor, left click and drag to create a box around the portion to zoom and release the left mouse button. The portion of the graph within the drag box expands to fill the entire graph. The time and Y-axis limits update accordingly.



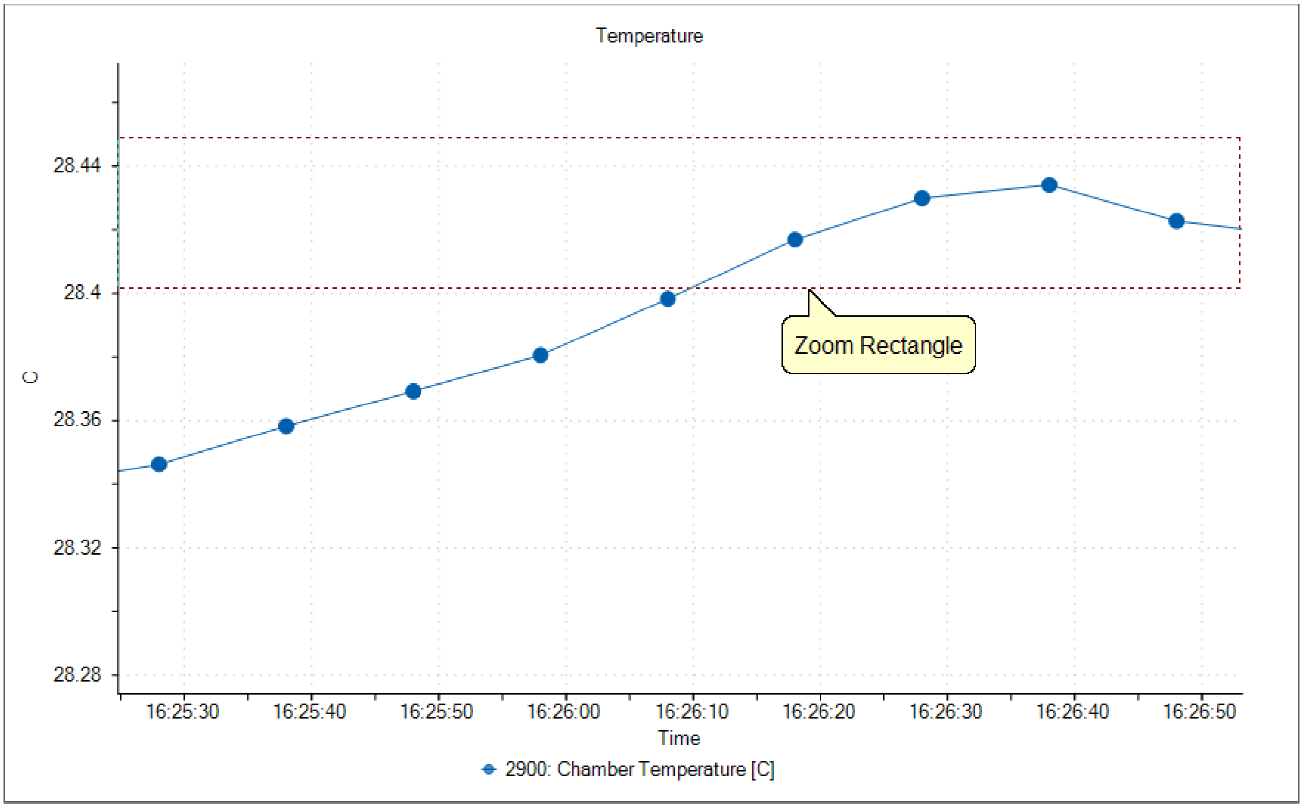
7.2.3 Zoom Graph's X-Axis

The user can select to zoom the X-axis of the graph from the Graph Menu Tab. Using the cursor, left-click on the graph and drag the cursor so that the portion of the X-axis (time axis) of interest is contained within the two vertical dashed lines. The portion contained within this region expands to fill the entire X-axis. The Y-axis remains unchanged.



7.2.4 Zoom Graph's Y-Axis

The user can select to zoom the Y-axis of the graph from the Graph Menu Tab. Using the cursor, left-click on the graph and drag the cursor so that the portion of the Y-axis of interest is contained within the two horizontal dashed lines. The portion contained within this region expands to fill the entire Y-axis. The X-axis remains unchanged.



7.2.5 Auto Scale

Selecting the Auto Scale command automatically resets both axes of the graph, so the entire data set for each selected item is contained within the boundaries of the graph.

7.2.6 Scale

The Scale command allows the user to scale the X and Y-axis. Dragging the cursor up scales the display in (zooms in), and dragging the cursor down scales the display out (zoom out).

7.2.7 Scale X-Axis

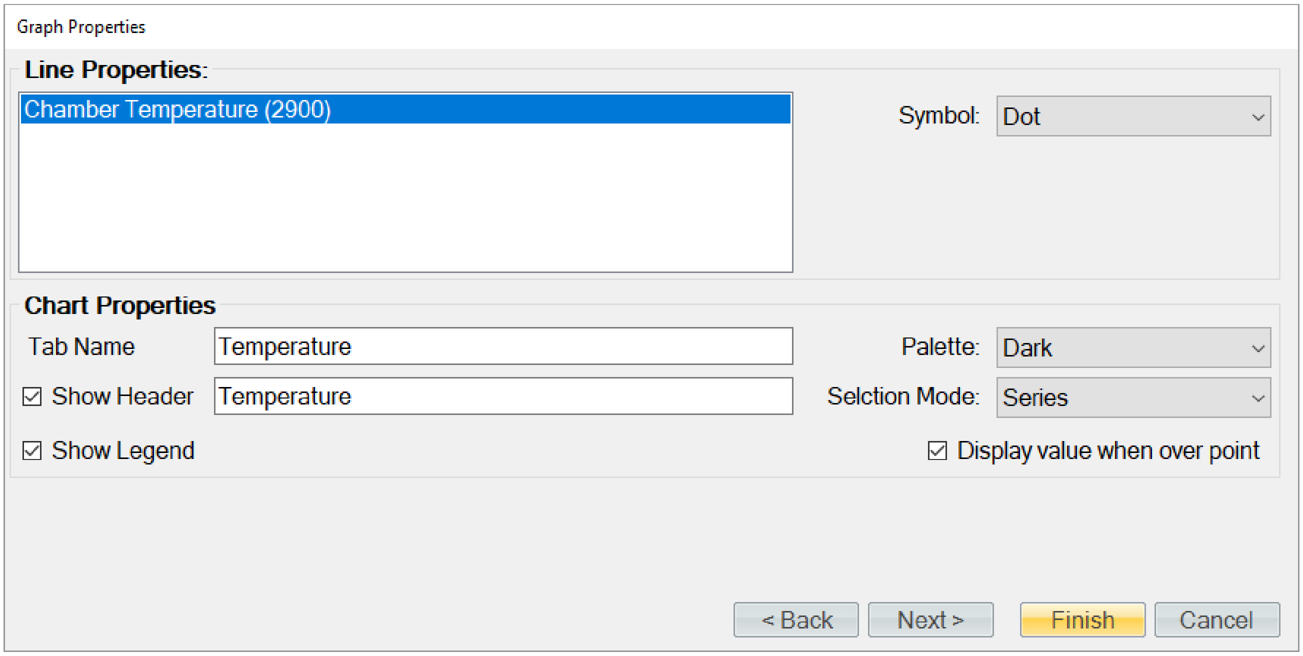
The Scale X-Axis command allows the user to scale the X-axis. Dragging the cursor up scales the X-Axis in (zooms Y-Axis in), and dragging the cursor down scales the X-Axis out (zooms X-Axis out).

7.2.8 Scale Y-Axis

The Scale Y-Axis command allows the user to scale the Y-axis. Dragging the cursor up scales the Y-Axis in (zooms Y-Axis in), and dragging the cursor down scales the Y-Axis out (zooms Y-Axis out).

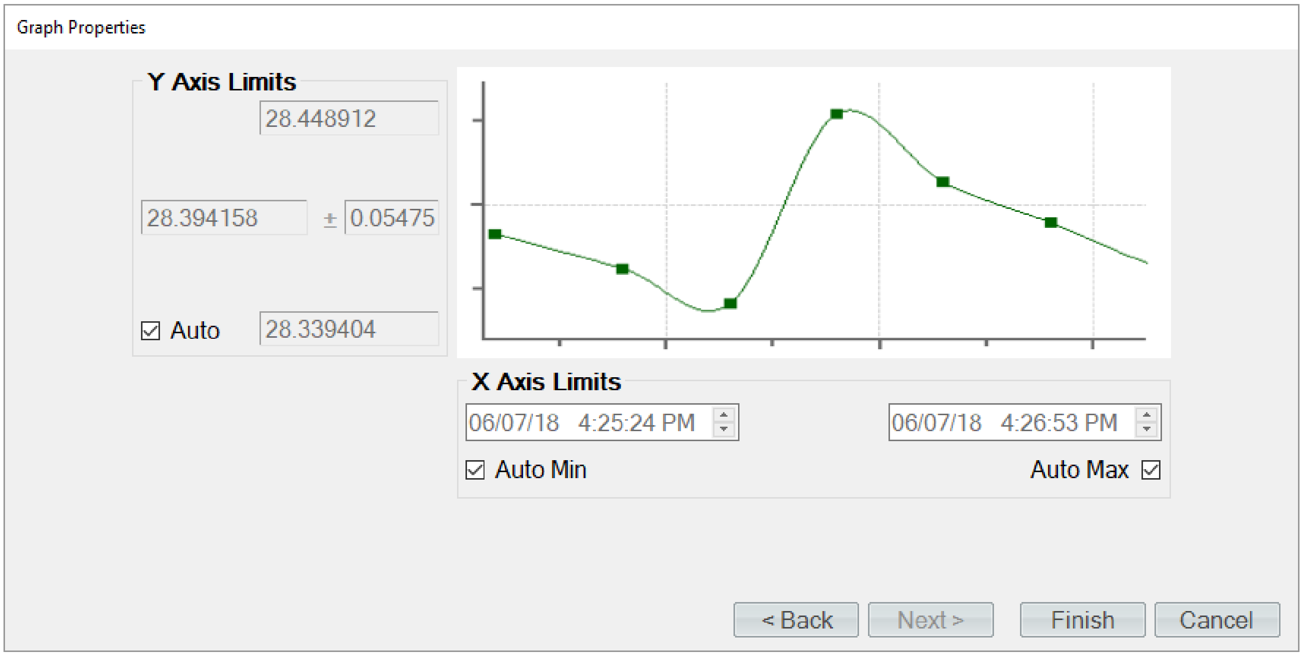
7.2.9 Graph Properties

The Graph Properties command allows the user to modify the properties of the selected graph. Selecting the command opens the Graph Properties dialog that allows the user to change what data is graphed, line properties, and axis values.



The first two pages of the Graph Properties dialog are the same as the New Graph Wizard used to create new graphs. The Graph Properties dialog starts on the properties page, from which the user can customize the look of each graphed line and the chart itself. Clicking the "Back" button moves back to the data selection page, where the user can select which device items they want to include in the graph.

Clicking the "Next" button moves to the Axis page, where the user can specify the starting and ending X and Y-axis values.



7.2.9.1 Y-Axis Limits

The Y-Axis Limits define the Y-Axis's maximum, minimum, middle, and span values.

- The Maximum value defines the maximum Y value for the Y-Axis. No values beyond this maximum are displayed on the graph.
- The Minimum value defines the minimum Y value for the Y-Axis. No values below this minimum are displayed on the graph.
- The Middle value defines the middle Y value for the Y-Axis.
- The Span value defines the amount above and below the middle value where the maximum and minimum Y values lie.
- The Auto check box tells ControLog to automatically calculate the best Y-Axis limits to encompass the current data.

  Note – *The maximum, minimum, middle, and span values are interrelated, and changing any one value may result in another value automatically changing to ensure all values mathematically equate.*

7.2.9.2 X-Axis Limits

The X-Axis Limits define the maximum and minimum values for the X-Axis.

- The Minimum value defines the minimum date and time for the X-Axis. No values below this minimum date and time are displayed on the graph.
- The Auto Min check box tells ControLog to automatically use the starting date and time for the current data as the X-Axis minimum.
- The Maximum value defines the maximum date and time for the X-Axis. No values above this maximum date and time are displayed on the graph.
- The Auto Max check box tells ControLog to automatically use the last date and time for the current data as the X-Axis maximum. The graph constantly expands as new data points are recorded.

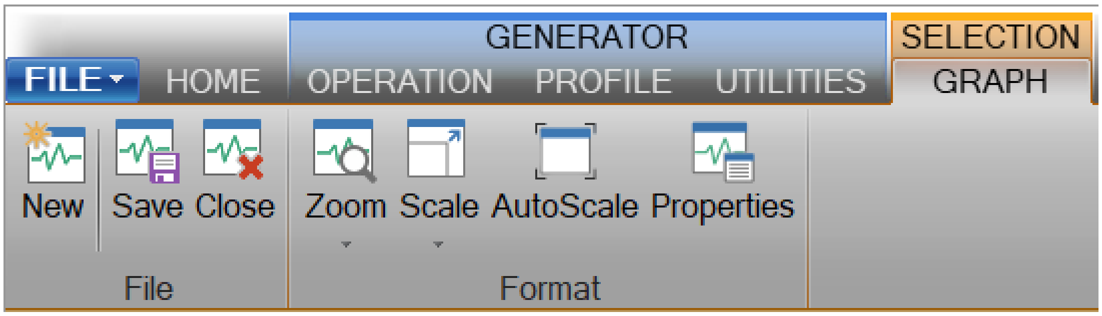
Once complete, clicking the “Finish” button displays the graph in the same tab with the new property settings.

7.3 Saving a Graph

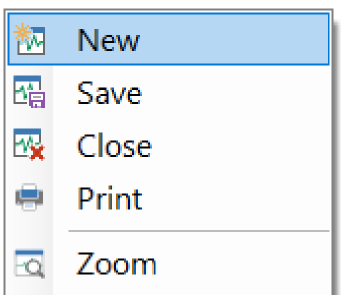
Each graph tab can be saved to a file in any of the following graphic file types:

- Joint Photographic Experts Group (*.jpg)
- W3C Portable Network Graphics (*.png)
- Scalable Vector Graphics (*.svg)

To perform the save, select "Save" from the graph menu tab or right-click a graph and select "Save."

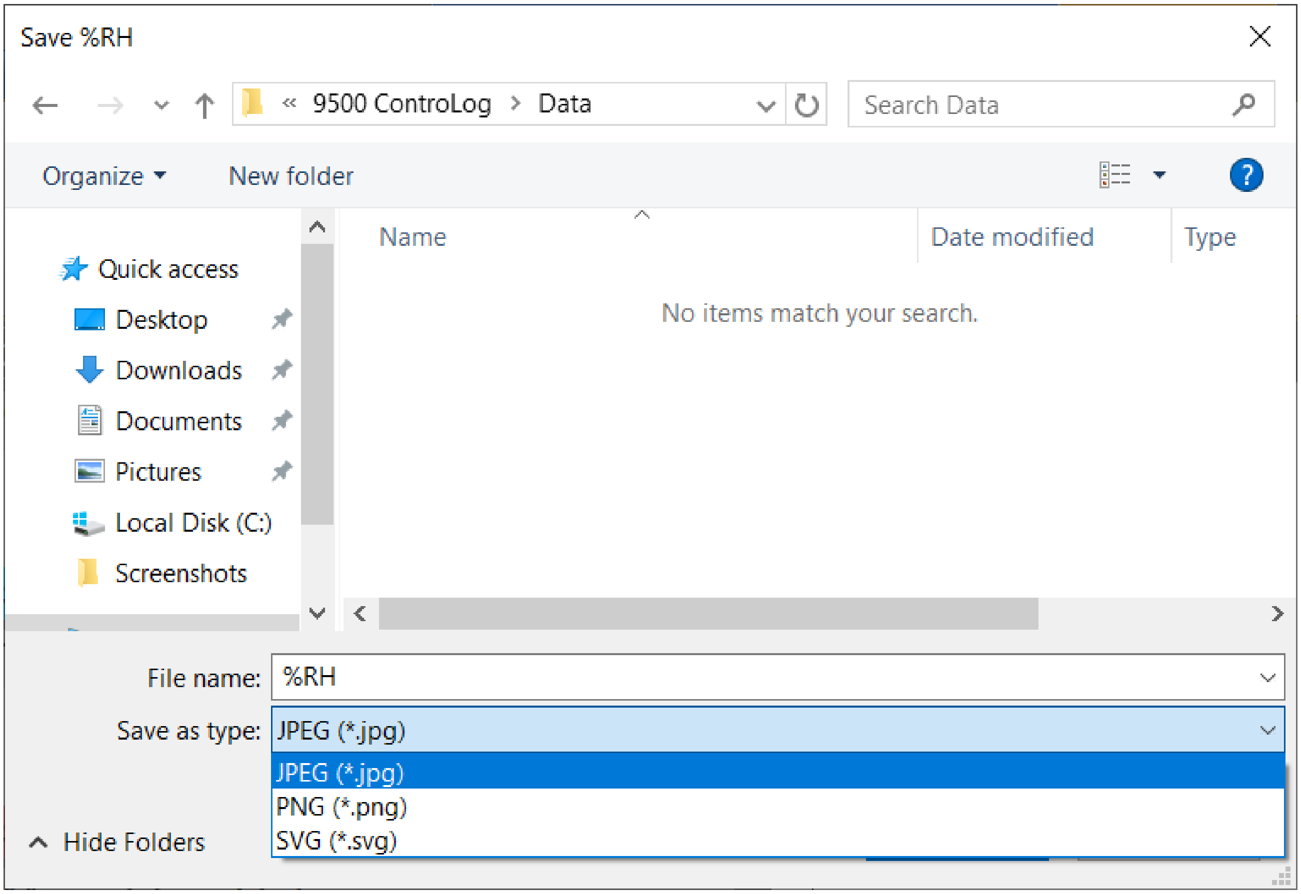


Or



Using the “Save” dialog, select the location, name, and graphic type you want to save the graph as.

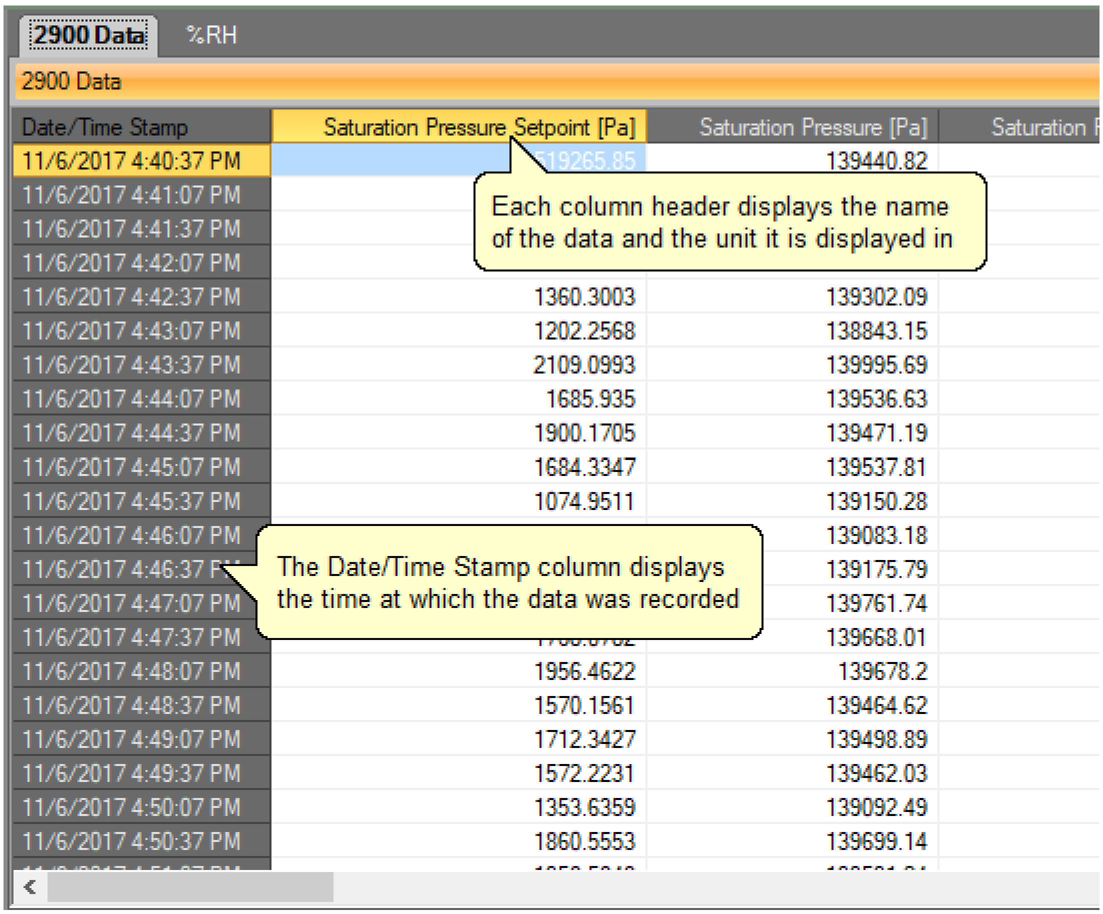
Note – *ControLog defaults the file name to the name of the graph tab.*



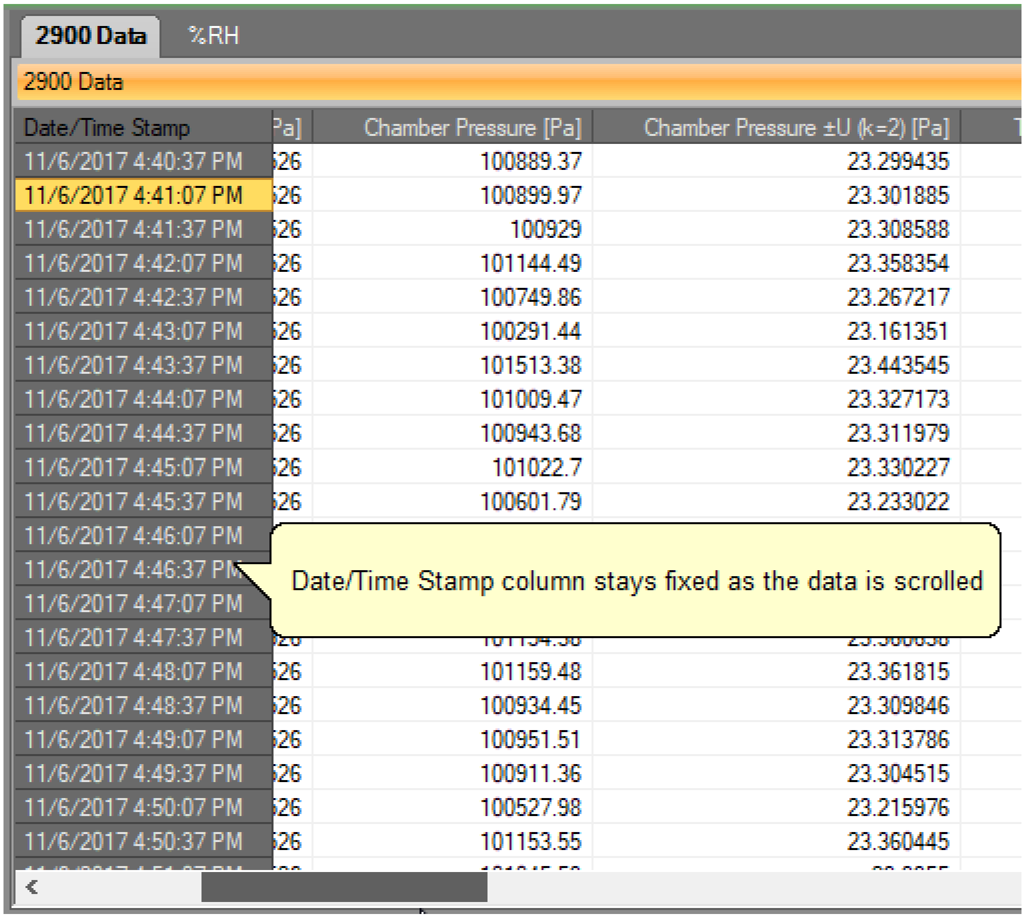
8 DATA AND DATA SUMMARY

ControLog stores data into individual Data Tabs. Each data tab contains a spreadsheet-type view that consists of a date/time stamp and the measured data items corresponding to that date/time stamp. Data tabs consist of three similar but different types: Device Data, File Data, and Data Summary. Each type has the same spreadsheet view and operation, but all three have different data sources.

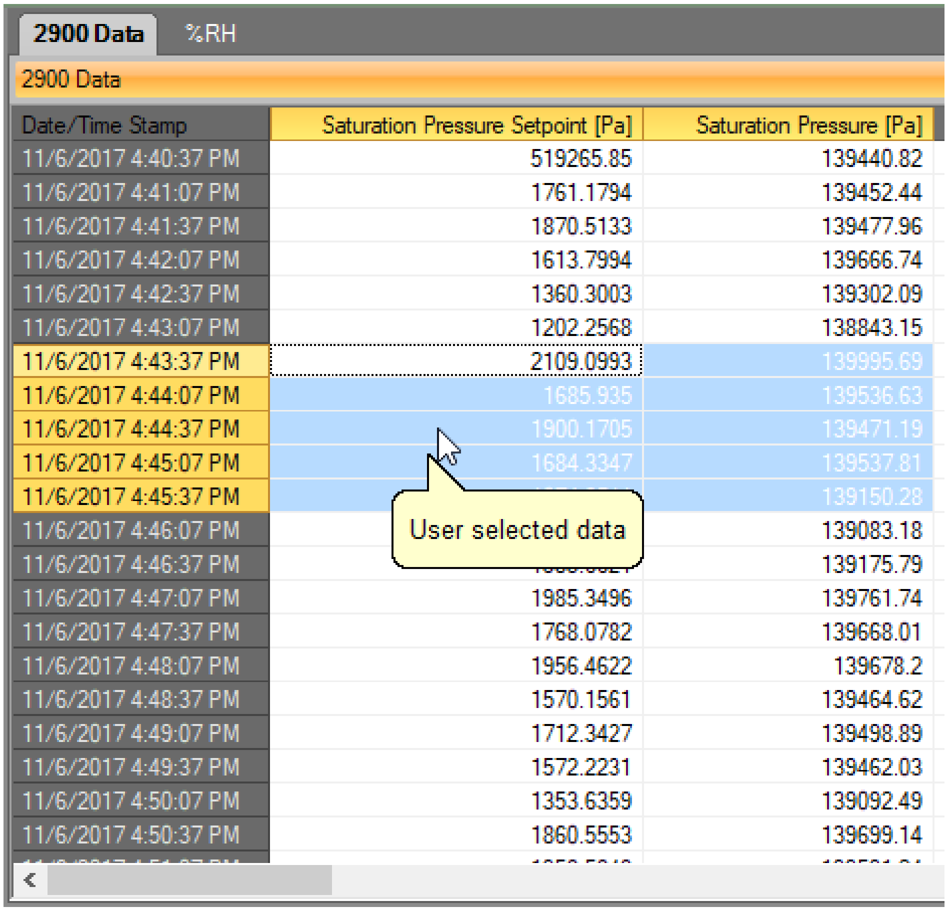
> **Note** – *The data tab data is always stored in SI units regardless of the current system unit settings. The only exception is for Data Summary tabs which are created using currently selected system units but will not update on further unit changes.*



The user can navigate through the data using the scroll bars.

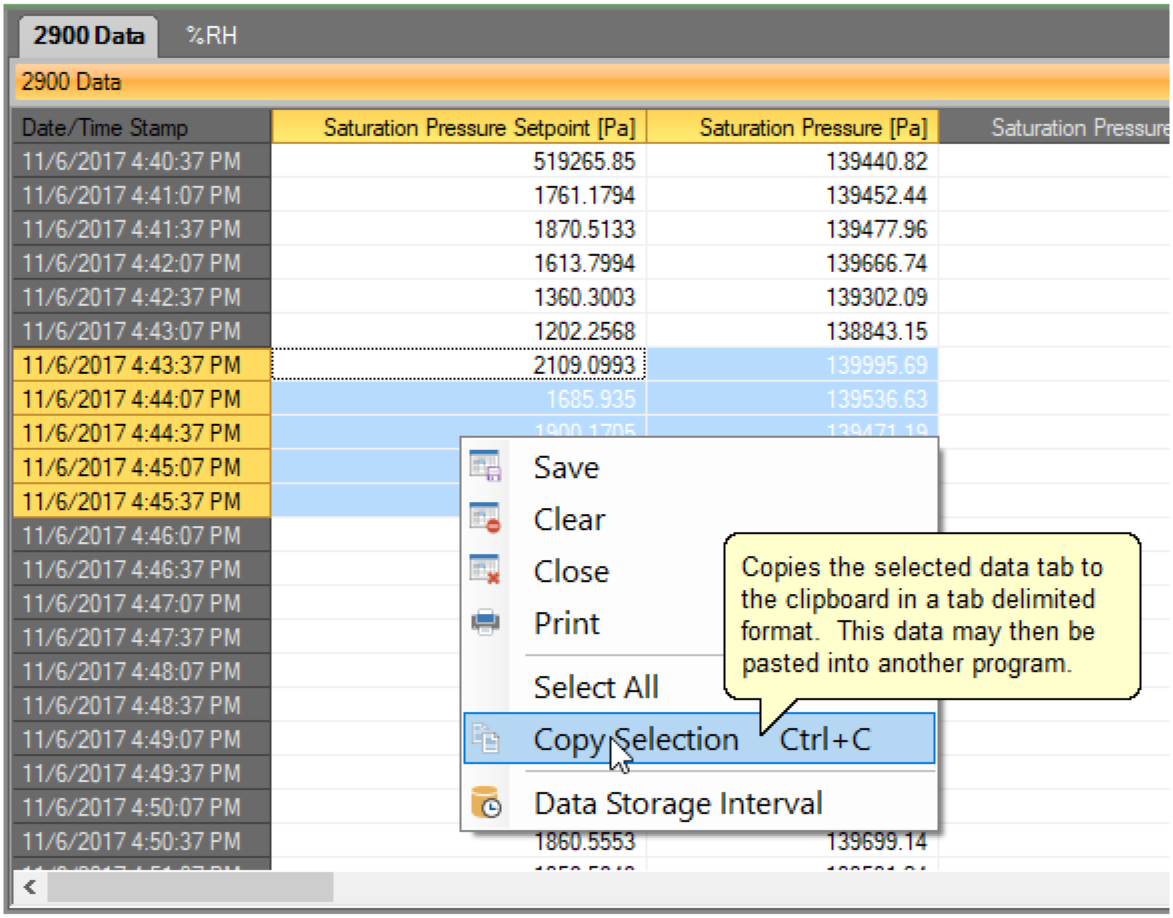


The user can also select specific data by clicking and dragging the desired cells.



Date/Time Stamp	Saturation Pressure Setpoint [Pa]	Saturation Pressure [Pa]
11/6/2017 4:40:37 PM	519265.85	139440.82
11/6/2017 4:41:07 PM	1761.1794	139452.44
11/6/2017 4:41:37 PM	1870.5133	139477.96
11/6/2017 4:42:07 PM	1613.7994	139666.74
11/6/2017 4:42:37 PM	1360.3003	139302.09
11/6/2017 4:43:07 PM	1202.2568	138843.15
11/6/2017 4:43:37 PM	2109.0993	139995.69
11/6/2017 4:44:07 PM	1685.935	139536.63
11/6/2017 4:44:37 PM	1900.1705	139471.19
11/6/2017 4:45:07 PM	1684.3347	139537.81
11/6/2017 4:45:37 PM	[illegible]	139150.28
11/6/2017 4:46:07 PM	[illegible]	139083.18
11/6/2017 4:46:37 PM	[illegible]	139175.79
11/6/2017 4:47:07 PM	1985.3496	139761.74
11/6/2017 4:47:37 PM	1768.0782	139668.01
11/6/2017 4:48:07 PM	1956.4622	139678.2
11/6/2017 4:48:37 PM	1570.1561	139464.62
11/6/2017 4:49:07 PM	1712.3427	139498.89
11/6/2017 4:49:37 PM	1572.2231	139462.03
11/6/2017 4:50:07 PM	1353.6359	139092.49
11/6/2017 4:50:37 PM	1860.5553	139699.14

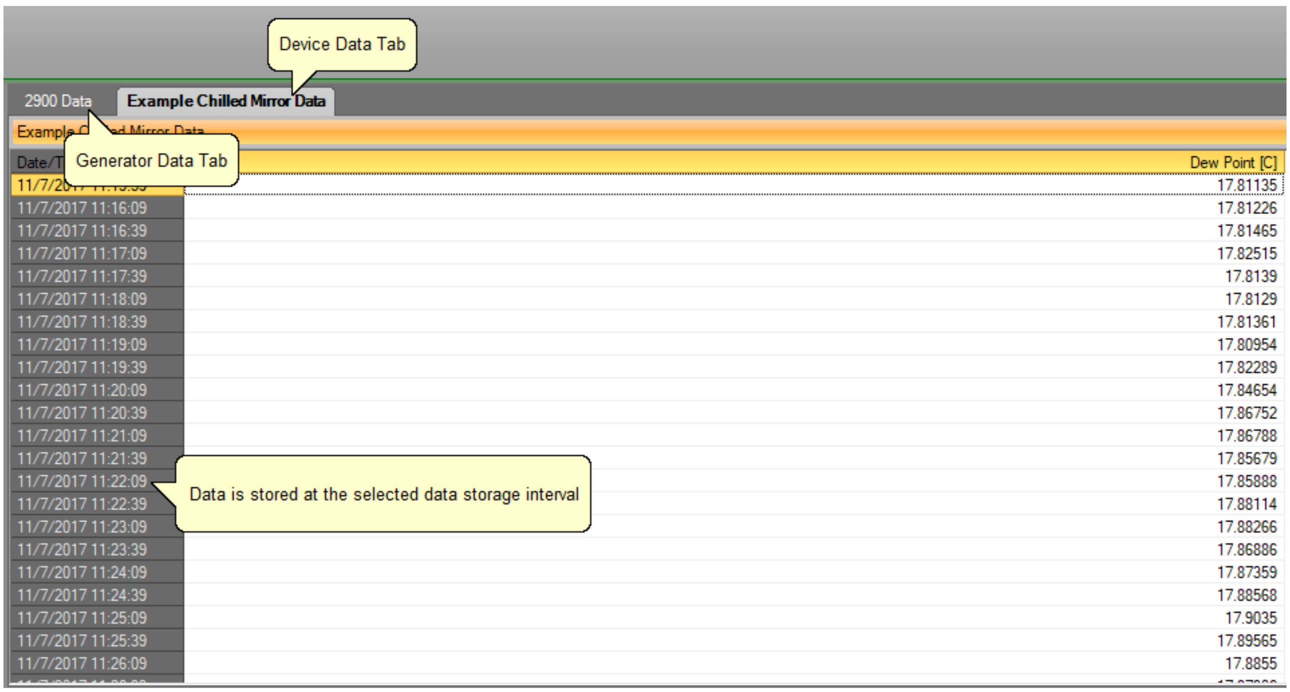
The user can copy selected data to the clipboard by selecting “Copy Selection” from the context menu or using the keyboard shortcut combination of Crtl+C.



8.1 Device Data Tabs

The Device Data Tabs contain stored data values from the connected generator or device. After establishing communication with the generator or device, an individual data tab for the device is created. These tabs store the data readings from the connected device at the specified data storage interval.

> **Note** – *Data is only recorded while the 9500 is in generate mode. Data is stored at the generate rate whenever a device is connected, and the 9500 is not connected. This allows the user to use ControLog as a logging application for any device they connect without needing a Model 9500 Humidity generator (only when using the Desktop version of ControLog).*



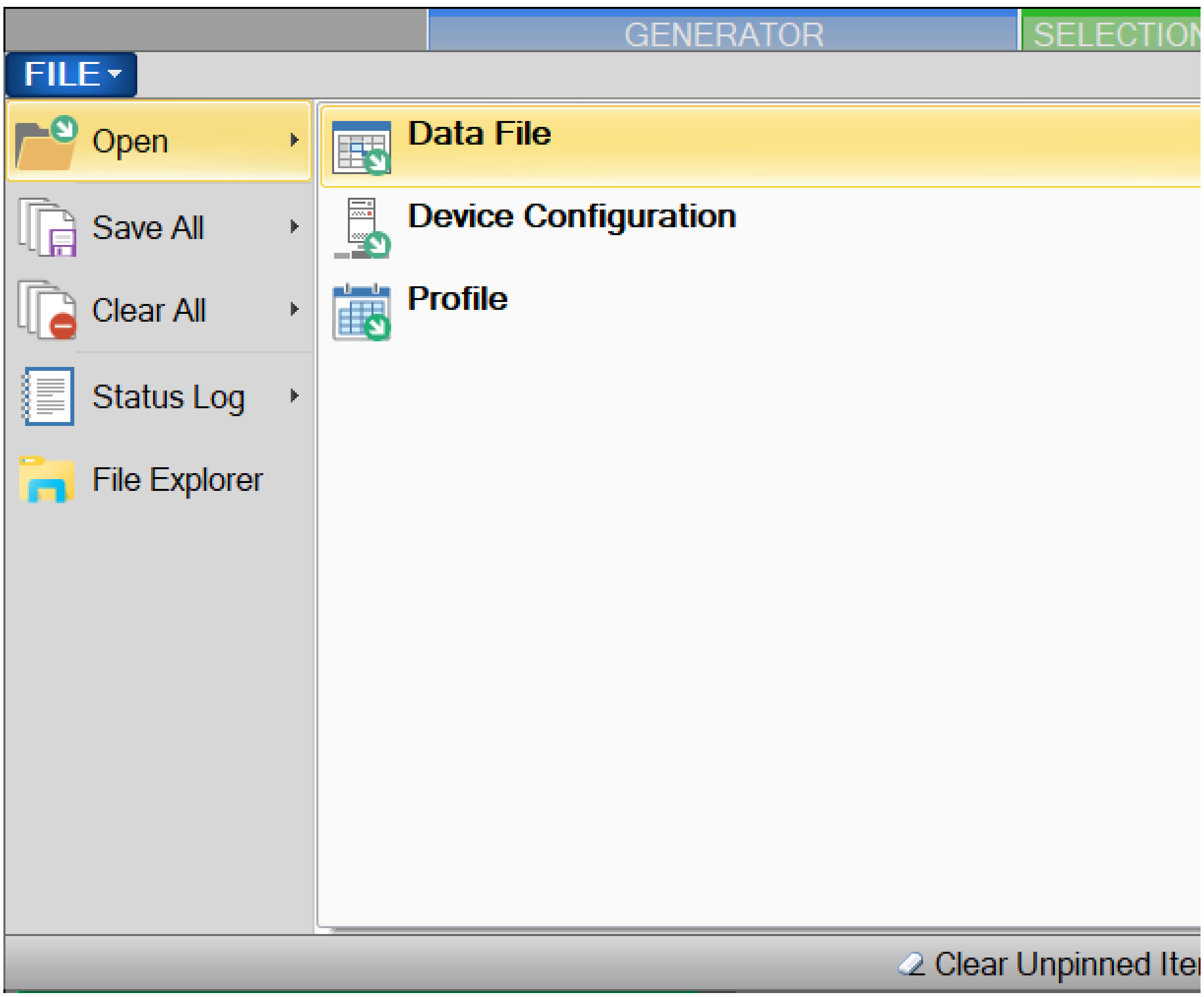
8.2 FILE DATA TABS

The File Data Tabs contain data values loaded from a previously saved Device Data Tab. ControLog can open data saved in the following types and formats:

- Text File (Comma Delimited) (*.csv;*.txt)
- Text File (Tab Delimited) (*.dat;*.txt)
- Excel Workbook (*.xlsx;*.xls)
- Backup ControLog File (*.backup)

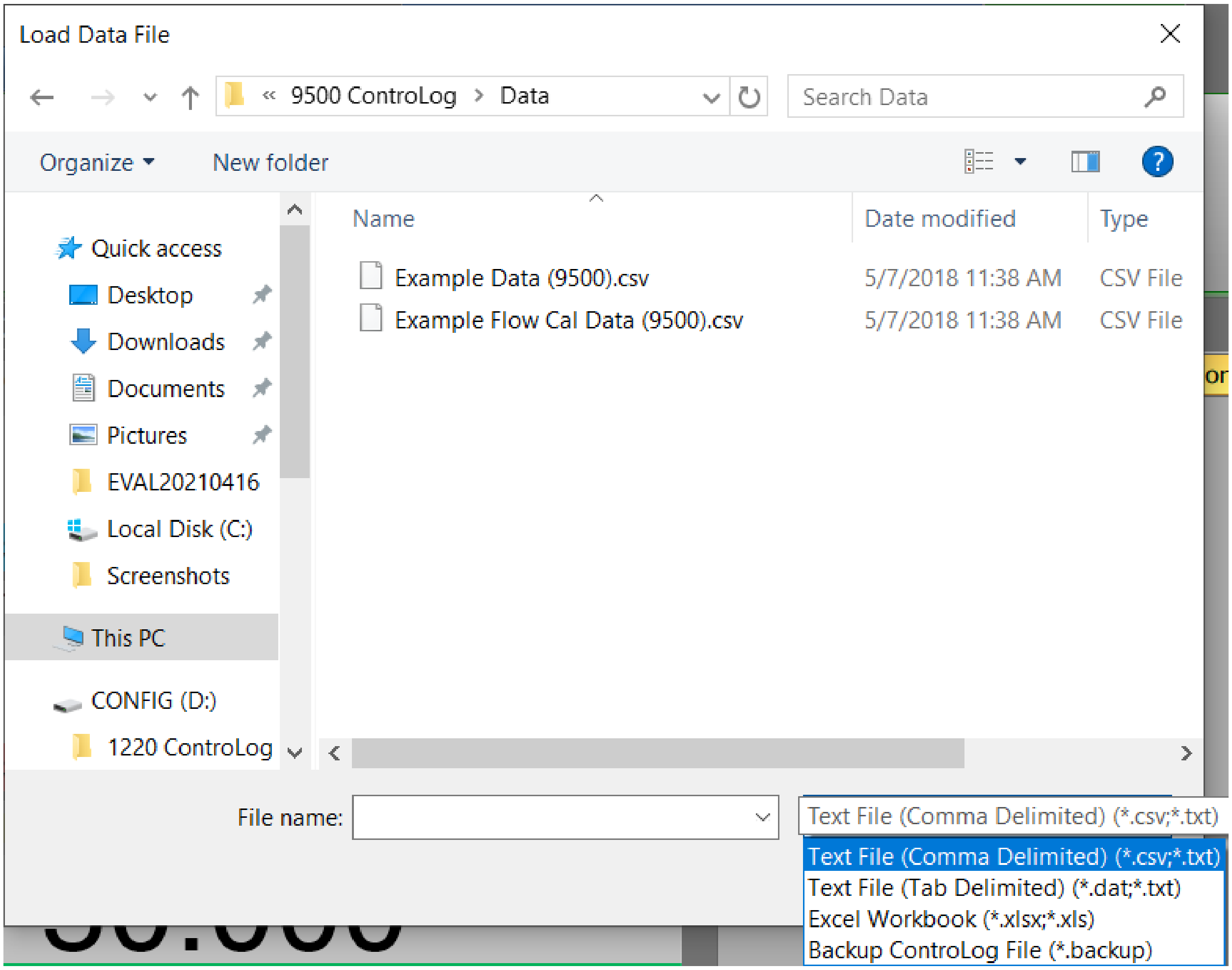
The only requirement for loading data from the data files mentioned above is that the data must be formatted, so date/time values appear in the first column and all other columns contain numeric values.

Select "Open>Data File" from the file menu to open a data file.

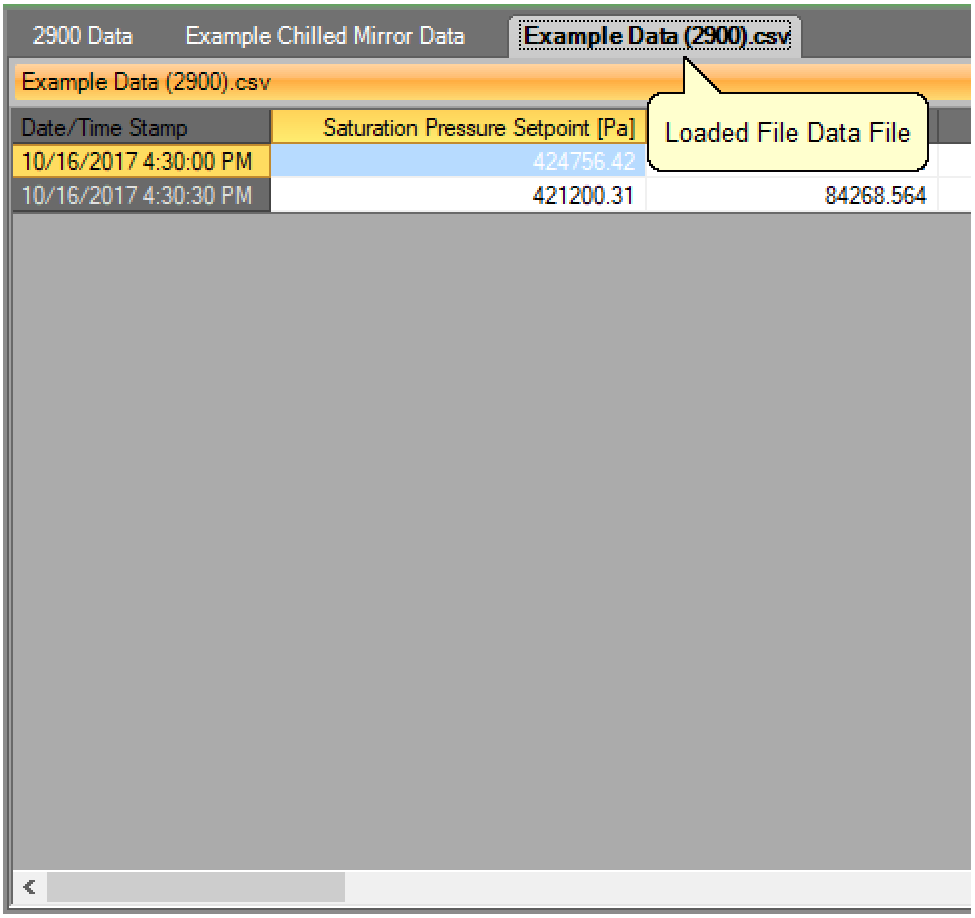


Note – *ControLog has a limit of five file data tabs opened at any given time.*

Using the “Load Data File” dialog, browse and select the data file you want to open.



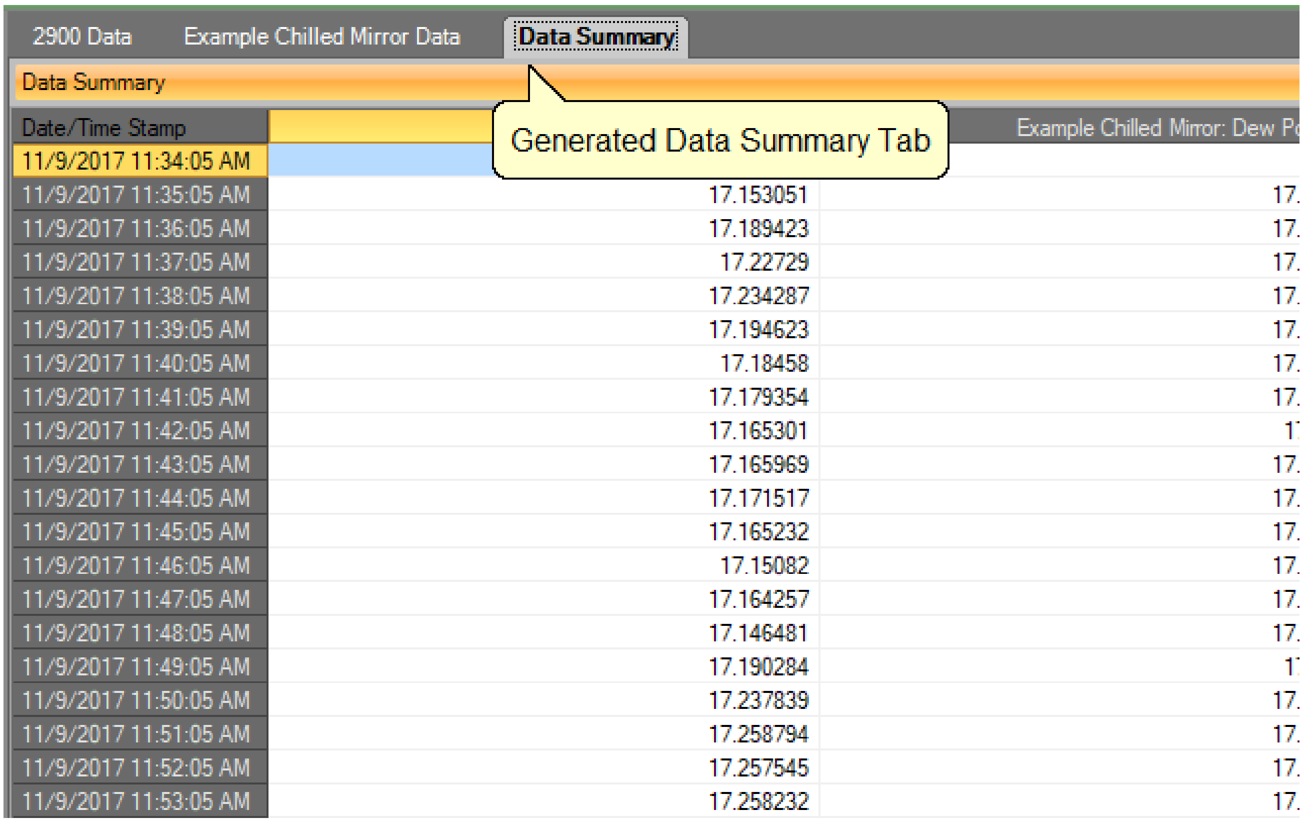
Once the load is complete, the loaded file data tab is displayed.



8.3 DATA SUMMARY TABS

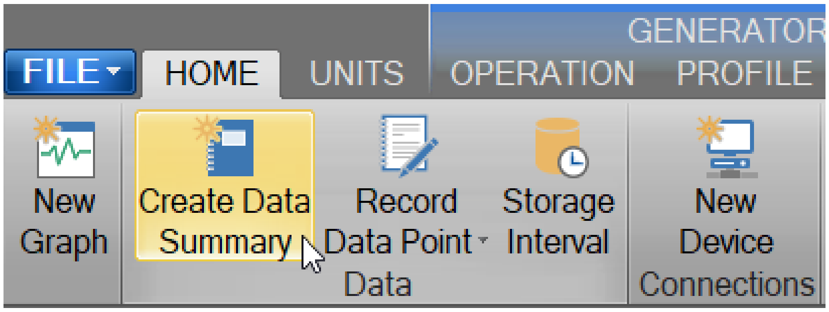
The Data Summary Tabs contain data values generated from a Data Summary. The data summary allows the user to summarize the available data into a single data tab. The data summary also allows the user to calculate errors or differences between selected standard values and selected device values.

> **Note** – *Data Summary tabs are created using the currently selected system units instead of SI units. ControLog has a limit of five data summary tabs opened at any given time.*

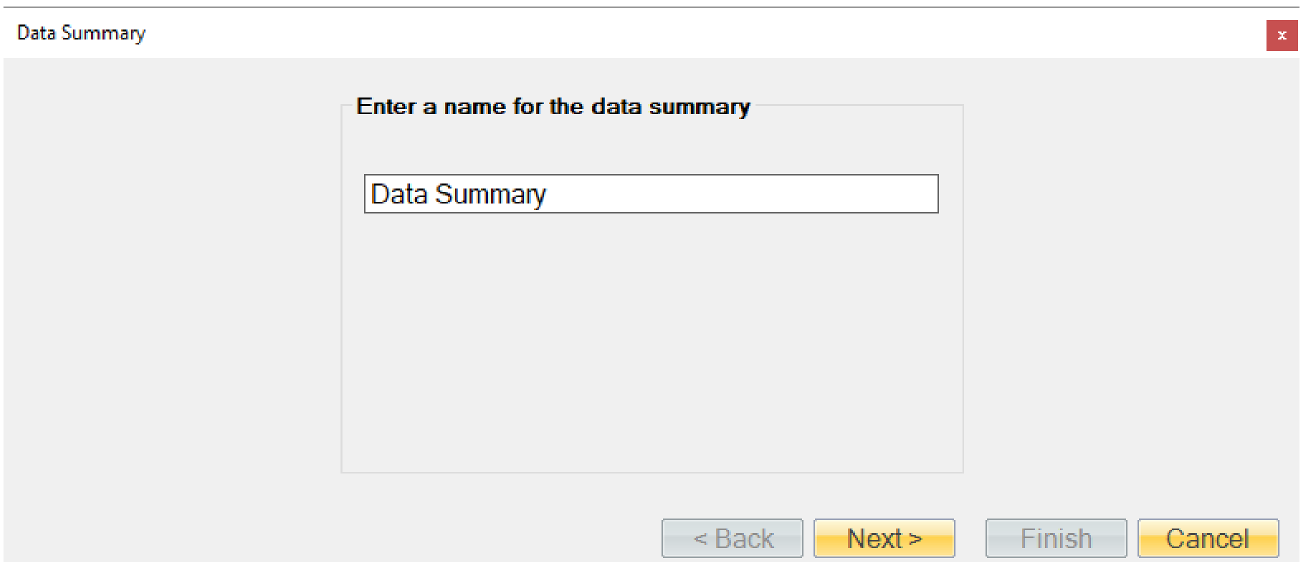


8.3.1 Creating a Data Summary

To create a Data Summary, select “Create Data Summary” from the Home ribbon menu tab. The selection opens the Data Summary Wizard dialog that steps the user through the creation process.



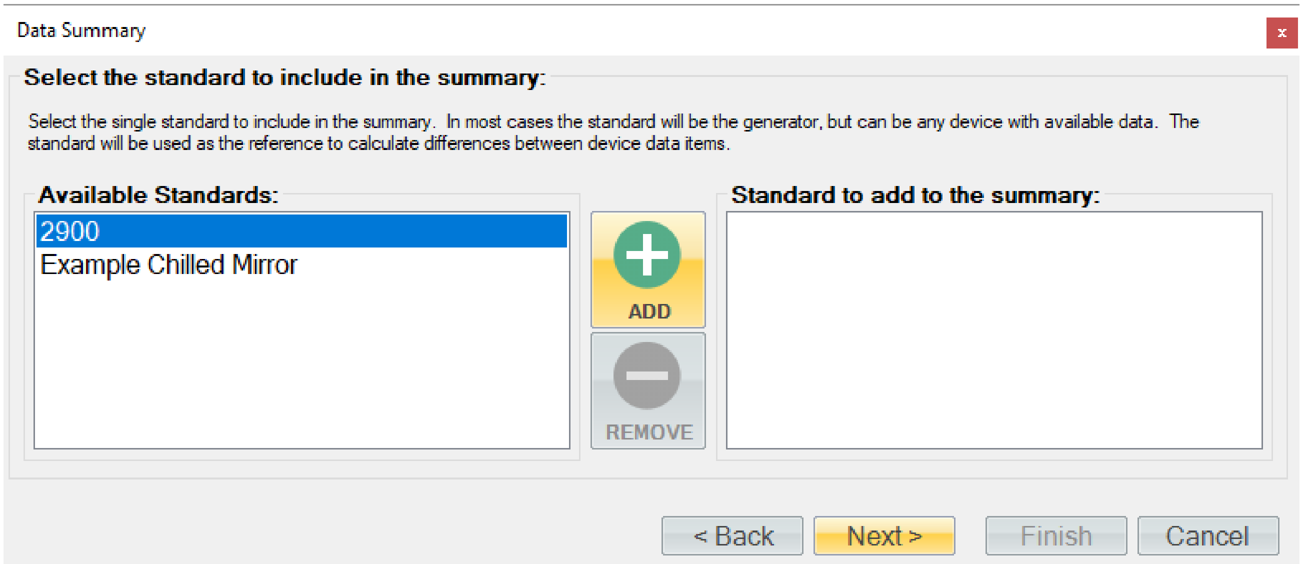
The first step in the data summary creation process is to give the data summary a name. This is the tab's name that appears in the Data and Graph Tab Group.



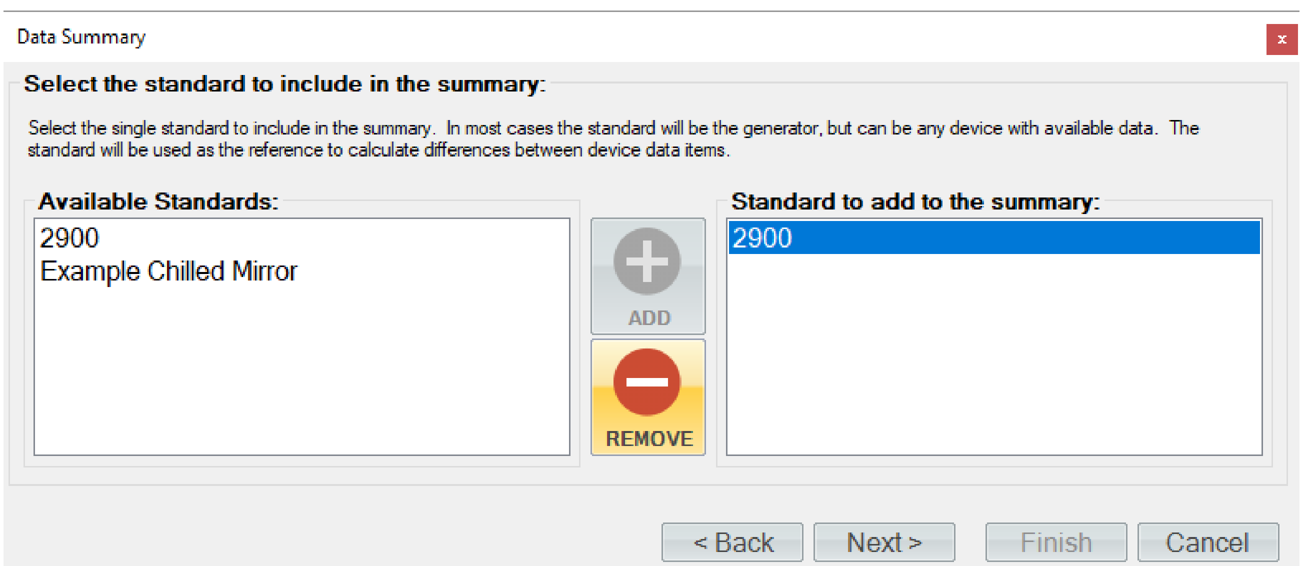
The next step in the data summary creation process is to select the standard. The standard is used as the reference to calculate differences between the device data items if the user chooses to do so.

On the left-hand side are the available devices to choose from and on the right-hand side is the selected standard to add to the summary. To select a device, highlight it and click the "Add" button. In almost all cases, the standard is the 9500.

Note – *Only one device can be selected as the standard for the summary.*

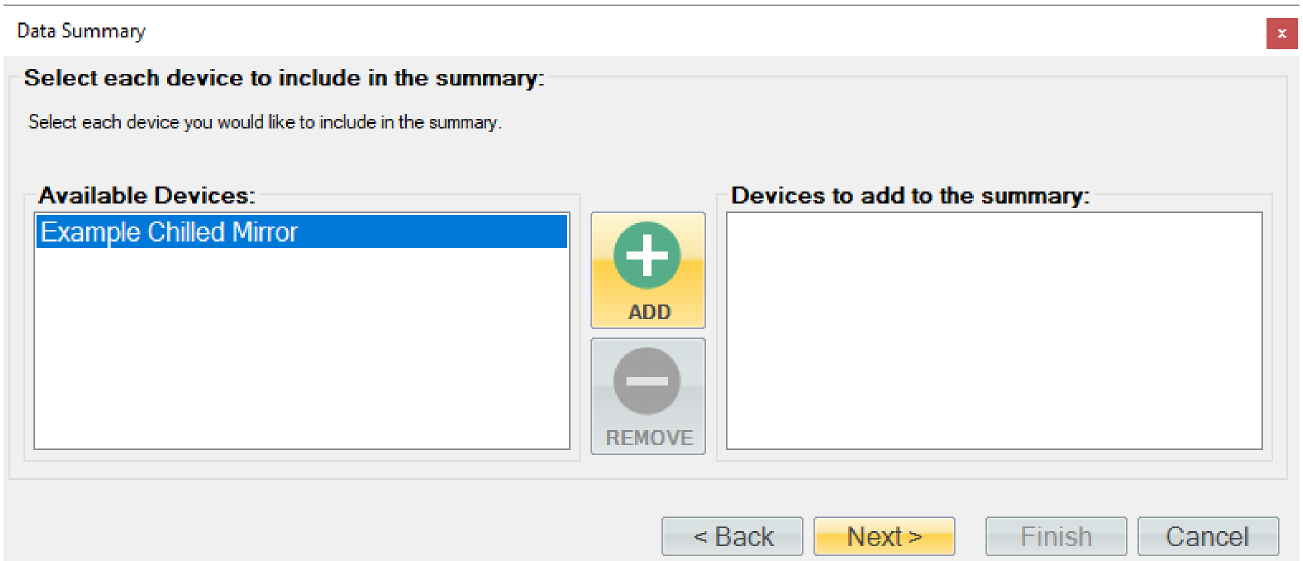


To remove an item as the selected standard, select the desired item from the right-hand side and click the "Remove" button.



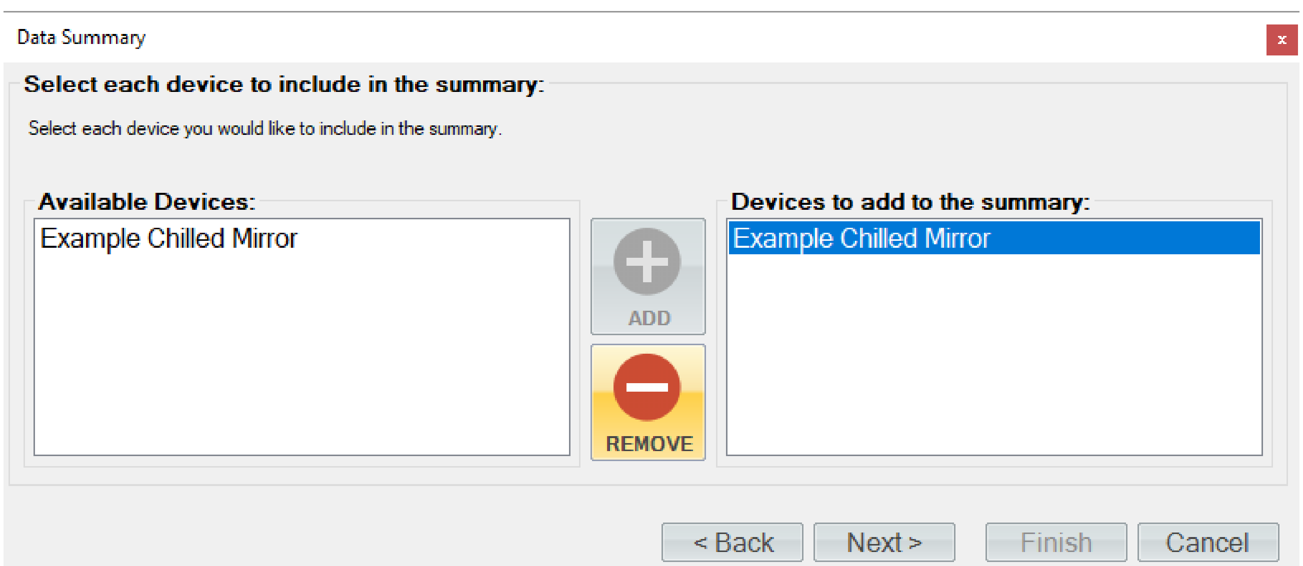
Once complete, selecting the “Next” button allows the user to select each device they want to include in the summary. On the left-hand side are the available devices to choose from and on the right-hand side are the selected devices to add to the summary. To select a device, highlight it and click the “Add” button.

Note – *Multiple devices can be selected and added to the summary.*

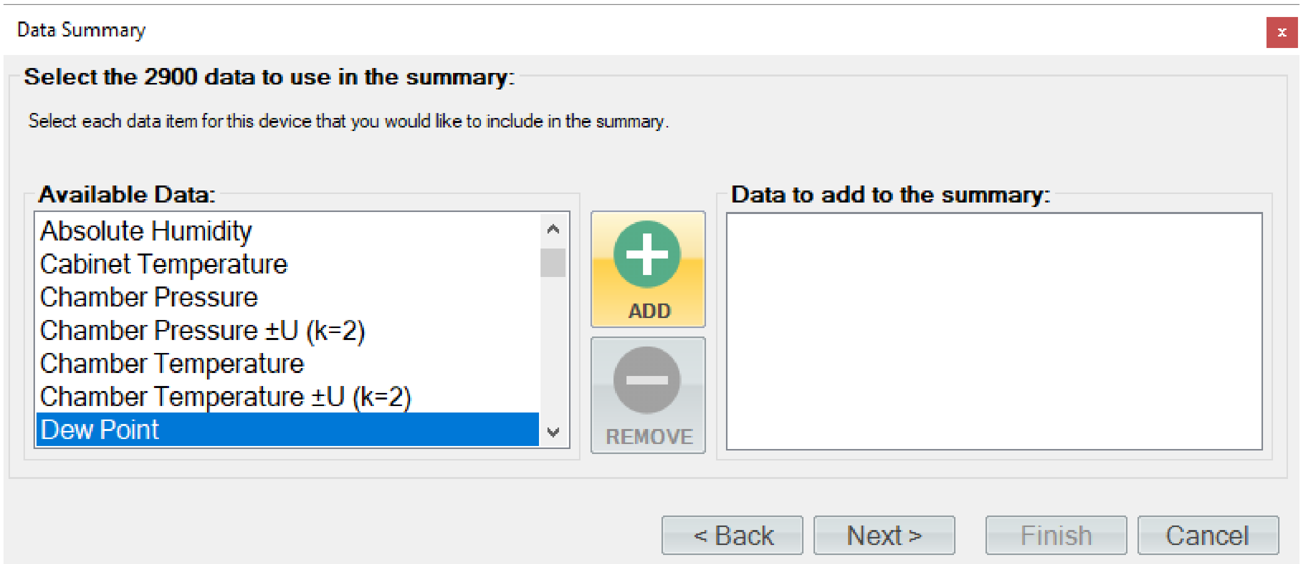


Note – *The user can invert any selection by right-clicking. This highlights all items that are not currently highlighted and removes the highlight from any items that are currently highlighted.*

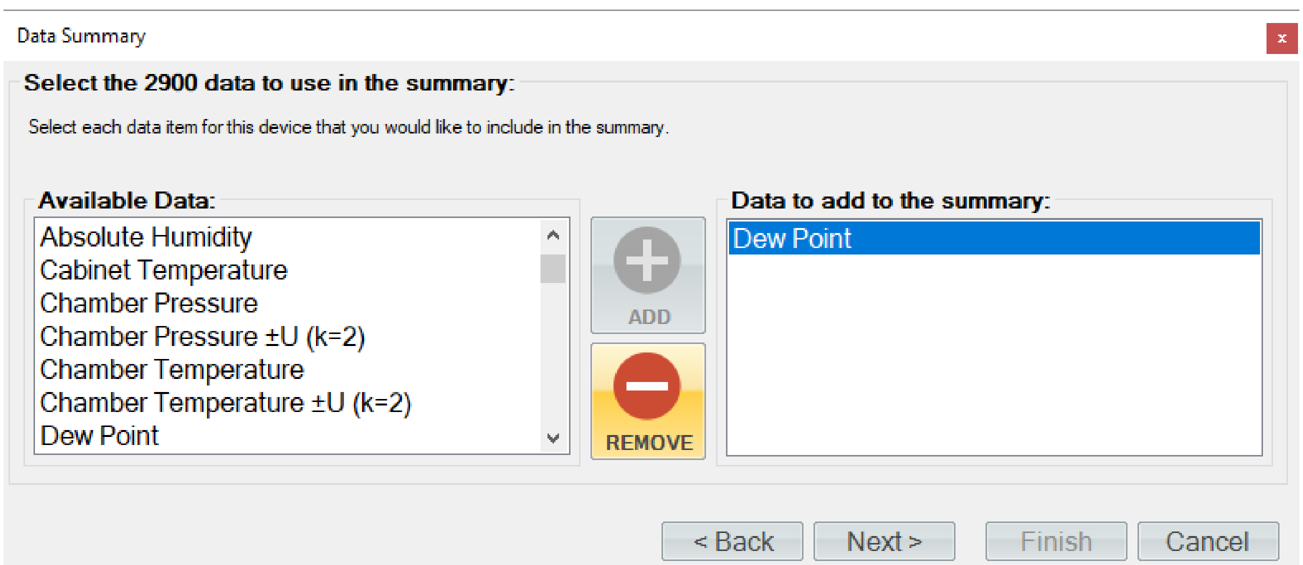
To remove an item from the list of devices, select the desired item or items from the right-hand side and click the “Remove” button.



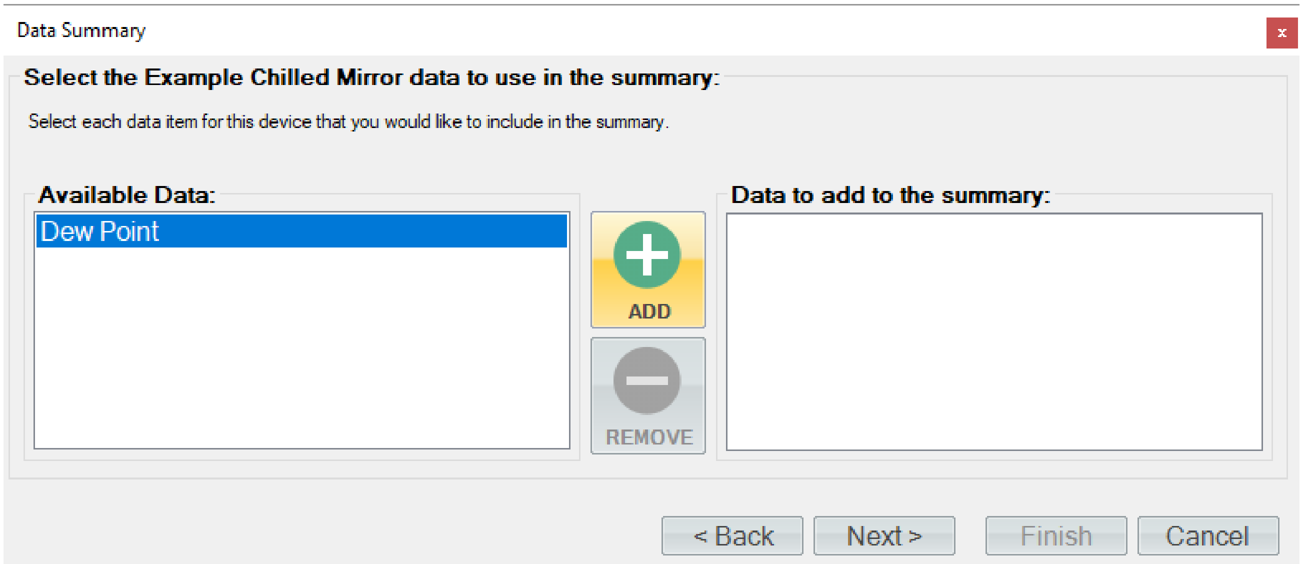
Once complete, selecting the "Next" button allows the user to select the standard's data items they would like to include in the summary. On the left-hand side are the available data items to choose from and on the right-hand side are the selected data items to add to the summary. To select a data item or items, highlight them and click the "Add" button.



To remove an item or items from the list of data items, select the desired item or items from the right-hand side and click the "Remove" button.

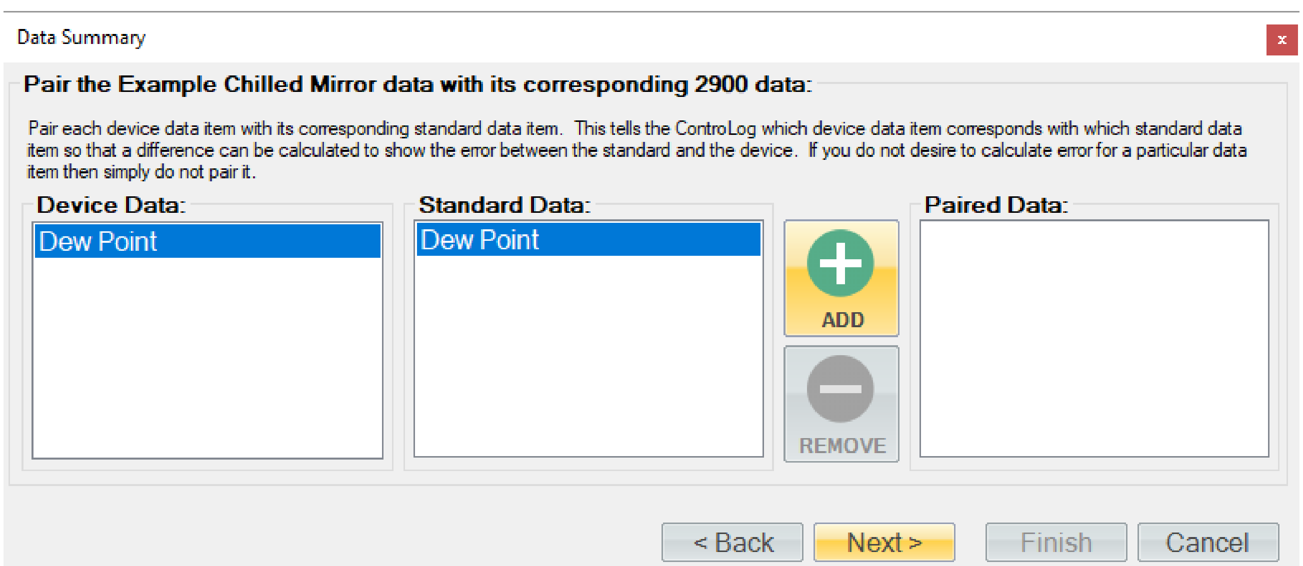


Selecting the "Next" button repeats the process of selecting data for the next device in the series. This continues until the user defines the device data they wish to include in the data summary.

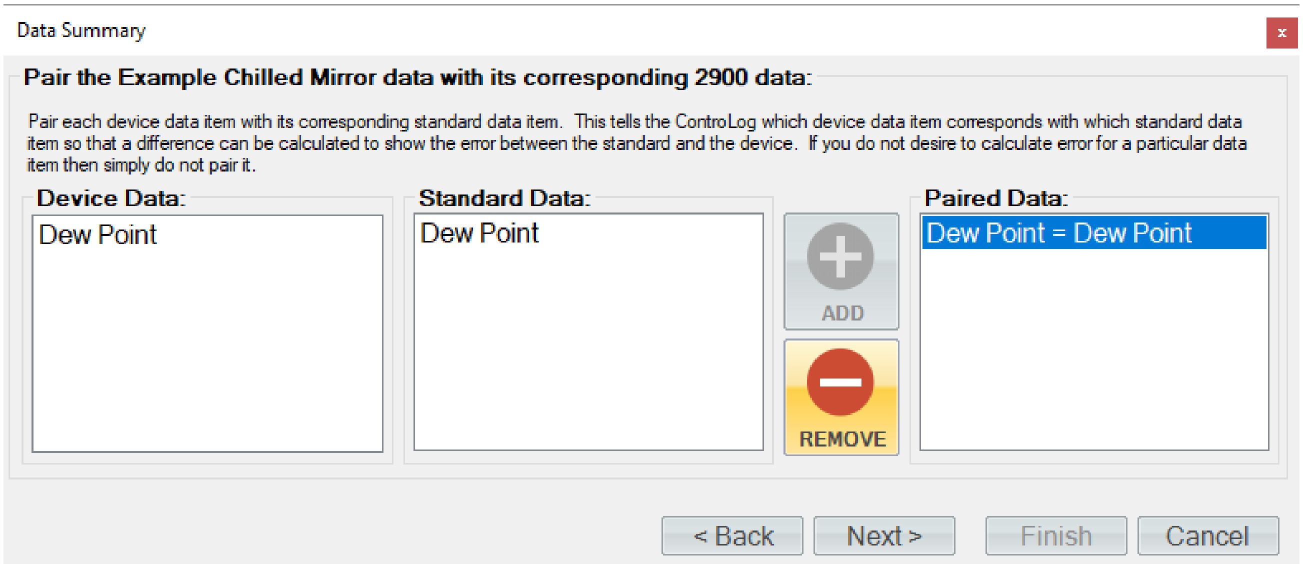


Once the user has selected data, ControLog asks the user to pair each device data item with its corresponding standard data item. This tells ControLog which device data item corresponds with which standard data item so that a difference can be calculated and the error between the standard and the device can be included in the summary. If the user does not want to calculate an error for a particular data item, they need not pair it.

Select the desired device data item and the standard data item to pair a data item. Select "Add" to create the pairing.



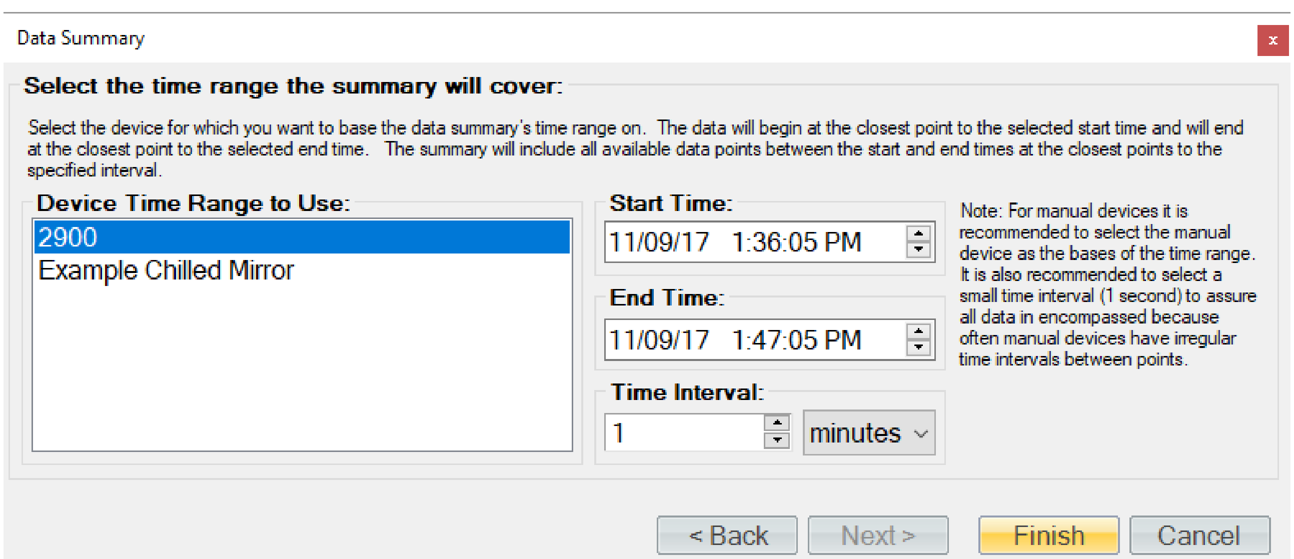
To remove a data item pairing, select the desired pair or pairings from the right-hand side and click the "Remove" button.



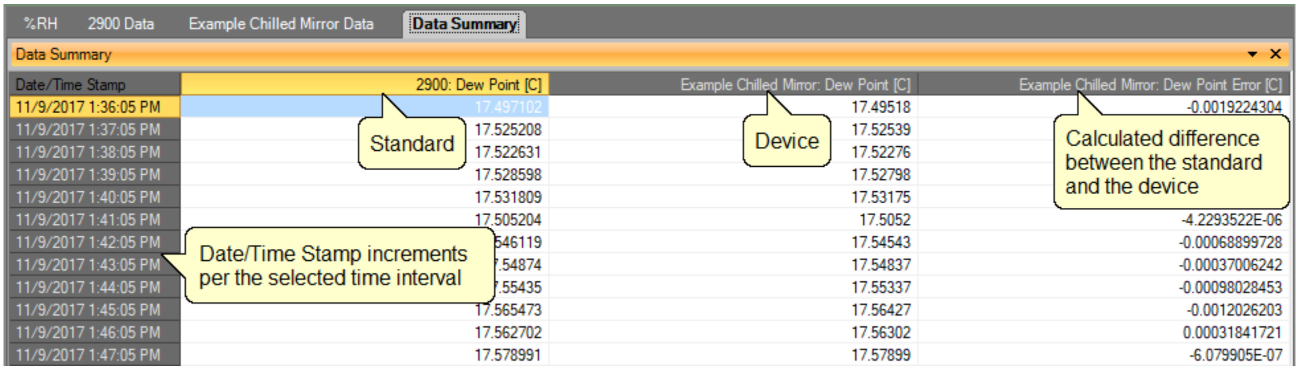
Selecting the "Next" button repeats the process of pairing data for the next device in the series. This continues until the user defines all the desired data pairs they wish to include in the data summary.

Once data pairing is complete, the user is asked to select the time range and interval the data summary covers. The selected device's time range determines which points to include. The data begins at the closest point to the selected start time and ends at the closest point to the selected end time. The summary includes all available data points between the start and end times at the closest points to the specified interval. If a particular device does not have a corresponding time for a given base time, then the value fields are left blank for that device for that given time.

> **Note** – *For manual devices, it is recommended to select the manual device as the bases for the time range to use. It is also recommended to select a small interval (1 second) to ensure all data is encompassed because manual devices often have irregular time intervals between points.*



Upon clicking the “Finish” button, ControLog opens a new data tab with the newly created data summary.

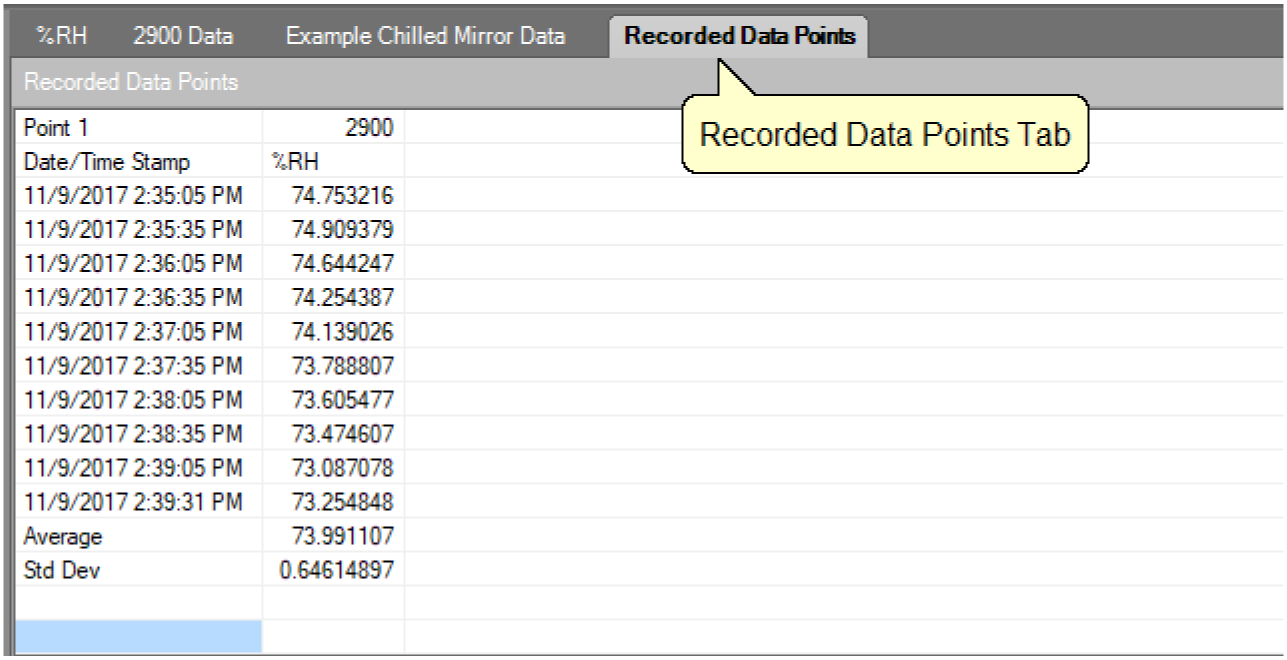


Date/Time Stamp	2900: Dew Point [C]	Example Chilled Mirror: Dew Point [C]	Example Chilled Mirror: Dew Point Error [C]
11/9/2017 1:36:05 PM	17.497102	17.49518	-0.0019224304
11/9/2017 1:37:05 PM	17.525208	17.52539	
11/9/2017 1:38:05 PM	17.522631	17.52276	
11/9/2017 1:39:05 PM	17.528598	17.52798	
11/9/2017 1:40:05 PM	17.531809	17.53175	
11/9/2017 1:41:05 PM	17.505204	17.5052	-4.2293522E-06
11/9/2017 1:42:05 PM	546119	17.54543	-0.00068899728
11/9/2017 1:43:05 PM	.54874	17.54837	-0.00037006242
11/9/2017 1:44:05 PM	.55435	17.55337	-0.00098028453
11/9/2017 1:45:05 PM	17.565473	17.56427	-0.0012026203
11/9/2017 1:46:05 PM	17.562702	17.56302	0.00031841721
11/9/2017 1:47:05 PM	17.578991	17.57899	-6.079905E-07

8.4 RECORDED DATA POINTS TAB

The Recorded Data Points Tab contains the recorded data points that have been taken manually by the user, after a manual device entry, or after a soak phase during an auto profile. Each data point can also calculate the average and or standard deviation for the defined number of prior points taken with each recorded data point.

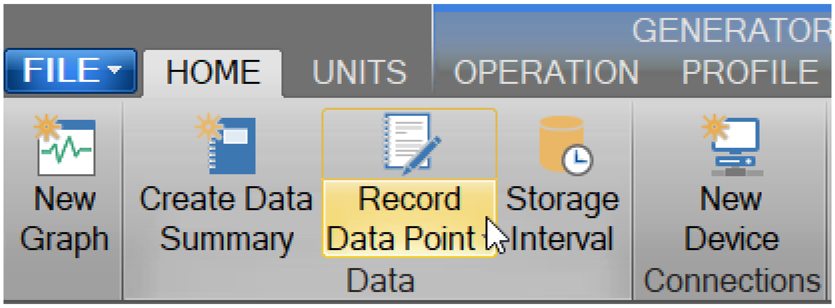
> **Note** – *Each entry point in the Recorded Data Points tab is created using the currently selected system units.*



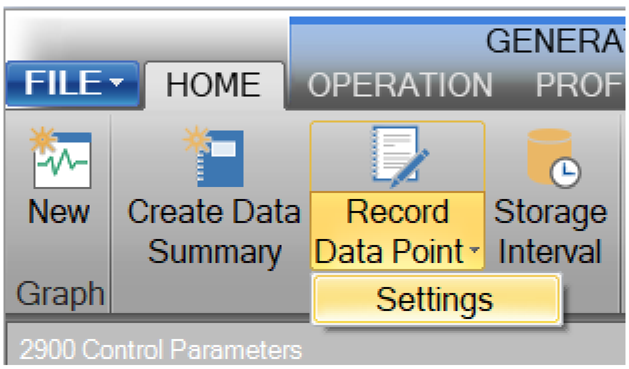
Point 1	2900
Date/Time Stamp	%RH
11/9/2017 2:35:05 PM	74.753216
11/9/2017 2:35:35 PM	74.909379
11/9/2017 2:36:05 PM	74.644247
11/9/2017 2:36:35 PM	74.254387
11/9/2017 2:37:05 PM	74.139026
11/9/2017 2:37:35 PM	73.788807
11/9/2017 2:38:05 PM	73.605477
11/9/2017 2:38:35 PM	73.474607
11/9/2017 2:39:05 PM	73.087078
11/9/2017 2:39:31 PM	73.254848
Average	73.991107
Std Dev	0.64614897

8.4.1 How to Record a Data Point

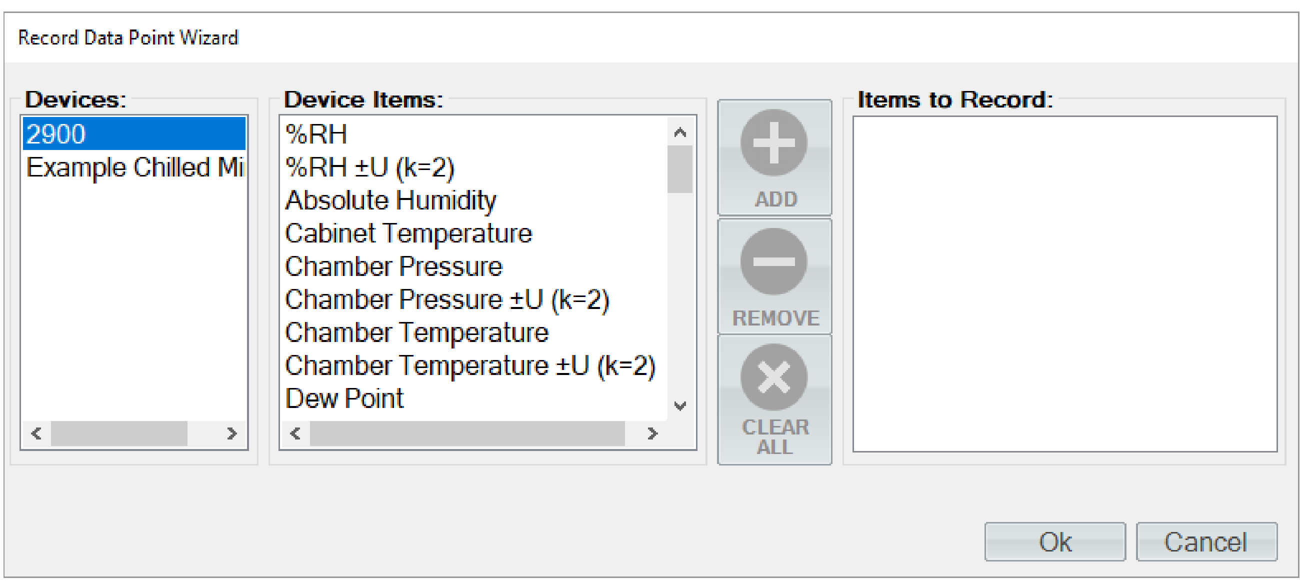
To Record a Data Point, select "Record Data Point" from the main menu or right-click a data tab and select "Record Data Point."



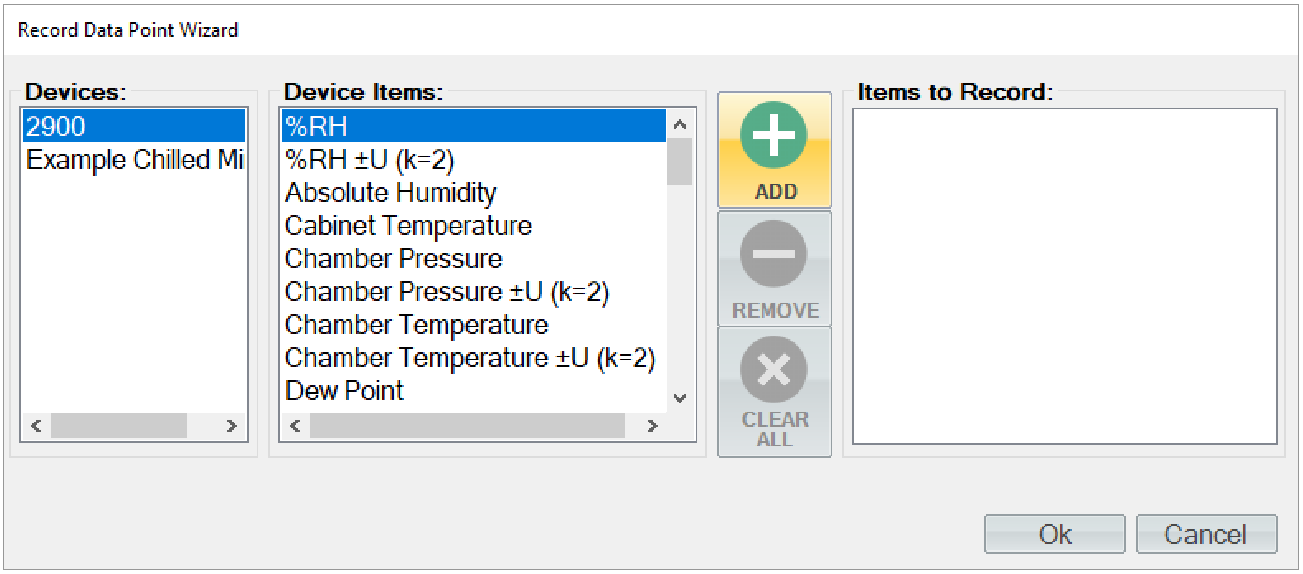
The first step in recording data points is configuring what and how to take each point. Use the Settings menu to open the Record Data Point Wizard to define the data points to be taken.



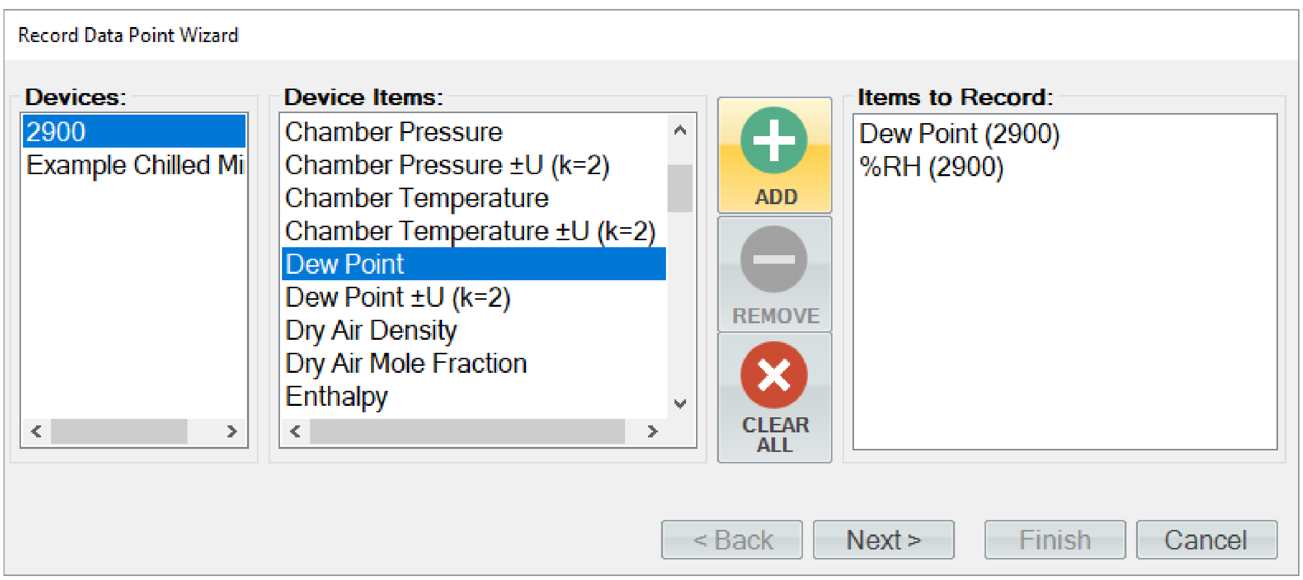
A "Record Data Point Wizard" dialog appears.



The first page of the Record Data Point Wizard is where the user selects which device items they would like to record. On the left-hand side is a list of all available devices. Selecting a device from the list updates the "Device Items" list to reflect the available items. To add an item, highlight the desired item or items in the "Device Items" list and click the "Add" button.

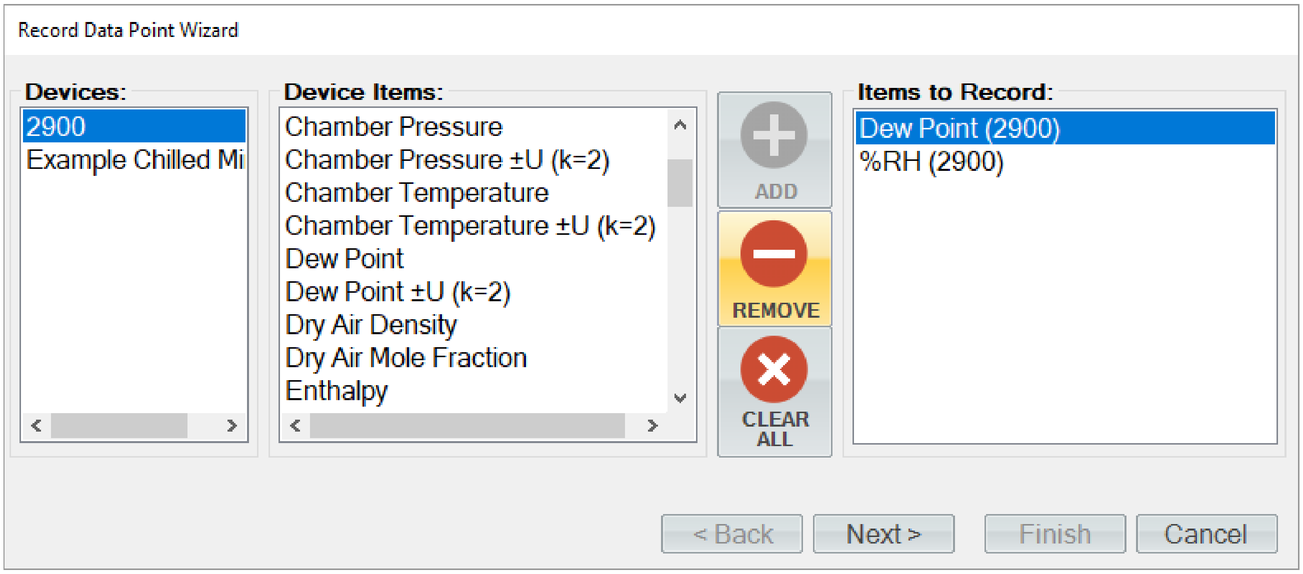


Repeat this process until all the desired items are listed on the right side.

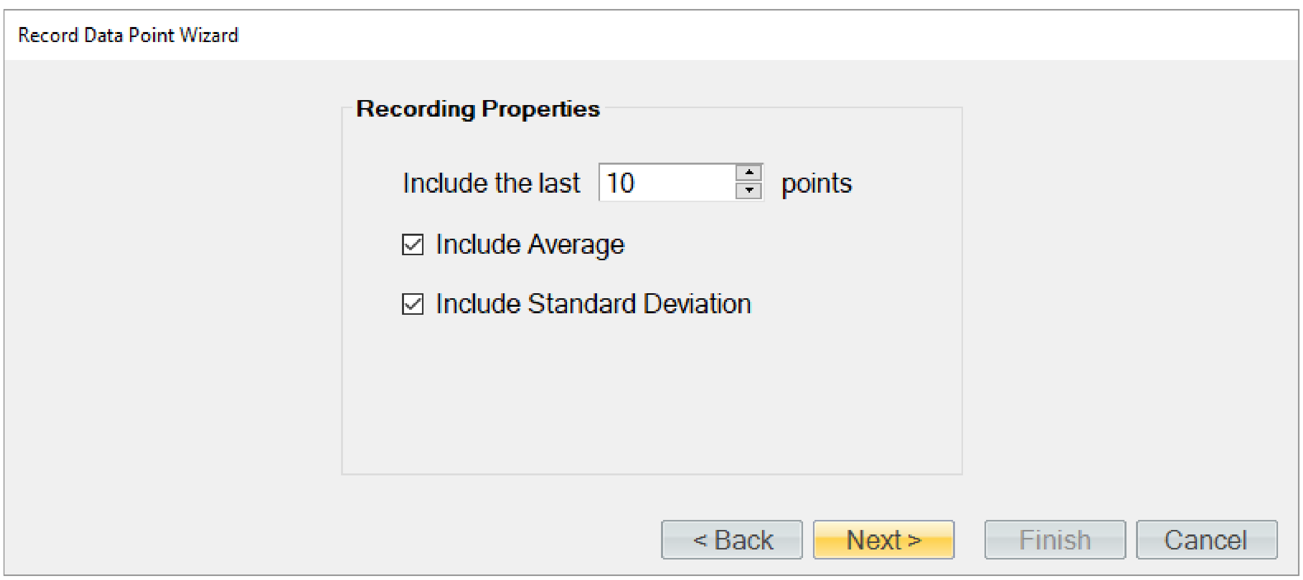


Note – *The user can invert any selection by right-clicking. This highlights all items that are not currently highlighted and removes the highlight from any items that are currently highlighted.*

To remove an item from the list of items to record, the user can either click the “Clear All” button to remove all items or simply select the desired item from the “Items to Record” list and click the “Remove” button.



Once complete, clicking the “Next” button brings up the Properties page. The properties page lets the user define what is recorded for each point.

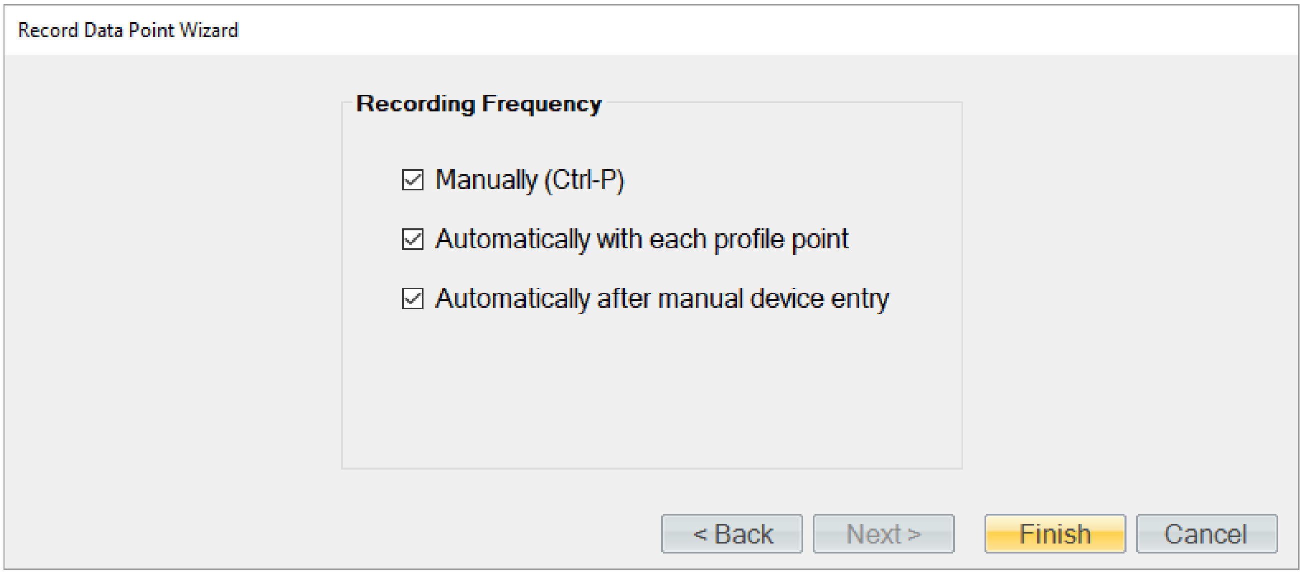


Recording Properties define the number of prior (last) points to include and whether to calculate the average and or standard deviation for the defined number of prior points taken with each recorded data point.

- ***Include the last … points*** defines the number of prior points to include with each recorded data point. The prior points are determined from the Data Tab for each recorded point. ControLog includes the number of prior (last) points directly using the entries in the Data Tab for the given point from when the data point was recorded.

- ***Include Average*** defines whether to include an average of the defined number of prior points for the recorded data items for each point taken.
- ***Include Standard Deviation*** defines whether to include the standard deviation of the defined number of prior points for the recorded data items for each point taken.

Once complete, clicking the "Next" button brings up the frequency page. The frequency page lets users define when and how to take a data point.



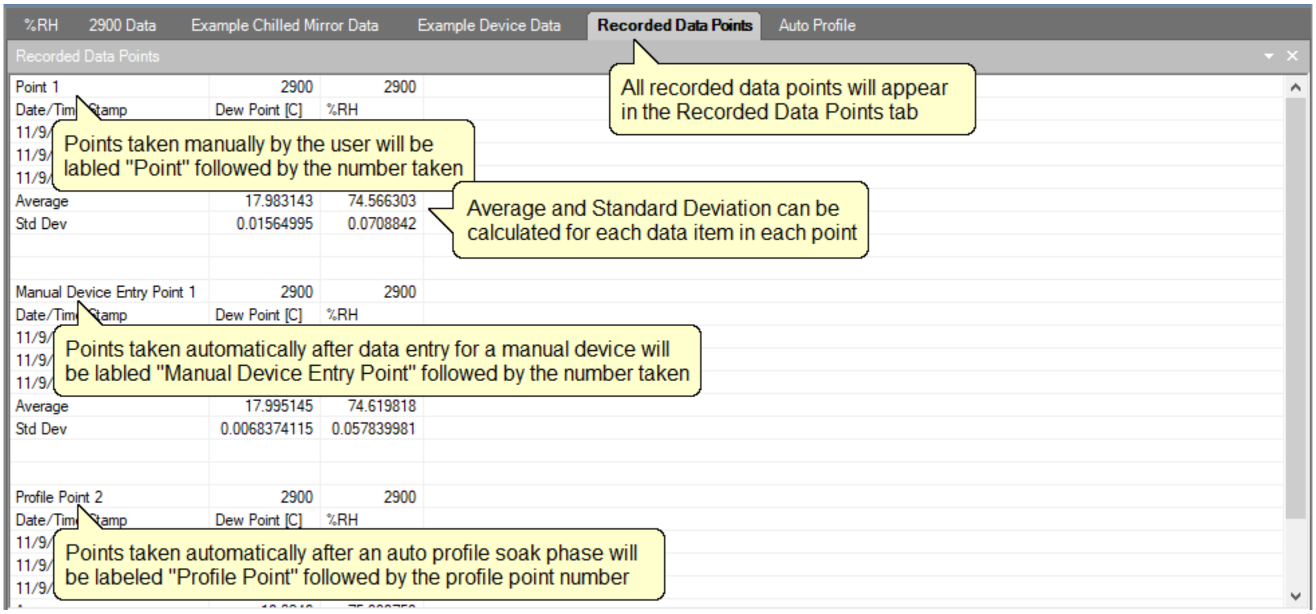
Recording Frequency defines when and how the system takes a data point. The user should select (place check mark) by each method they would like to use.

- ***Manually*** indicates that the user manually takes points when they want, using either the "Take Point" menu item or pressing the Ctrl-P key combination on the keyboard when ControLog is the active window.
- ***Automatically with each profile point*** indicates that a point is taken automatically after each profile soak phase.

  Note – *If the user manually bypasses the soak phase using the manual profile control buttons, an automatic point is NOT taken regardless of the "Automatically with each profile point" setting selection.*

- ***Automatically after manual device entry*** indicates that a point is taken automatically when the user completes a manual device entry.

Once complete, clicking the “Finish” closes the wizard and saves the user selection for recording data points.

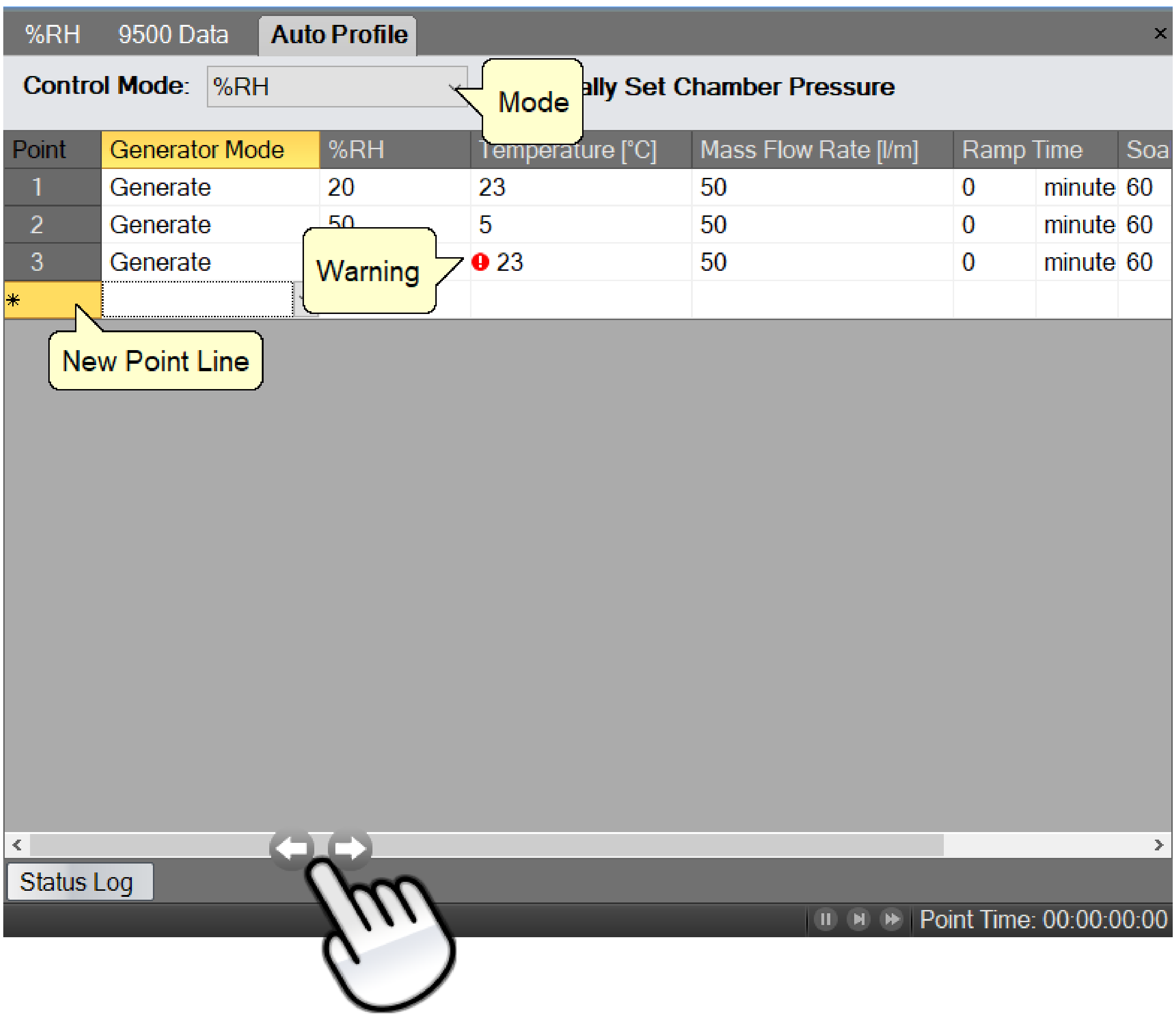


9 AUTO PROFILING

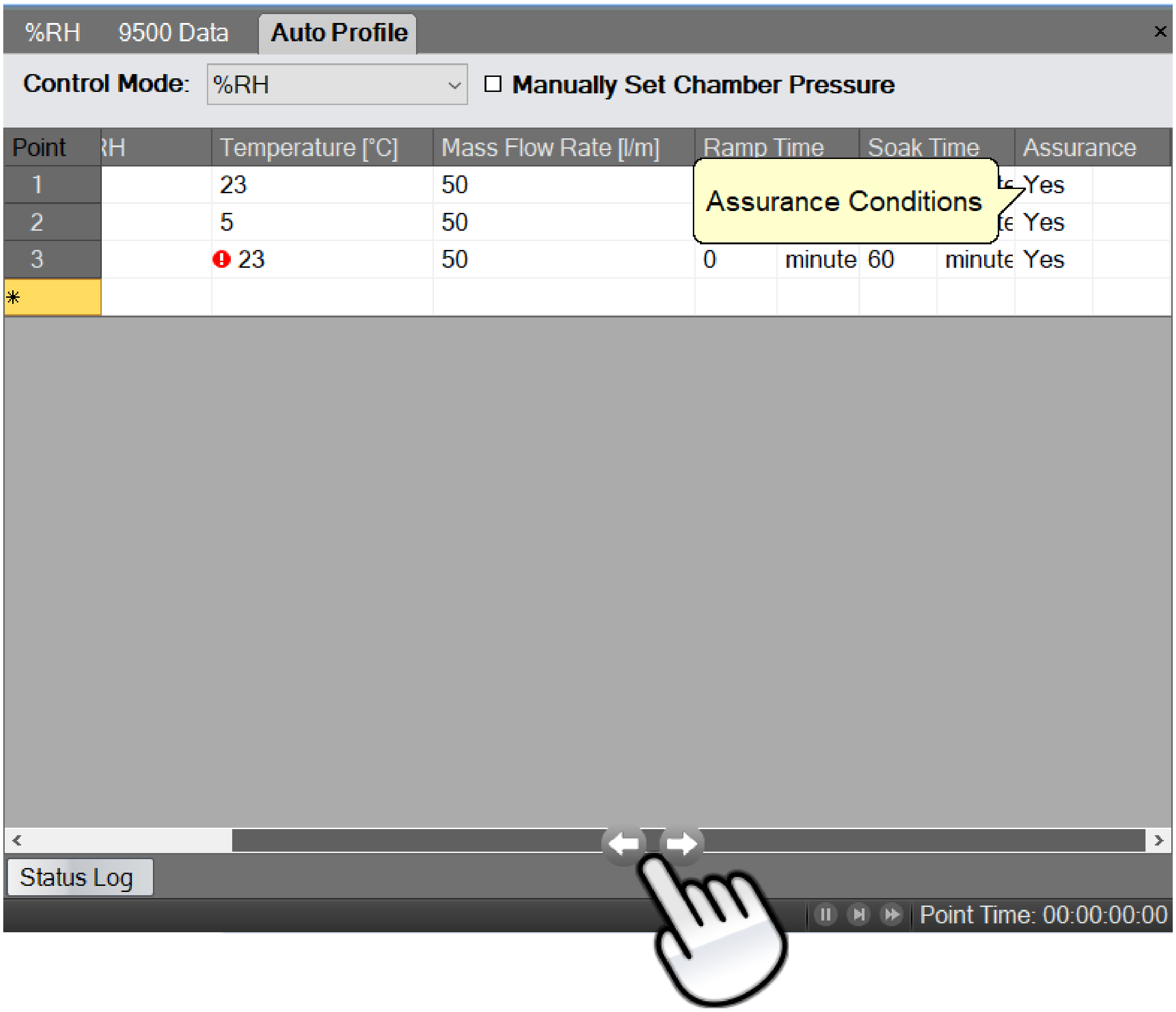
The Auto Profiling feature is very similar to the Generate mode, with the main exception that profiling relies on a predefined list of setpoints referred to as a profile. The user-configurable profile is used as ControLog's road map during Auto Profile operation. It defines which setpoint values to go to, at what rate to go from one setpoint to another, and how long to stay at a specific setpoint before moving to the next setpoint.

> **Note** – *Before attempting to operate the system in an Auto Profile mode, you should become thoroughly familiar with the manual Generate mode of operation.*

The Profile Tab is used to create and modify auto profiles. The tab consists of drop drowns, entry fields, and a data grid.



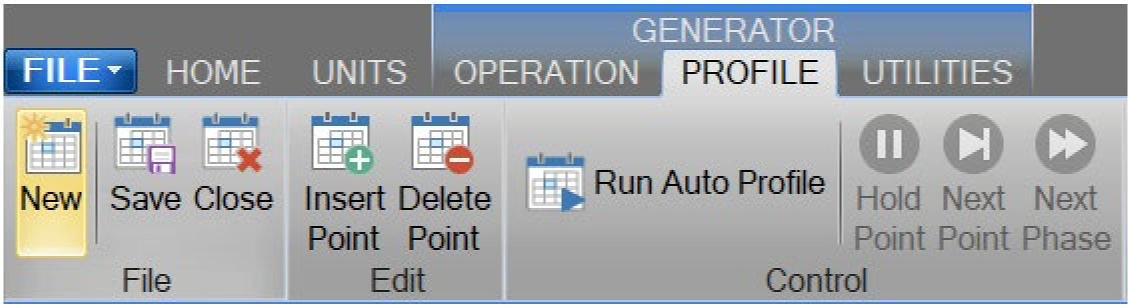
The scrollbar at the bottom can be used to scroll to the remaining profile fields.



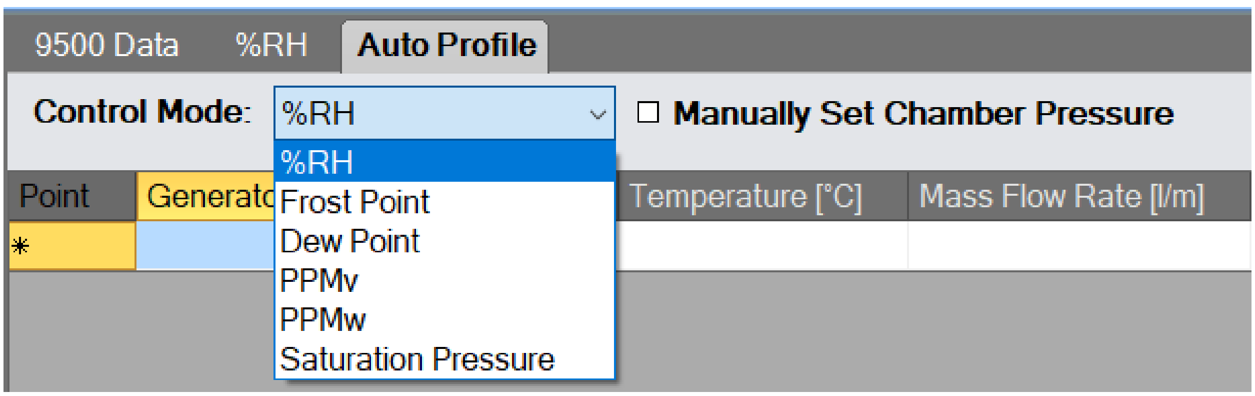
9.1 Creating a New Profile

A profile is a list of humidity, temperature, pressure, flow, and time parameters used during the automated control of the Model 9500 Humidity generator. The profile essentially programs the computer/controller operations.

Open a new profile tab by selecting "New" from the profile menu.

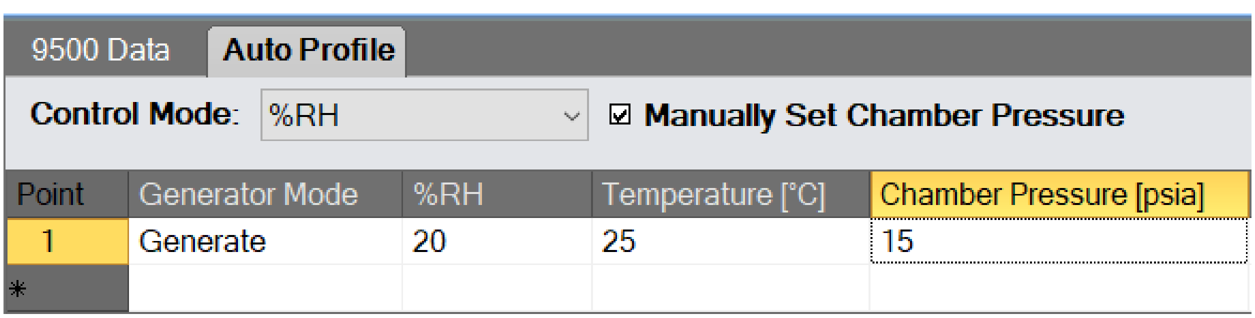


Select the desired **Control Mode** for the entire profile. The Control Mode is what the user wants to generate during the profile. The control modes are the same modes available during manual operation.



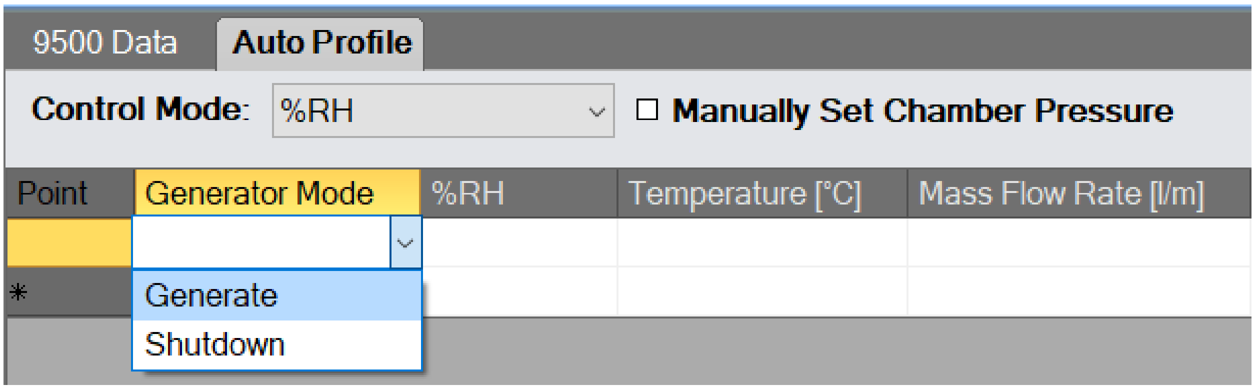
For more information, refer to section 4.1.4.1 [Mode](#)

The **Manually Set Chamber Pressure** checkbox toggles an additional Chamber Pressure column. The Chamber Pressure column contains values for the chamber pressure, which the generator maintains during each profile point. Generally, the same chamber pressure setpoint is used throughout a profile and should be specified above ambient barometric pressure to control chamber pressure effectively.



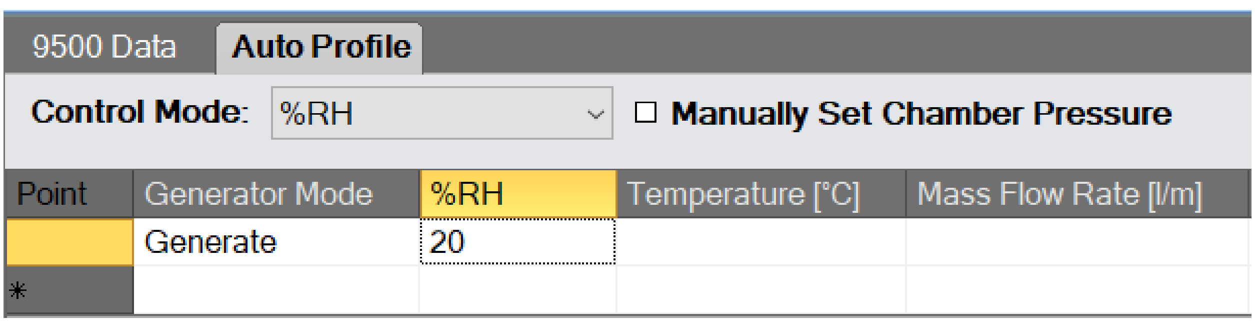
The first column, next to the point numbers, is the Generator Mode. The Generator Mode defines the run mode in which the 9500 operates for this profile point. The Generator Modes are the same run modes available during manual operation.

Note – *Shutdown is only available for the last point.*

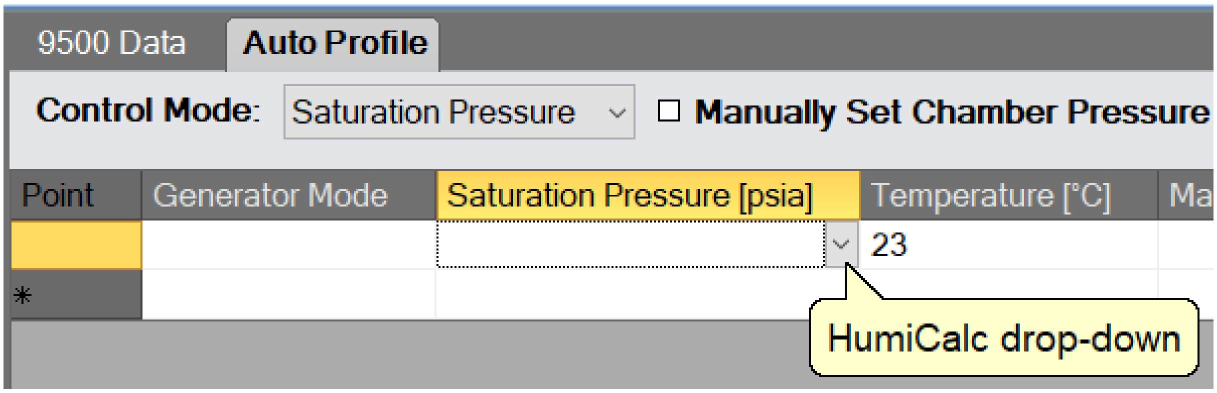


For more information, refer to section 4.1.4.2 Run Menu

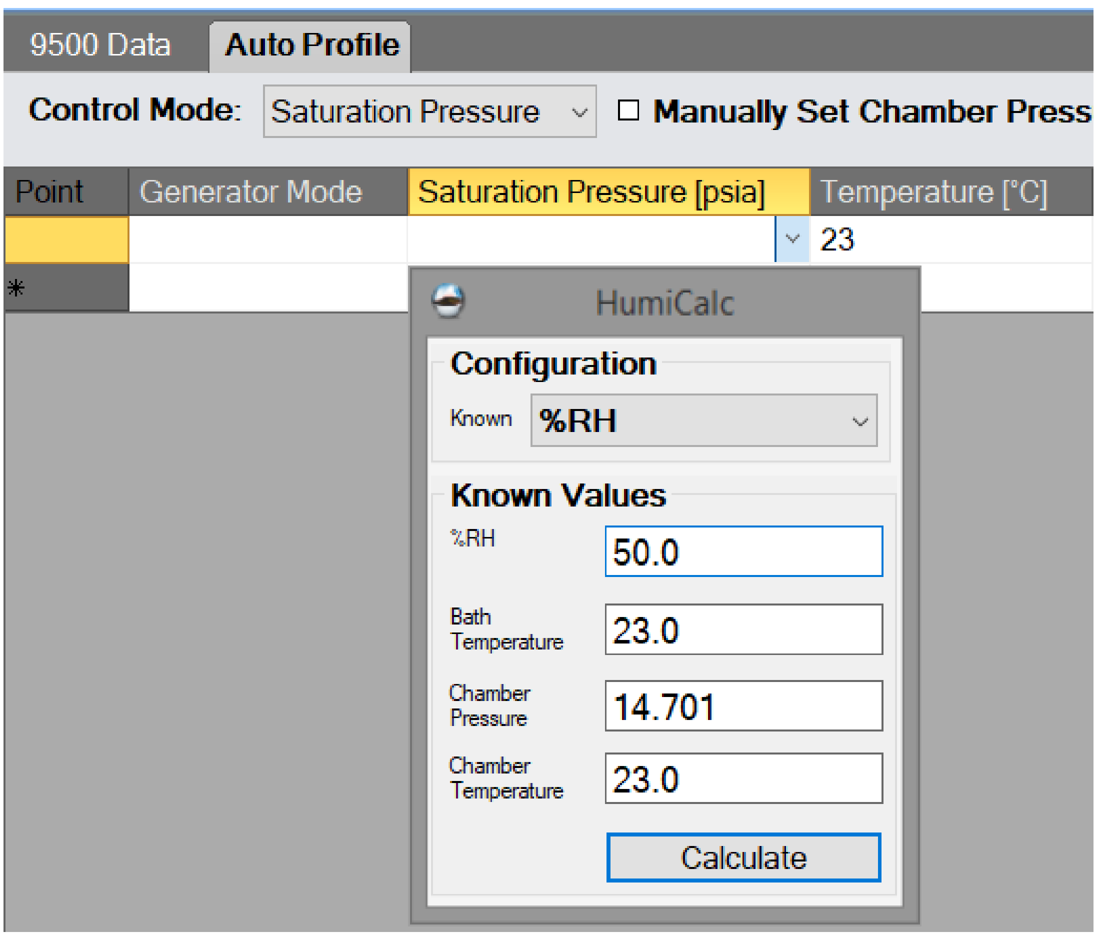
The first column next to the Generator Mode contains the humidity value to generate and is titled at the top according to the currently selected control mode. The profile control mode is set to %RH in the example shown. Whenever the profile control mode changes, the title on this column changes to reflect the selected control mode.



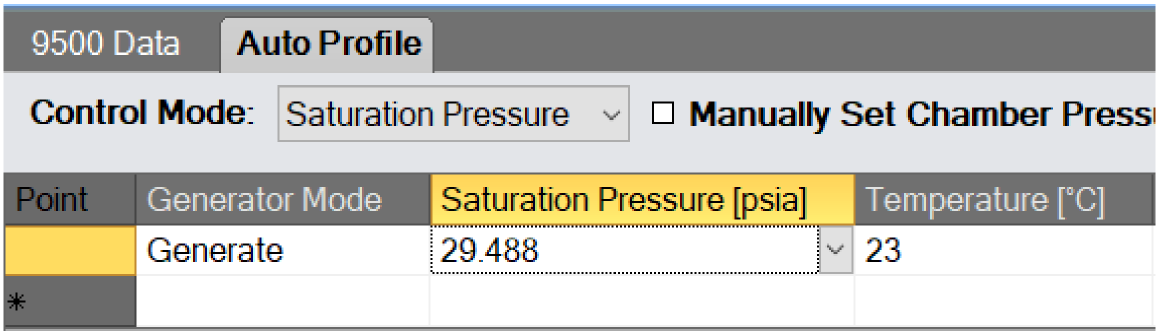
When the Control Mode is set to Saturation Pressure, the first column next to the Generator Mode contains the Saturation Pressure followed by the Temperature. In this control mode, the user can also drop down a Mini version of HumiCalc to help calculate the desired Saturation Pressure by clicking the drop-down arrow on the cell. For example, let us say the user wants to calculate the required Saturation Pressure needed to generate a 50 %RH with a Saturation Temperature of 23.0 °C. Start by selecting Saturation Pressure as the Control Mode. Next, enter a 23.0 °C Temperature and click the Saturation Pressure HumiCalc drop-down at the right of the grid cell box.



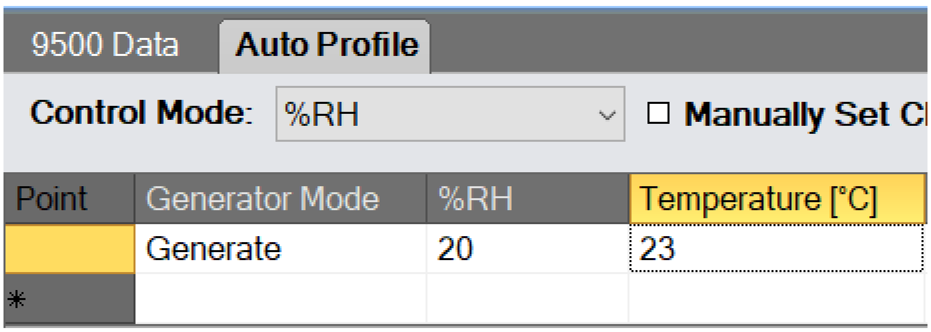
Next, select the known %RH and enter the desired percent relative humidity of 50. Notice that ControLog automatically entered the other known values based on the already entered profile values.



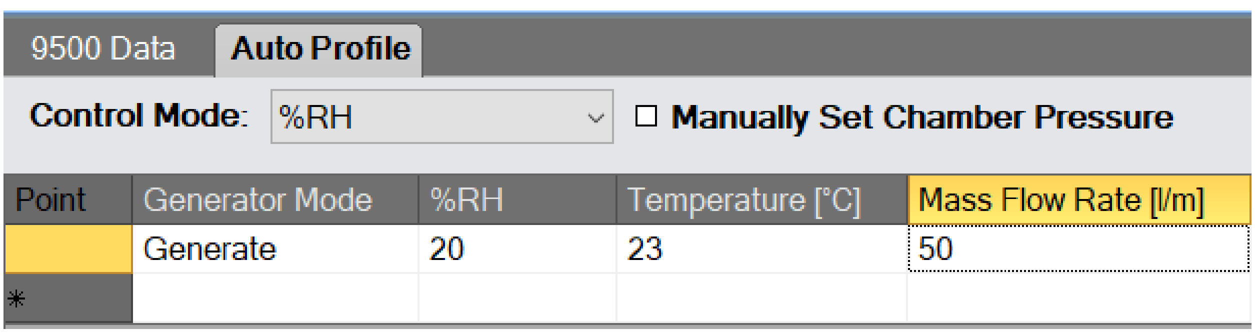
Clicking the “Calculate” button results in the calculated Saturation Pressure being placed in the profile cell, and the HumiCalc dropdown closes.



The Temperature column contains the bath fluid temperature value for the given point.

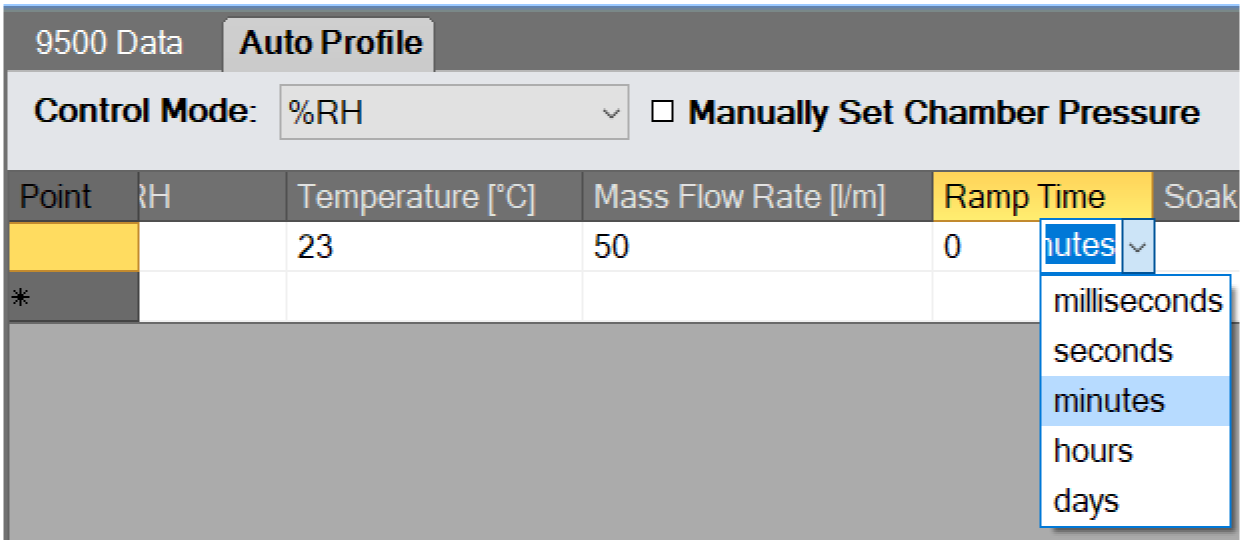


The Mass Flow Rate column contains the air flow values at which the generator operates. Although not affecting the generated value of humidity, the flow rate does affect the air exchange rate, equilibration time of the instruments under test, and permeation.

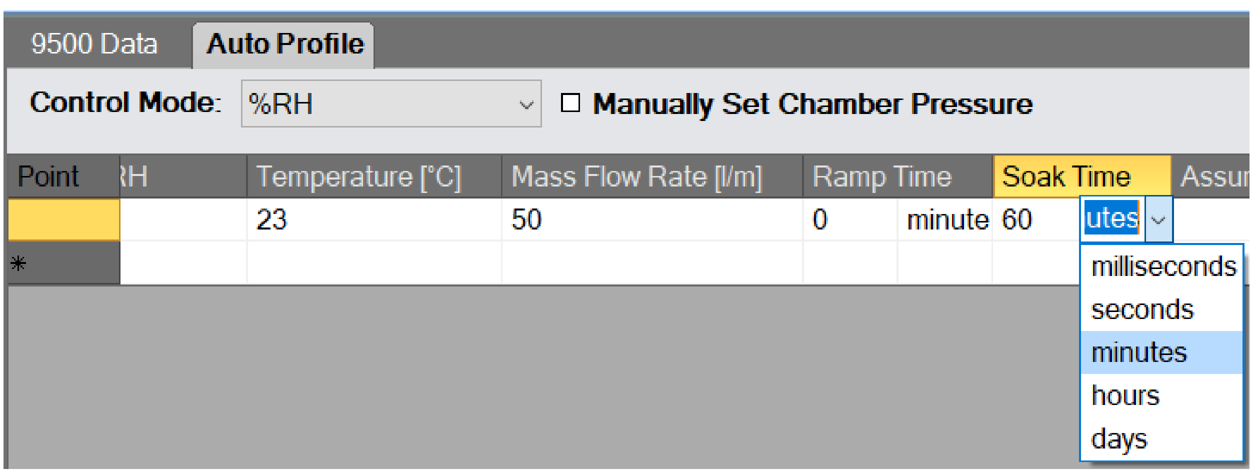


Ramp Time is the desired amount of time the 9500 should take to transition from one profile test point to another. Setting a ramp time of zero instructs the 9500 to make the transition as quickly as possible. Zero is the setting used for most profiles.

Note – *The first point cannot have a ramp time because the starting setpoints can vary.*

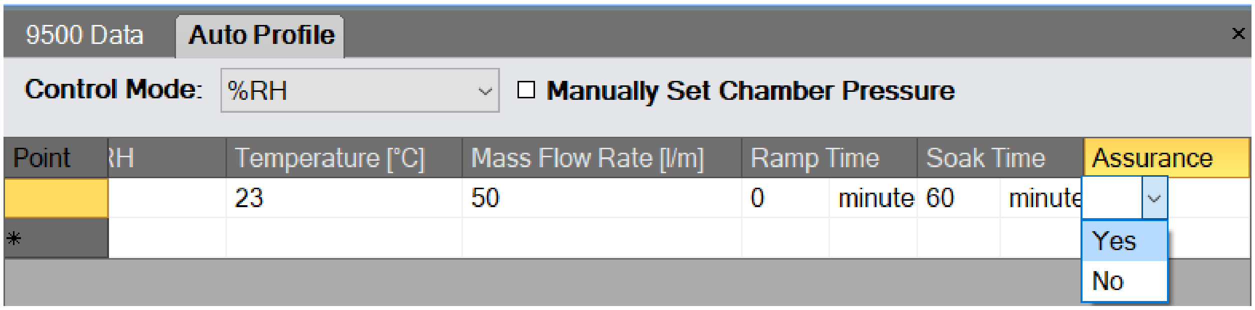


Soak Time is the desired amount of time to generate at a particular profile point. The required soak time depends on the application but should be a significant amount of time-based on the humidity devices being calibrated.

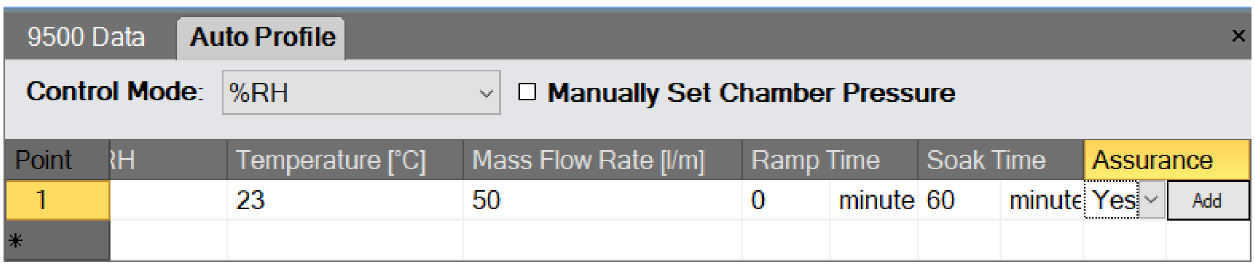


Note – *Both Ramp Time and Soak Time are limited to a maximum time of 24.855 days. You will likely run out of water before this maximum time is reached.*

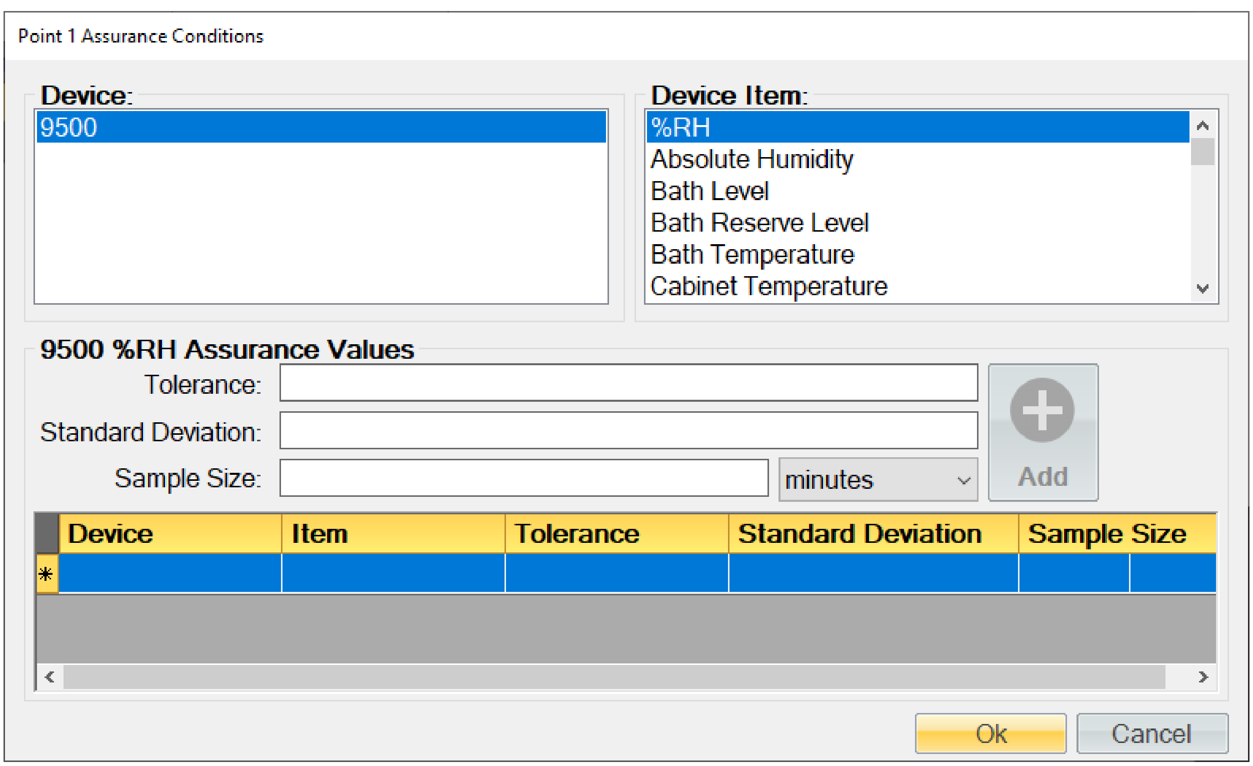
If set to "Yes," assurance forces the system to wait until the measured values are within a specified tolerance and/or stability before ControLog starts the Soak Phase. If *"No"* is set, the Soak Phase starts immediately upon completion of the Ramp Phase.



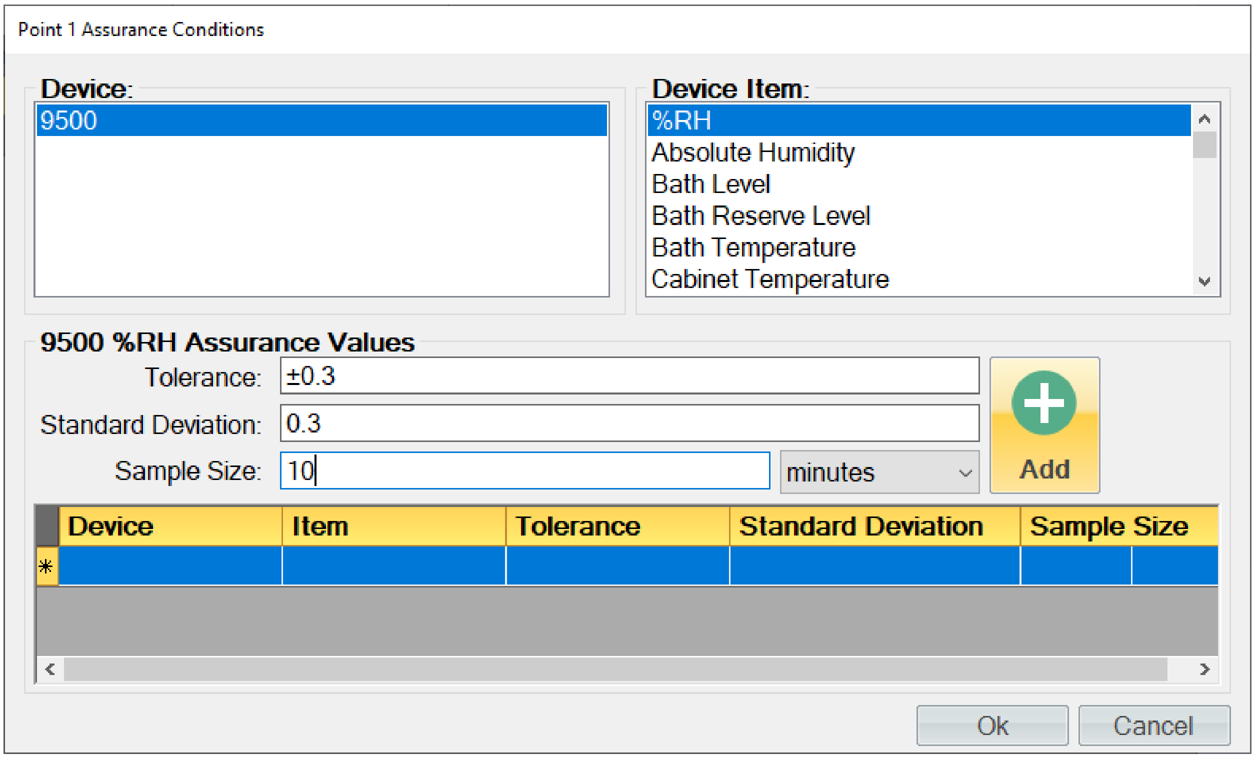
If Assurance is set to *"Yes,"* a small "Add" button appears on the right-hand side.



The "Add" button opens the "Assurance Conditions" dialog for the point. The dialog allows the user to enter various assurance conditions for the profile point.



On the upper left-hand side is a list of all available devices. Selecting a device results in the "Device Items" lists being updated to reflect the available items for the selected device. To add an item, highlight the desired item in the Device Item list, enter the desired Tolerance and/or Standard Deviation and click the "Add" button. For quicker assurance times, increase the Tolerance and/or the Standard Deviation values. Tighter tolerances or standard deviations (smaller values) result in longer assurance times. Setting these values too small could prevent assurance conditions from being met, preventing the system from advancing to the next profile point.



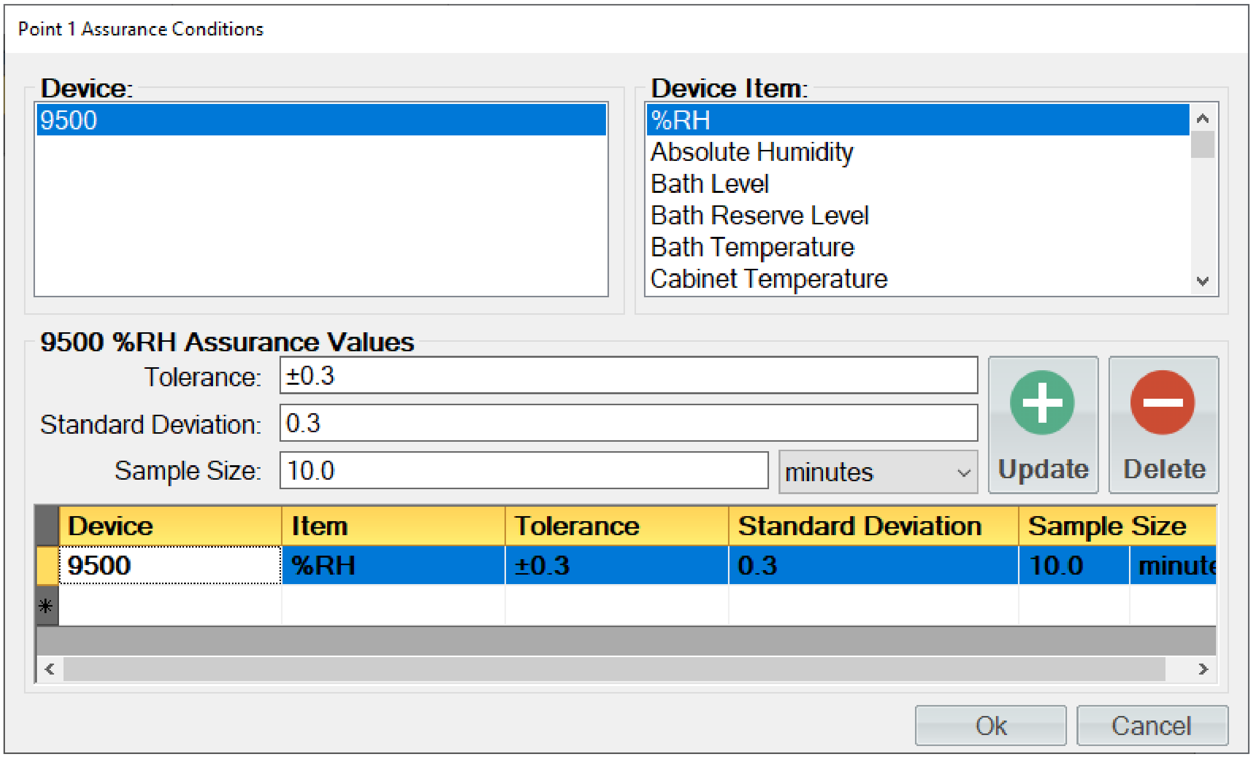
Tolerance is the allowable variation between the setpoint and the actual. This is best thought of as a window based on a minimum and maximum value, the minimum being the setpoint minus the tolerance and the maximum being the setpoint plus the tolerance. Once the actual value is within the window, the tolerance portion of the condition is considered met.

> **Note** – *Tolerances can only be entered for 9500 setpoints. The field is grayed out for all other non-9500 setpoint device items. This is because ControLog can only assure a tolerance for an item that it can directly control. Remember, the 9500 directly controls Bath Fluid Temperature, which then indirectly controls Saturation and Chamber Temperature. If you want a tolerance on the temperature, you need to use Bath Temperature instead of Saturation or Chamber temperature.*

Standard Deviation is a statistic used to measure the variation in the actual data and can be thought of as how spread out or stable the data is. ControLog calculates the Standard Deviation from the device data tab for the points within the given **Sample Size**. When the actual standard deviation is less than the defined limit, the standard deviation portion of the condition is considered met.

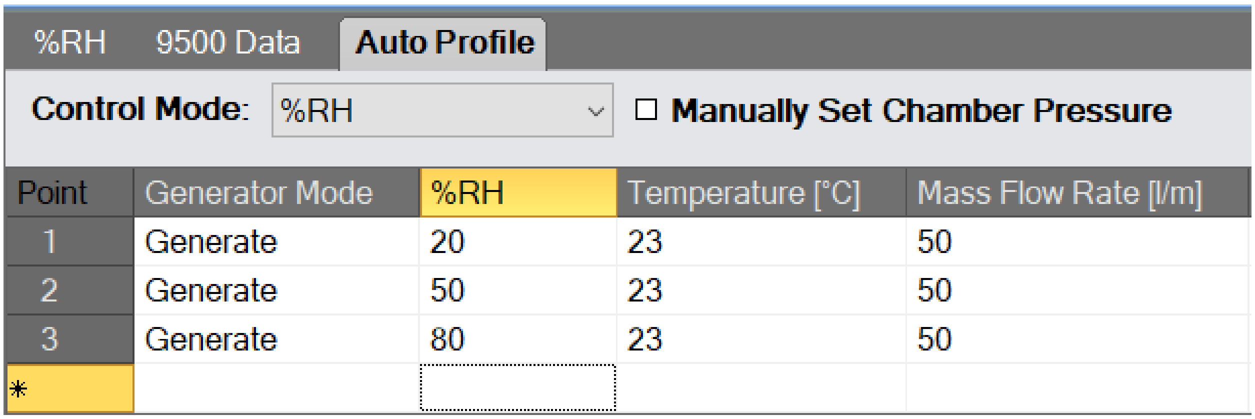
Note – *The sample size should always be carefully considered based on the data storage interval. Too small of a sample size in relation to the data storage interval results in a small number of points used to calculate the Standard Deviation.*

To update an assurance condition, select the desired condition from the list at the bottom, make the desired changes and select the Update button. To delete an assurance condition, select the desired condition from the list at the bottom and select the Delete button.

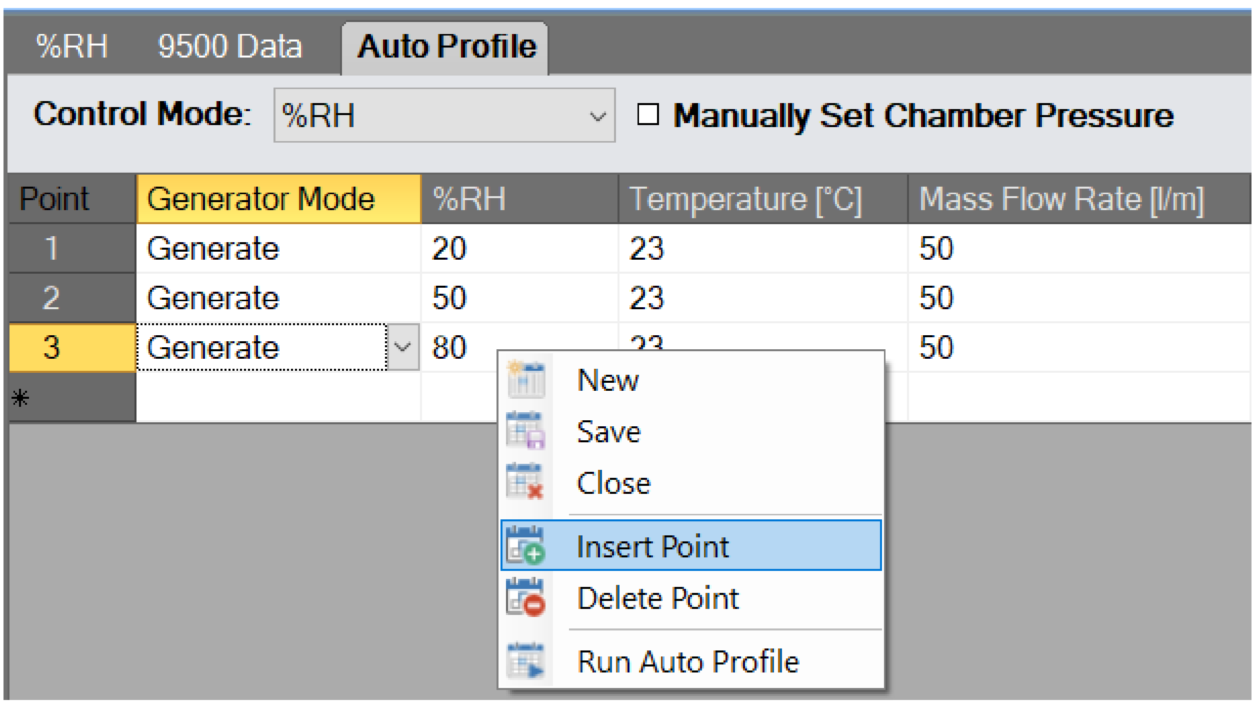


Once all assurance conditions have been completed, select the “Ok” button to close the dialog.

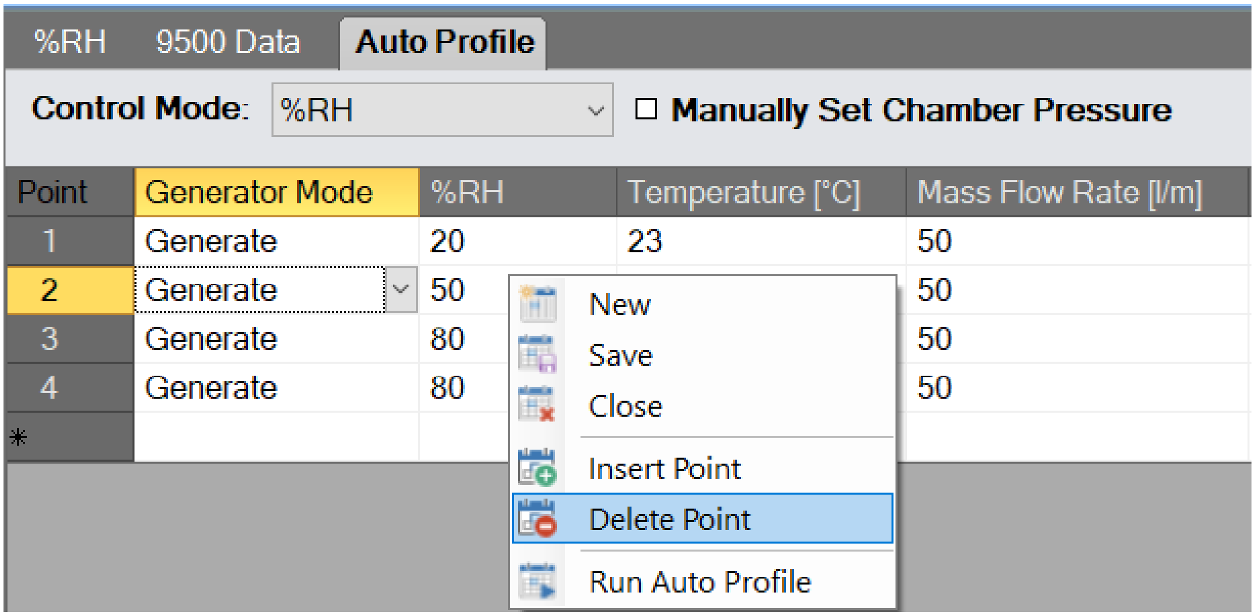
Adding more points to the auto profile is the same process as entering the first point, but the user can let ControLog help fill in values for the new point by simply entering the desired values and selecting the new point line (indicated by the * asterisk). ControLog predicts values for an empty field by either copying the values from the point above or continuing the previous points' pattern. For example, if the previous %RH points were 20% and 50%, ControLog automatically uses 80% for the next point if the user leaves that field empty.



New points can be inserted between existing points by long pressing or right-clicking and selecting “Insert Point” from the context menu. ControLog inserts a new point at the selected location and automatically predicts the values.



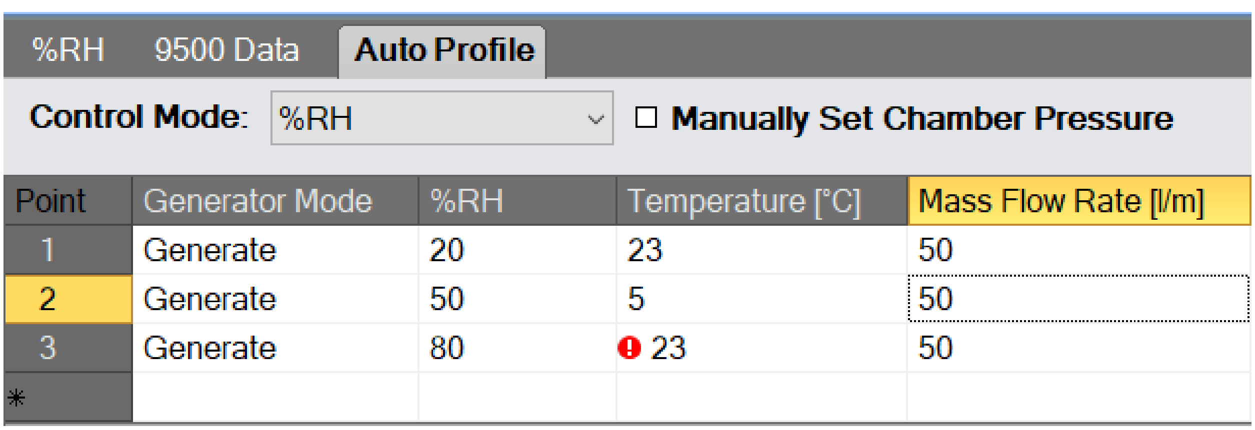
Existing points can also be deleted by selecting the desired point and then by long pressing or right-clicking and selecting “Delete Point” from the context menu.



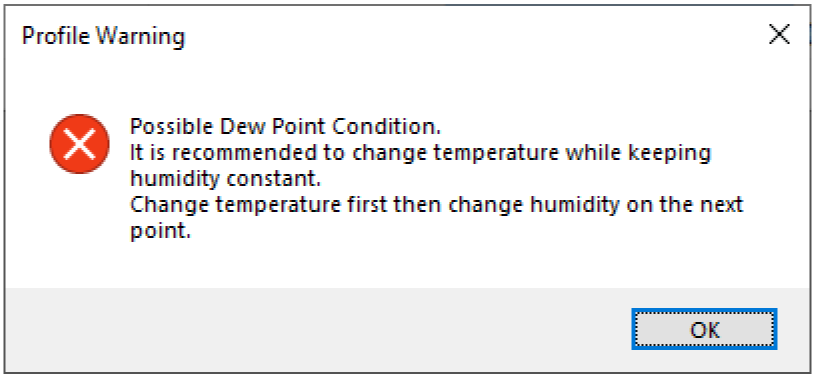
Profile points that cause operational issues for the 9500 are automatically flagged by ControLog and are indicated by a red circle with an exclamation point .

CAUTION!

THE USER SHOULD ADDRESS AND RESOLVE ALL ISSUES BEFORE ATTEMPTING TO RUN THE AUTO PROFILE.



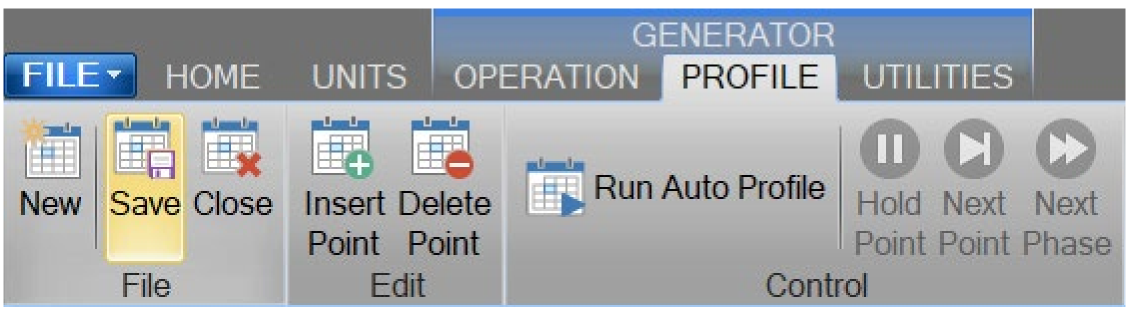
An explanation of the issue is also displayed.



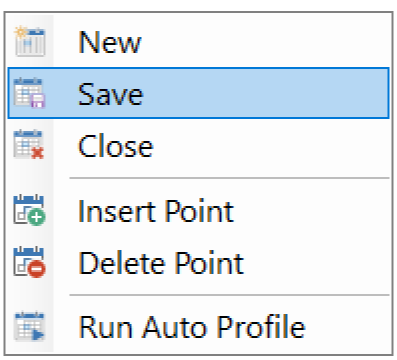
9.2 Saving a Profile

The Profile tab can be saved to a file for future recall. ControLog Auto Profiles are saved in XML format with a *.profile extension.

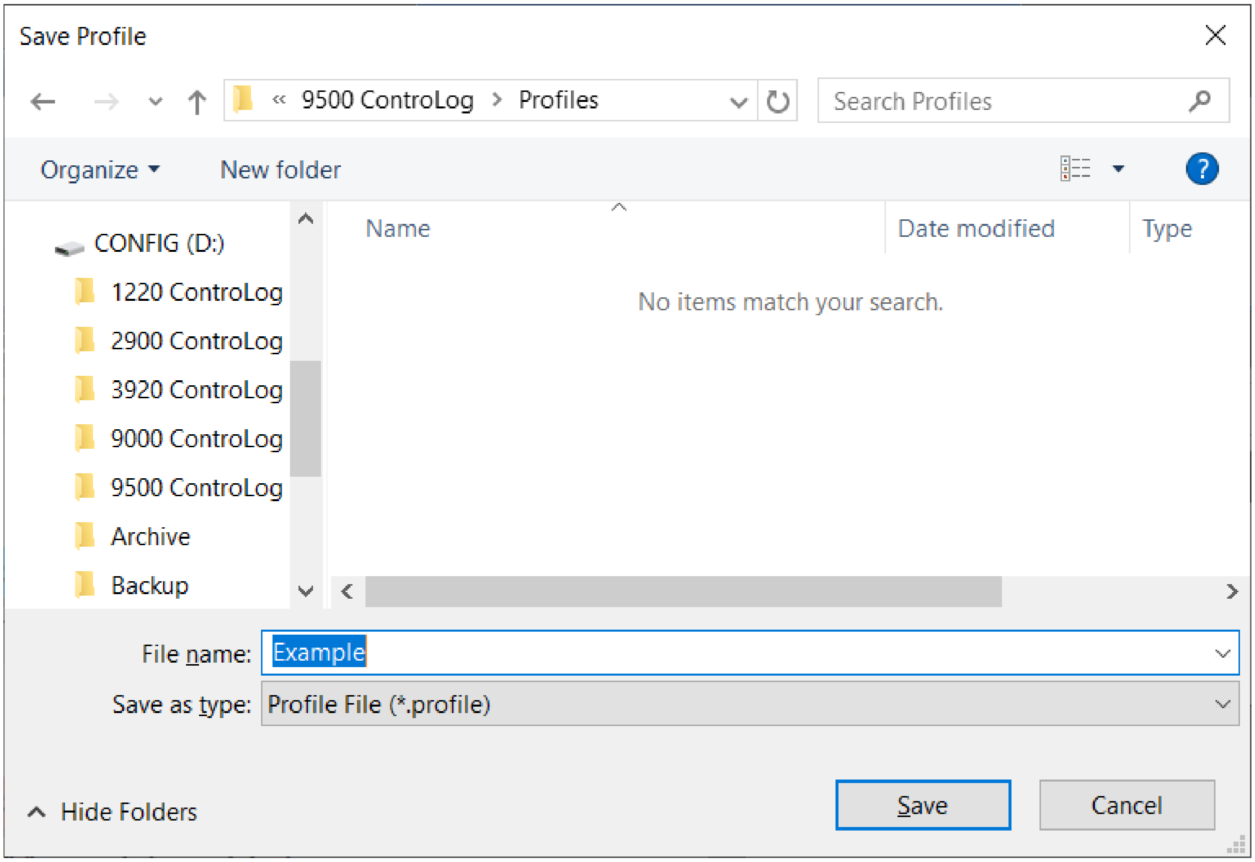
To perform the save, select "Save" from the main menu or right-click a profile tab and select "Save."



Or



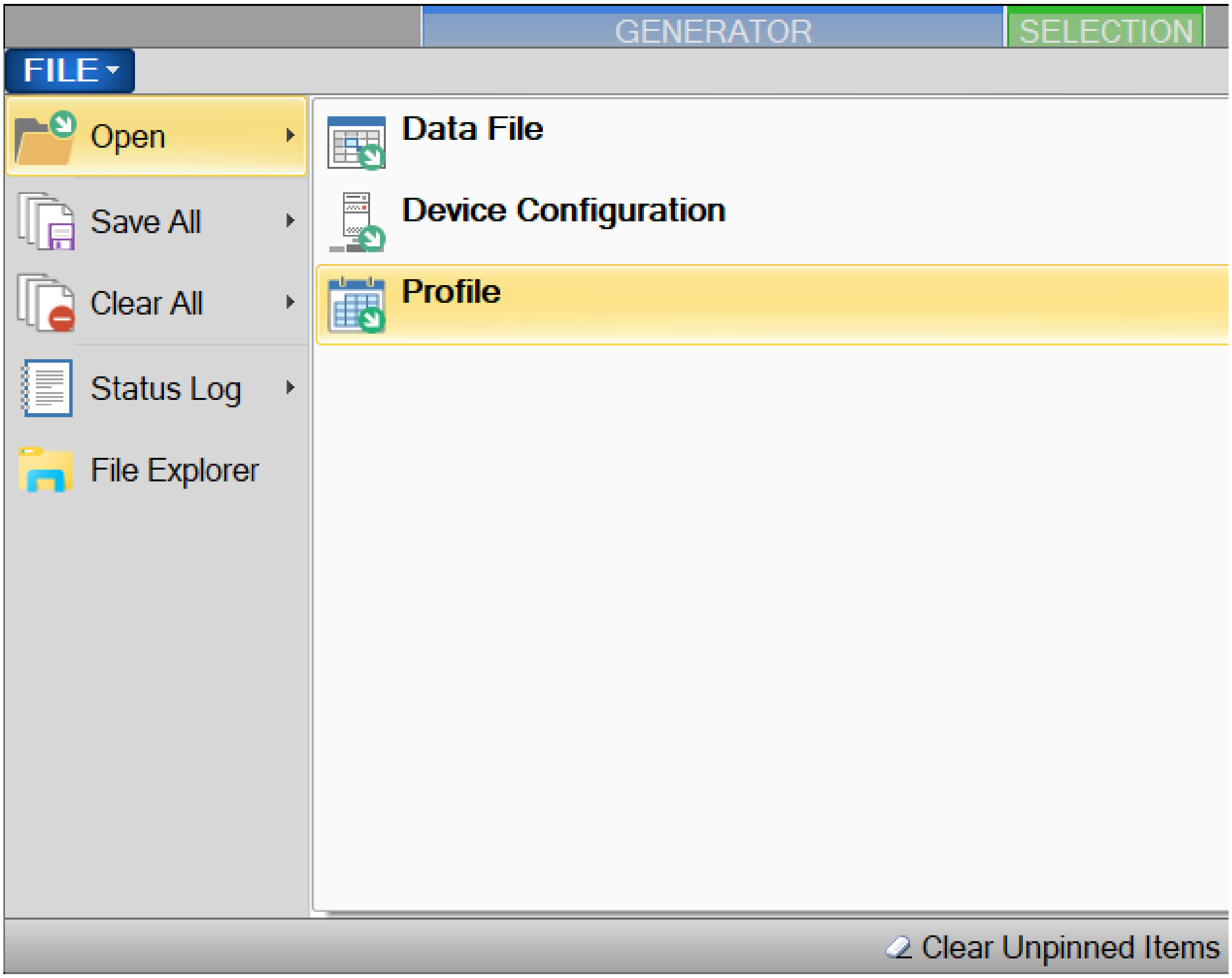
Using the “Save Profile” dialog, select the location and name you want to save the profile as.



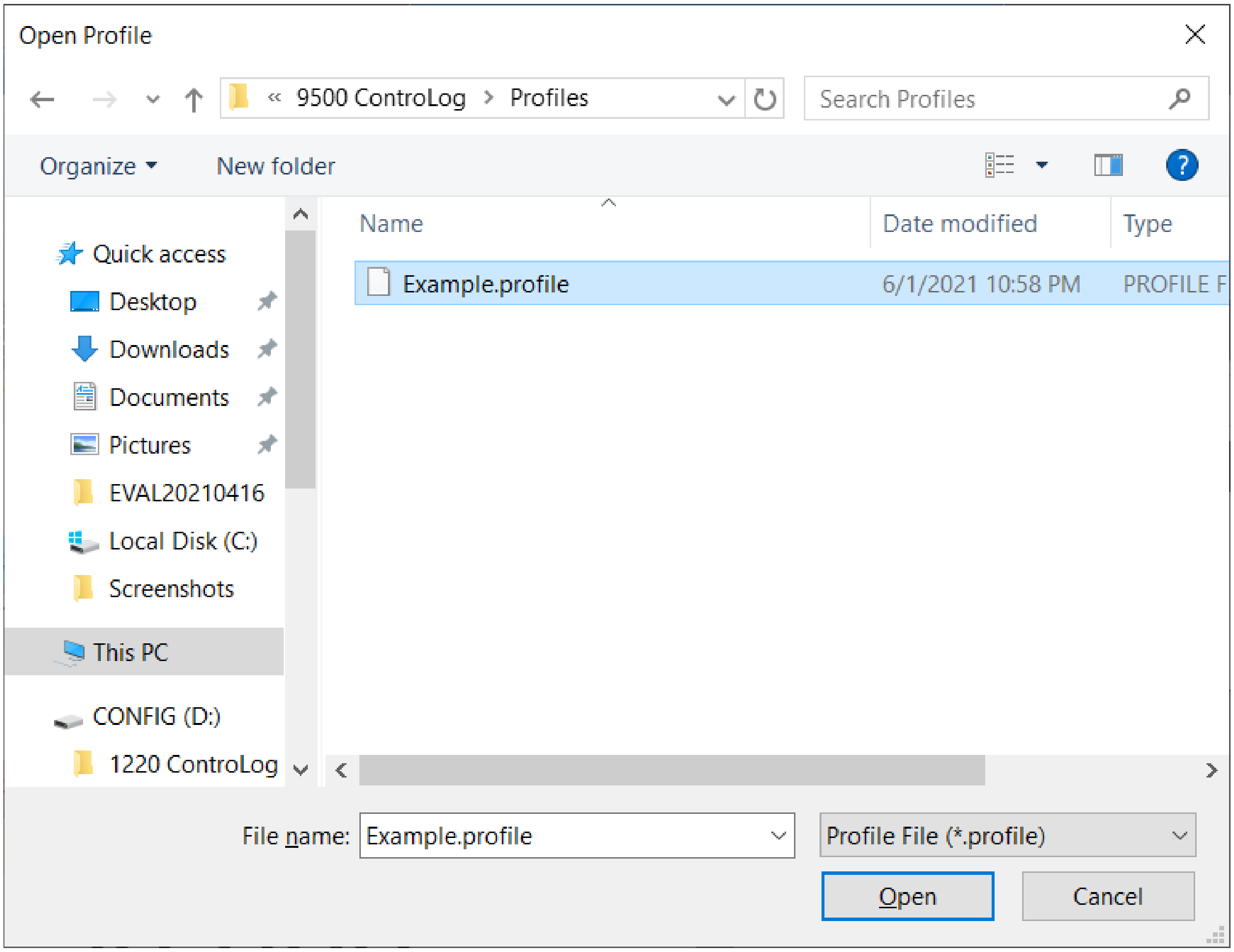
9.3 Opening a Profile

Profiles can be loaded from previously saved profile files.

Select "Open" then "Profile" from the File menu to open a profile file.



Using the “Open Profile” dialog, browse and select the profile file you want to open.

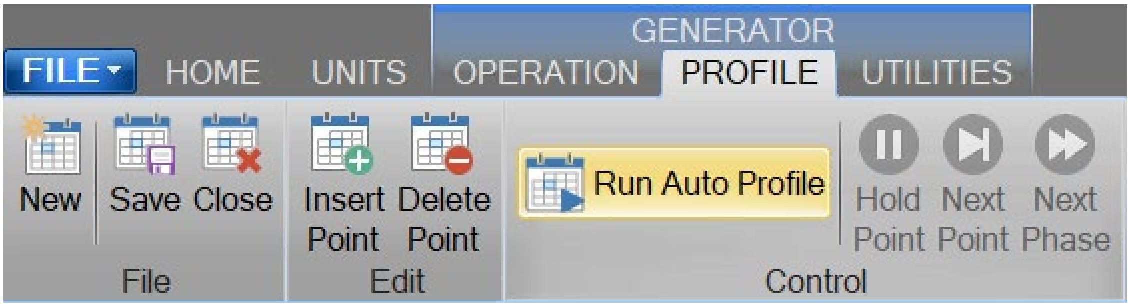


Once the load is complete, the profile tab is displayed with the loaded profile points.

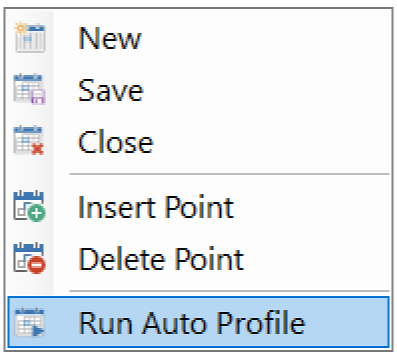
9.4 Running an Auto Profile

To run an auto profile, select "Run Auto Profile" from the main menu or right-click a profile tab and select "Run Auto Profile."

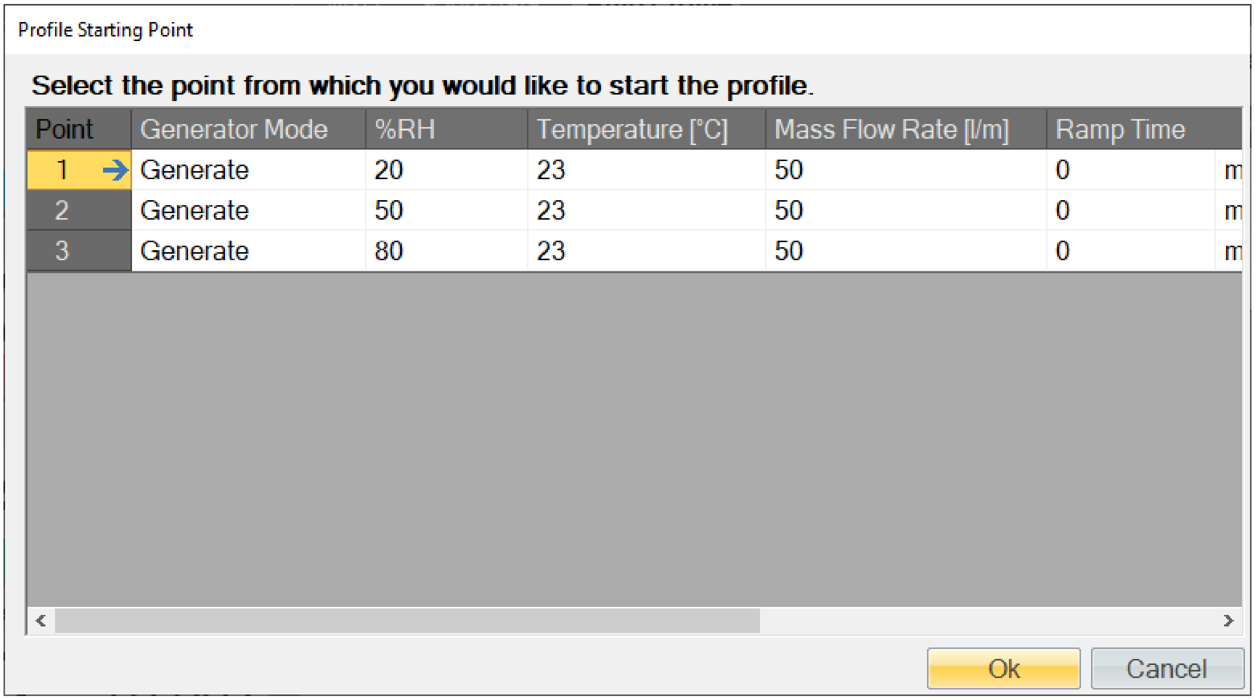
> **Note** – *Manual setpoint and mode changes are not allowed while operating the system in the Auto Profile mode.*



Or



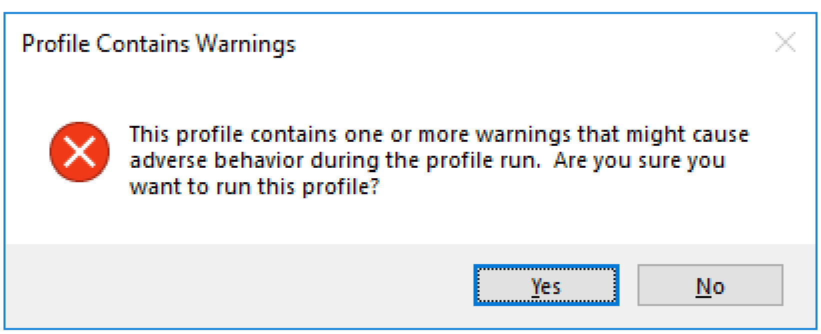
The selection opens the “Profile Starting Point” dialog, allowing the user to select which point in the profile they would like to start. This feature allows users to skip to the desired point within the auto profile.



If the profile contains errors indicated by a red circle with an exclamation point on the profile, a warning message appears when the user tries to run the profile.

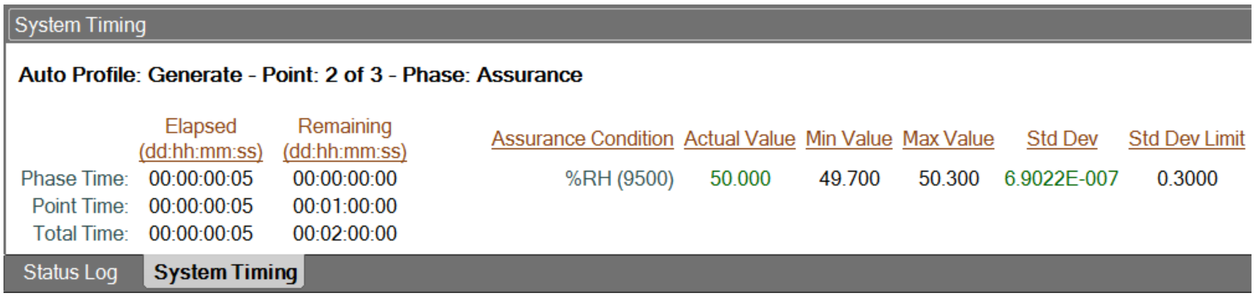
CAUTION!

RUNNING A PROFILE WITH ERRORS MAY CAUSE ADVERSE BEHAVIOR DURING THE PROFILE RUN. THE USER IS STRONGLY ENCOURAGED TO ADDRESS AND FIX ALL PROFILE ISSUES BEFORE ATTEMPTING TO RUN THE PROFILE.

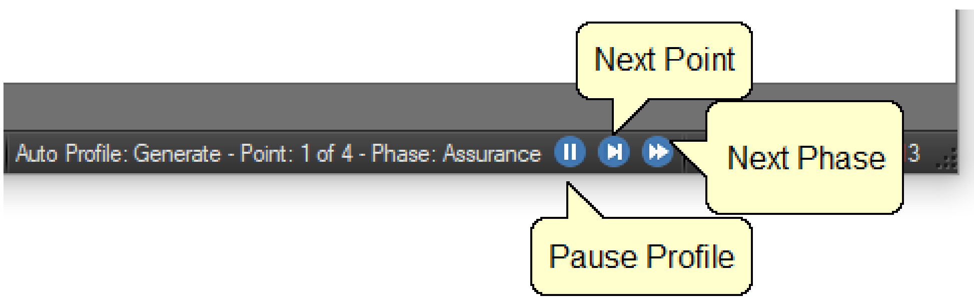


Once the auto profile begins, ControLog sends the commands and setpoints for the starting profile point. The System Timing tab is displayed in the information tab group, and the Auto Profile Controls and Status appear in the status bar.

The System Timing tab gives detailed information on the Auto Profile as it runs. The elapsed and remaining Phase, Point, and Total time are listed along with the detailed assurance conditions values and tolerances.



The Auto Profile Controls and Status consist of the generator run state for the current profile point, the profile point the system is currently running, and the current point phase. It also consists of three shortcut buttons to control the operation of the auto profile. There is a “Pause Profile” button, advance to the “Next Point” button, and advance to the “Next Phase” button. These are the same commands that are available in the profile menus.



9.4.1 Understanding Profile Phases

Each profile point consists of three phases: Ramp, Assurance, and Soak. Each phase accomplishes a specified task.

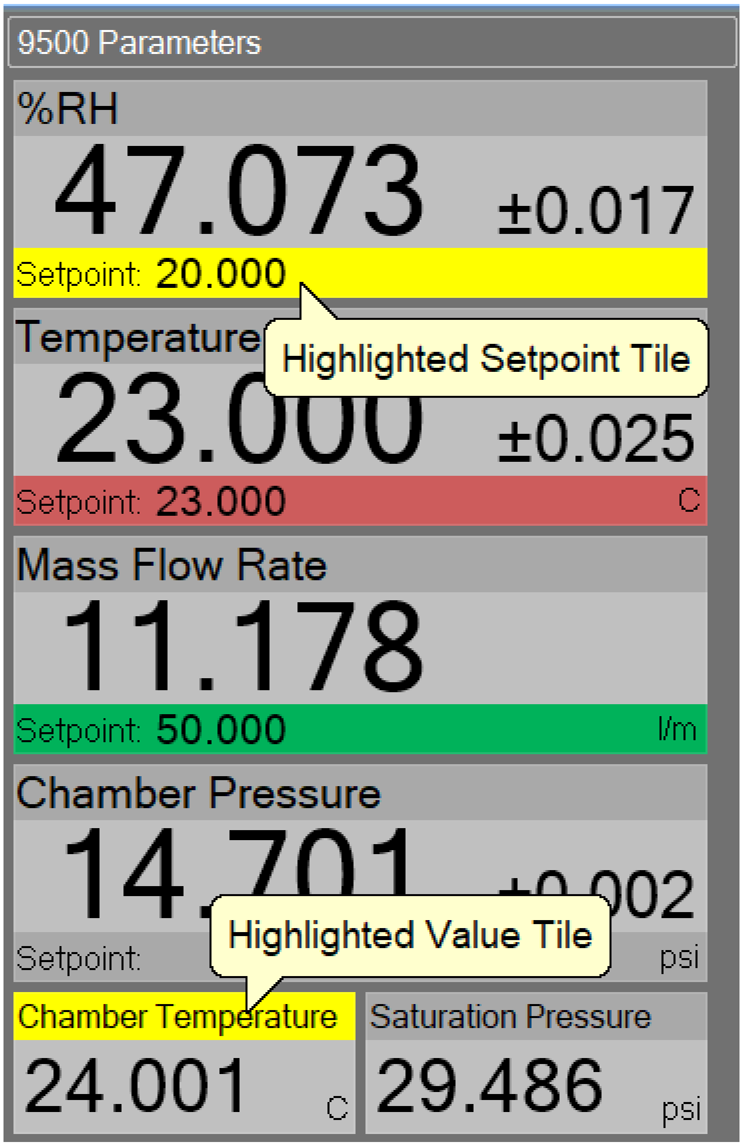
9.4.1.1 Ramp Phase

The Ramp Phase is used to linearly transition from one point to the next in a given amount of time.

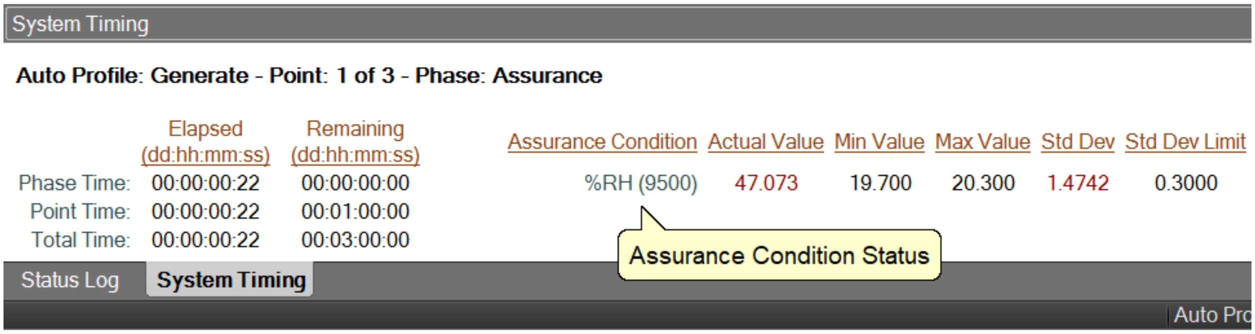
9.4.1.2 Assurance Phase

The Assurance Phase forces the system to wait until measured parameters, and setpoint values are within a specified tolerance and/or stability before the computer starts the Soak Phase.

During the assurance phase, assurance conditions that have not been met are displayed with a yellow footer block for Setpoint Tile and a yellow header block for Value Tile on the parameter tab of the device containing the condition.



The system timing tab provides a detailed view of each assurance condition for the current point. The actual value of each condition is displayed in red if not met and displayed in green once met. The system timing tab also displays the condition's tolerance and standard deviation criteria.



> **Note** – *The assurance phase is active for a minimum of 30 seconds. This delay allows the 9500 to calculate setpoints before ControLog begins to assure each condition.*

9.4.1.3 Soak Phase

The Soak phase is the desired amount of time to generate at a particular point before proceeding to the next.

9.4.1.4 Example 1

Point	Generator Mode	%RH	Temperature [°C]	Mass Flow Rate [l/m]	Ramp Time		Soak Time		Assurance
1	Generate	20	25	50	0	hours	1	hours	No

Example 1 causes the Soak phase to begin immediately at the start of the profile point, even though the 9500 may still be adjusting to the point. The next point starts after the 1-hour soak phase.

9.4.1.5 Example 2

Point	Generator Mode	%RH	Temperature [°C]	Mass Flow Rate [l/m]	Ramp Time		Soak Time		Assurance
1	Generate	20	25	50	0	hours	1	hours	Yes

Example 2 causes the Assurance phase to begin immediately at the start of the profile point. Measured values are continually compared with the setpoint values until they agree with the set tolerance and/or the measured values are stable to within the specified degree. Once assured (tolerances met), the Soak phase begins. The total time required for this point varies and depends upon the amount required for assurance (dictated by tolerances). Total time, for example, 2 is elapsed assurance time plus 1 hour.

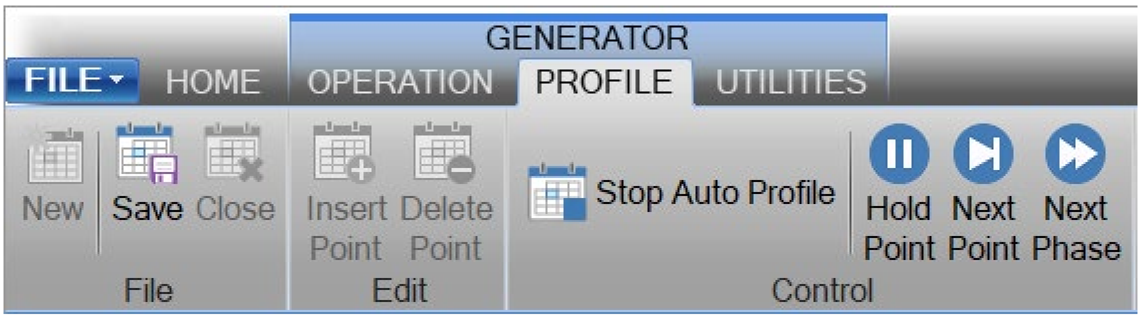
9.4.1.6 Example 3

Point	Generator Mode	%RH	Temperature [°C]	Mass Flow Rate [l/m]	Ramp Time		Soak Time		Assurance
2	Generate	30	25	50	15	minutes	1	hours	Yes

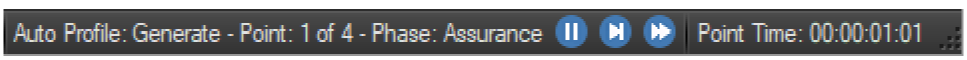
The Ramp phase (Ramp Timer) begins at the start of the point. The system adjusts slowly toward the setpoint, taking 15 minutes. Once the ramp time has elapsed, assurance starts and waits for tolerances to be met. When tolerances are met, the soak phase begins and lasts 1 hour. The total time for example 3 is 15 minutes, plus elapsed assurance time, plus 1 hour. Assurance time is a variable and depends on tolerances.

9.4.2 Manual Override of Profile

Although the system operates automatically, some manual control is allowed using the Hold Point, Next Phase, and Next Point menu items on the Run menu or Status Bar.



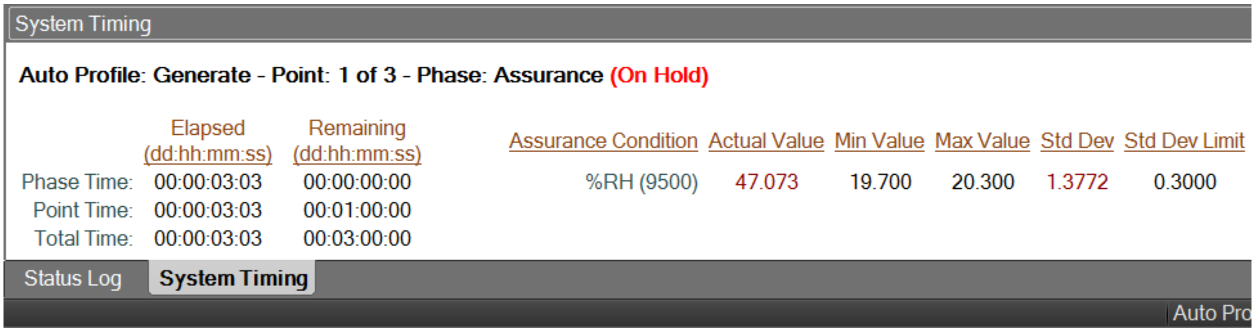
Or



9.4.2.1 Holding the Profile

Selecting Hold Point from the profile menu or status bar stops the current “Remaining Time” timers, allowing the system to remain indefinitely at the current point. While in a hold mode, the system is prevented from completing a point's ramp, assurance, or soak phases.

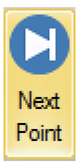
When holding, a hold indicator appears in the System Timing tab, and the hold menu buttons change into resume buttons.



Select the Resume Point from the profile menu or status bar to resume the profile point. This re-enables the timing functions and allows the profile to resume normal operation.

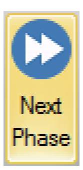
9.4.2.2 Advancing to the Next Point

Selecting Next Point from the Run menu or status bar manually duplicates the action, which automatically occurs when the Point time counter reaches zero.



9.4.2.3 Advancing to the Next Phase

Selecting Next Phase from the profile menu or status bar manually duplicates the action, automatically occurring when a Remaining Ramp or Soak Time counter reaches zero or when the assurance conditions are met. In other words, it causes Ramp Phase to proceed to the Assurance or Soak Phase, Assurance to proceed to Soak, or Soak to proceed to the Ramp of the next profile point. This allows for early manual termination of any phase within a profile point.



9.4.2.4 Stopping the Auto Profile

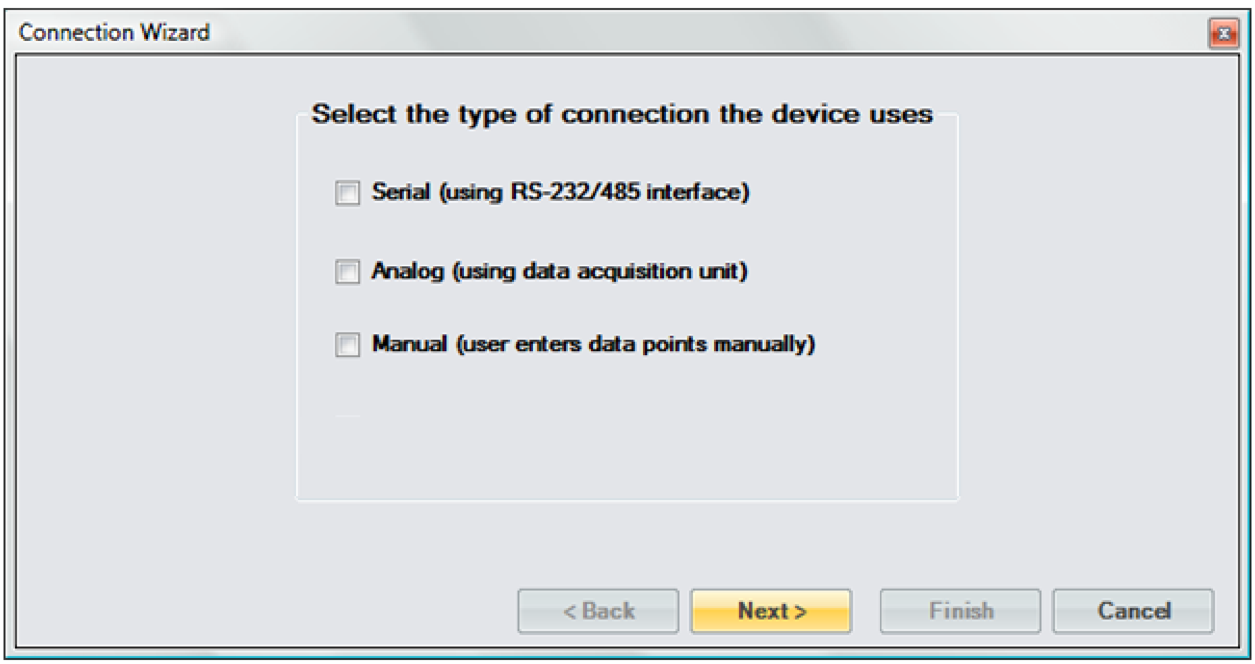
Selecting Stop Auto Profile from the profile menu or context menu terminates the profile at the current point, and the generator continues at its current setpoints for Saturation Pressure, Saturation Temperature, and Flow. Another way to exit the Auto Profile is to switch from Auto Profile to Generate or Shutdown.

10 CONNECTIONS

ControLog supports a customizable interface that works with most devices. ControLog allows the user to create a new device connection using the "Connection Wizard" or open previously saved connections. The wizard opens a separate dialog window containing various steps that guide the user in defining the communication required to receive the desired data items from the device. The user can create as many (up to 60) or as few data items as they see fit for any device. Each data item can be uniquely named and, once connected, is recorded in its own parameter and data tab. ControLog also allows the user to save these interfaces for future use.

Note – *ControLog has a limit of eight devices connected at any given time.*

The "Connection Wizard" allows the user to step through the connection configuration. The user can progress through the connection configuration steps using the "Next" and "Back" buttons. At any time, the user may cancel the new connection or opening of a connection by selecting the "Cancel" button. Once the last step has been completed, the "Finish" button is available to complete the new connection.



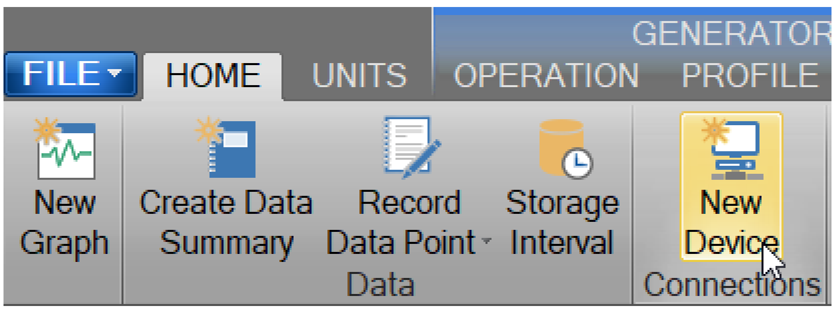
Note – *It is always recommended to have the manufacturer's documentation for the connected device while creating the new connection. It is also recommended to use a terminal-based application to test the various commands before creating a new connection.*

10.1 Serial Connection

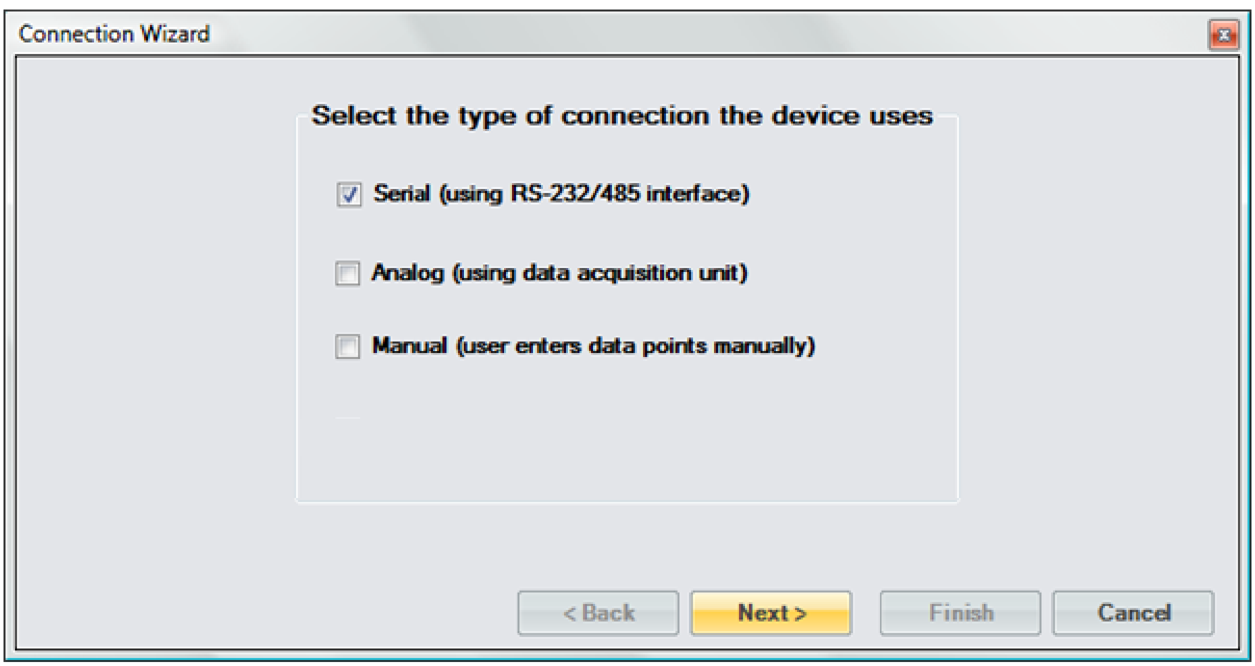
A Serial Connection uses an RS-232 or RS-485 interface to acquire data from a given ASCII-based serial device. The customizable interface provided by ControLog allows the user to define the ASCII commands sent and/or received through the RS-232/485 interface to communicate with the serial device. The system supports both a "request to receive" type of communication and a "receive only" type of communication.

NOTE: MOXA® line of USB to serial adapters are pre-configured to work with the 9500. Contact Thunder Scientific support for more information. Refer to section 2.4 Technical Support.

Select "New Device" from the Home menu tab to create a new serial connection. This opens a "Connection Wizard" dialog that steps the user through the connection definition process.

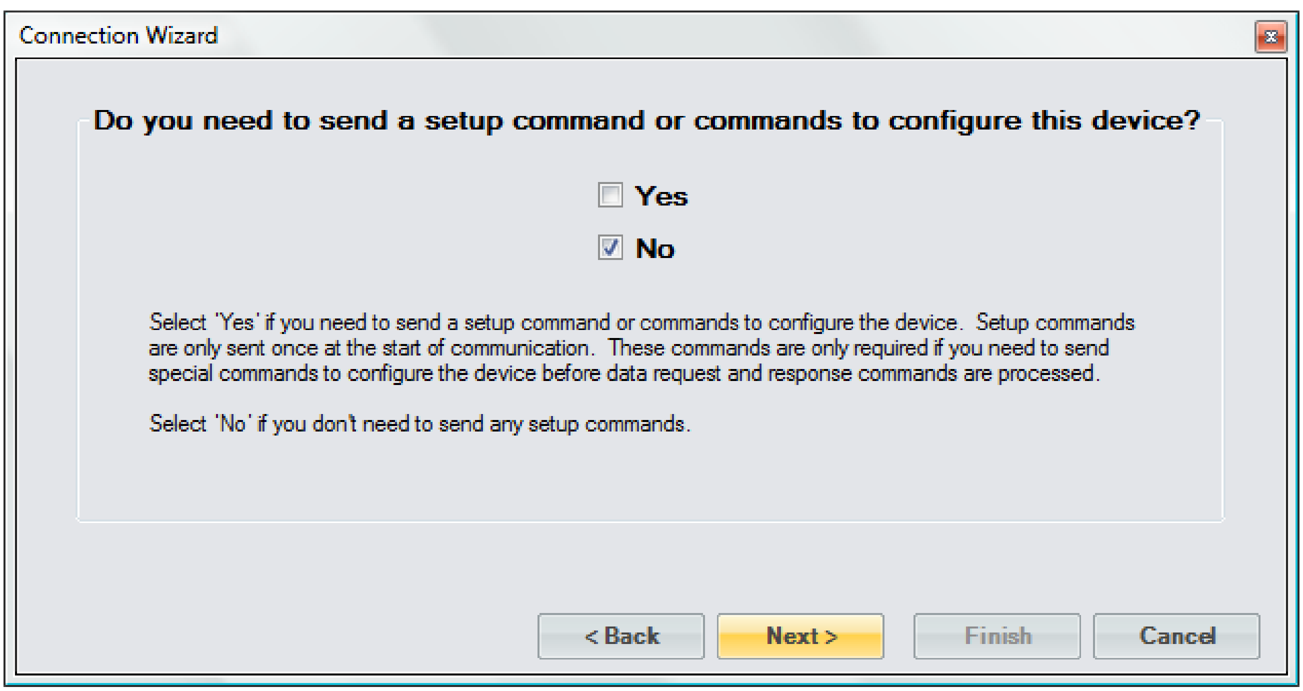


Select "Serial" as the type of connection the device uses.



Enter a unique name for the device.

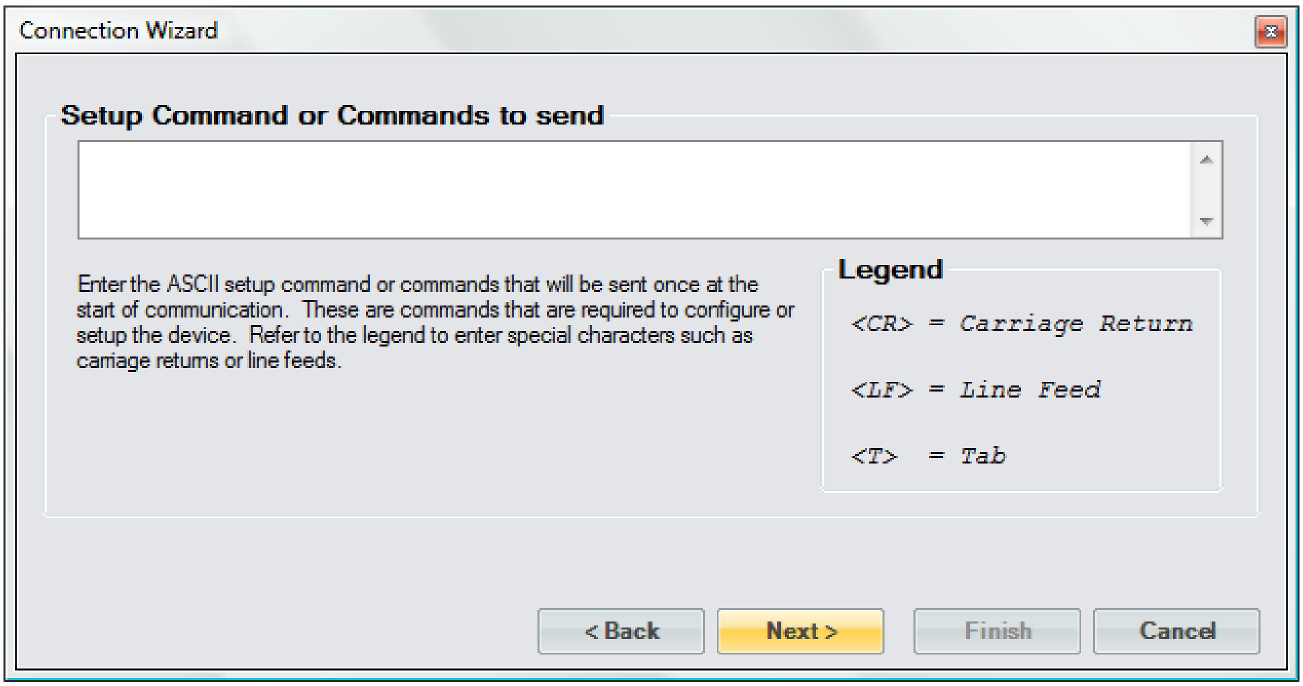
Select whether the device requires a setup command or commands. Setup commands are only sent once at the start of communication. These commands are only required if you need to send special commands to configure the device before data request and response commands are processed.



If setup commands are required, enter the ASCII setup command or commands sent at the start of communication. Refer to the legend to enter special characters such as carriage returns and/or line feeds.

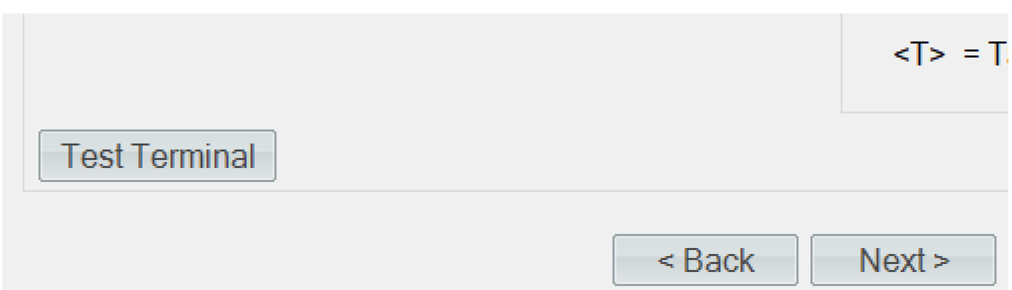
Note – *All commands are case-sensitive.*

Note – *End of Line (EOL) or End of Transmission (EOT) characters, such as carriage returns and/or line feeds, are critical and are the leading cause of failed communication. Refer to the manufacturer's documentation for the device to verify the required EOL or EOT characters.*

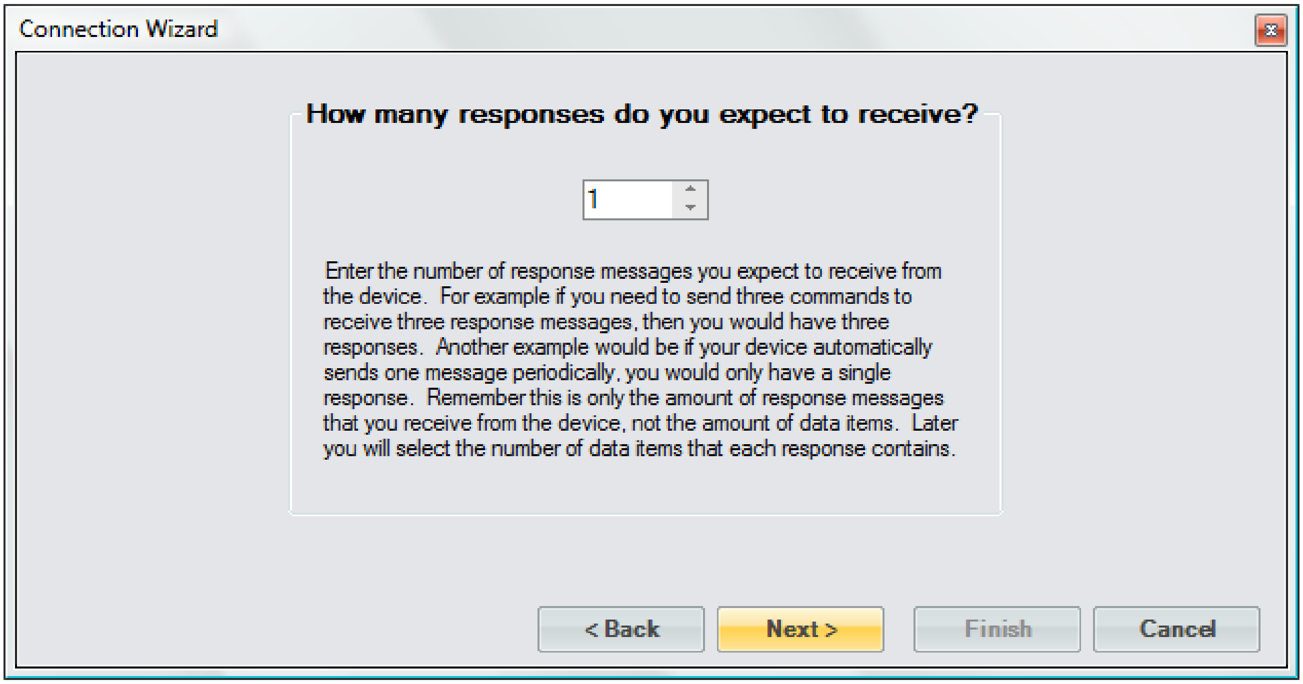


Enter the number of responses you expect to receive from the device. This is the number of response messages you receive from the device, not necessarily the number of data items. A device response message could contain multiple data items. Later you can select the number of data items each response message contains.

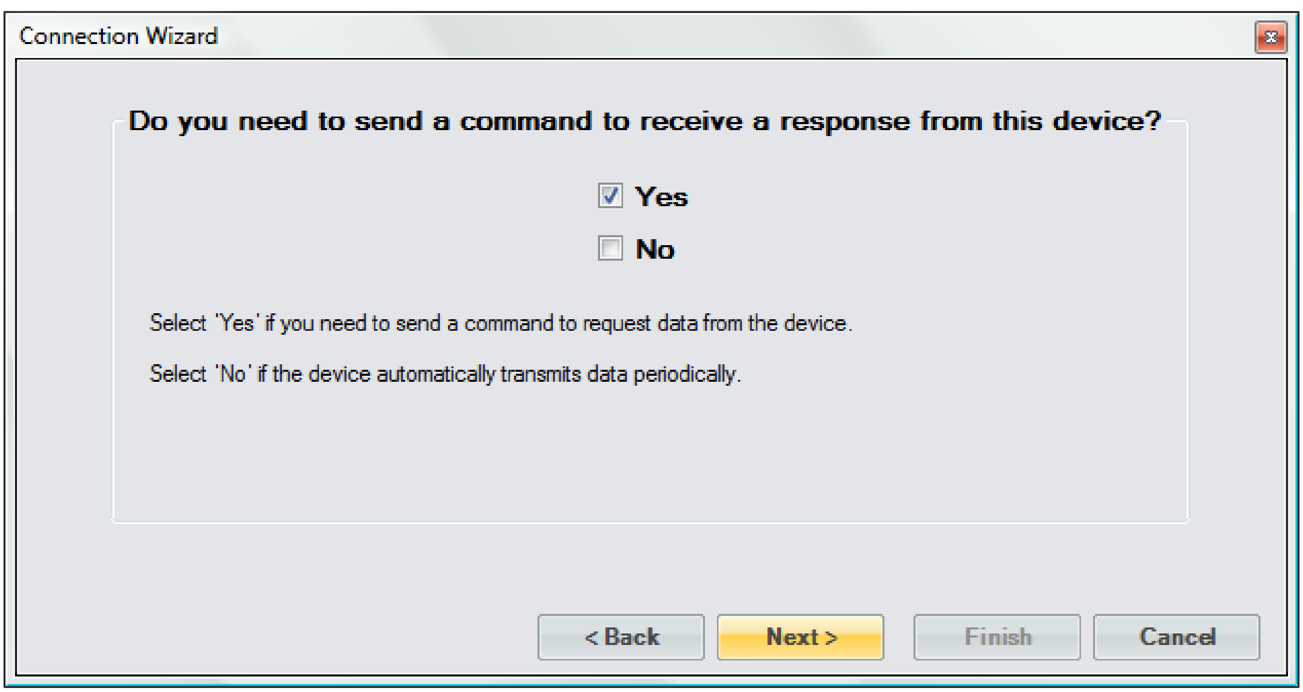
A "Test Terminal" button may appear on systems with a terminal emulator installed. Clicking this button opens the terminal emulator program. The terminal emulator program can aid the user in determining the correct format of a command or the format of a response with a connected device.



For example, if you need to send three commands to receive three response messages, you would enter three. Or, if your device automatically sends one message periodically, you would only have a single response, and you would enter one.

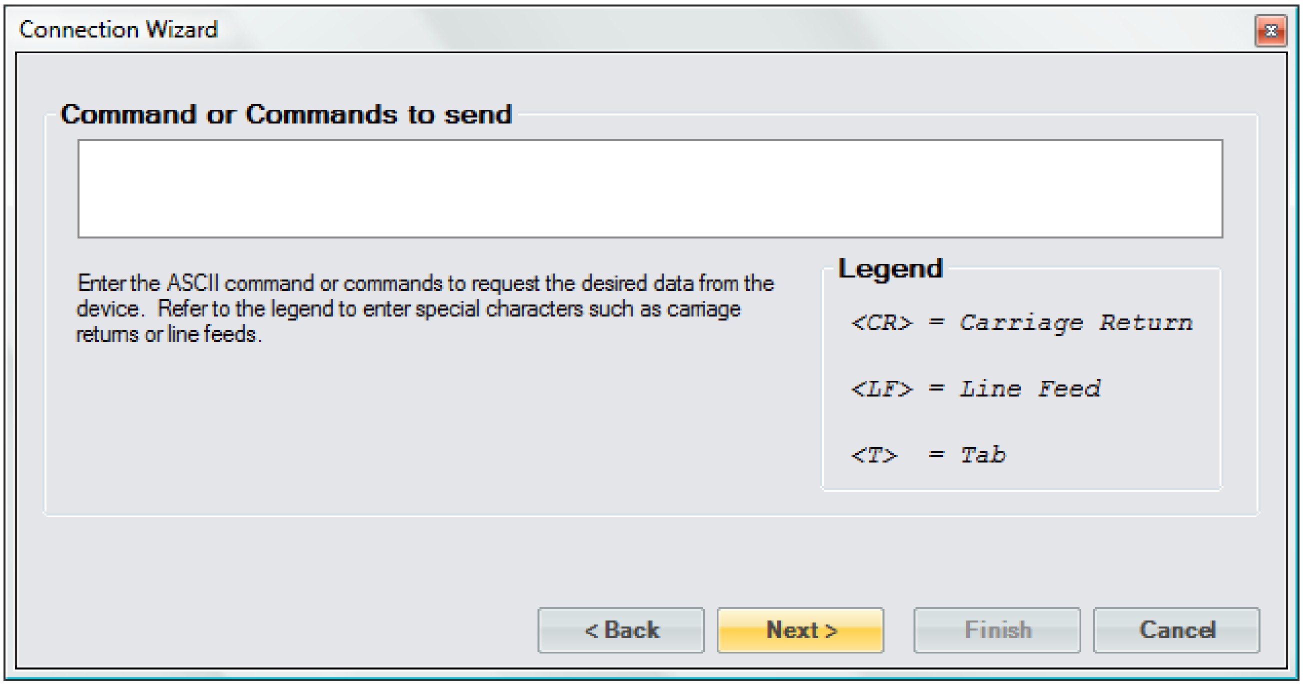


Select whether a command needs to be sent to request a response. If the device requires a command to be sent to receive a response, then select "Yes." If the device automatically outputs data without any request, select "No."

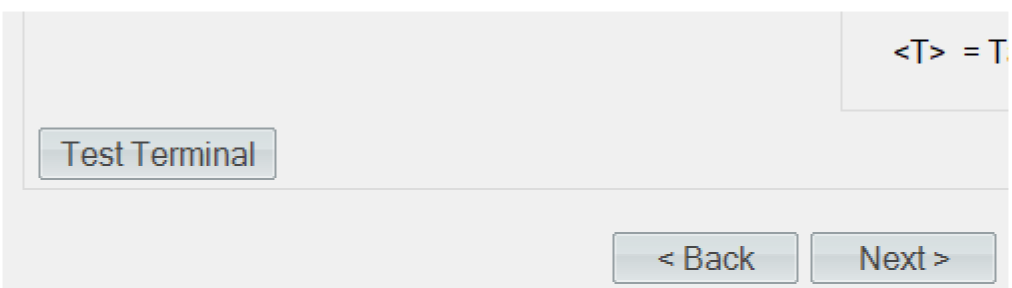


If a command was required, enter the ASCII Command or Commands to request the desired data from the device. Refer to the legend to enter special characters such as carriage returns and/or line feeds.

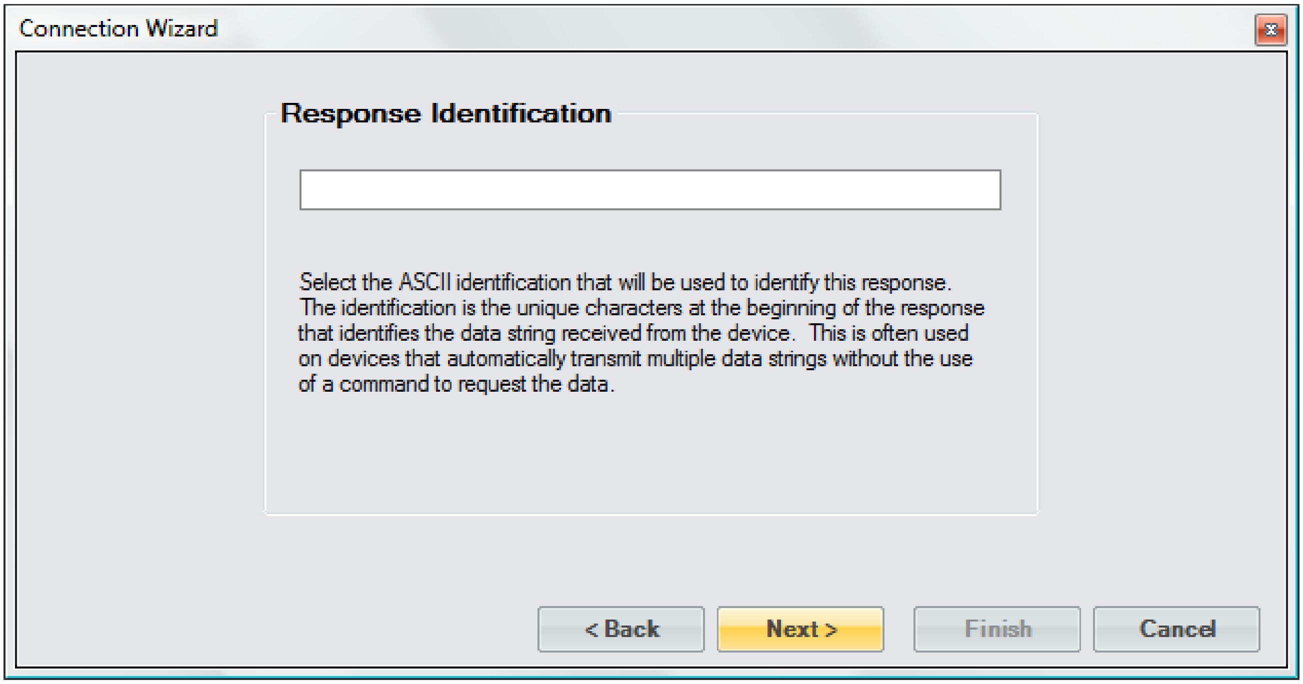
Note – *All commands are case-sensitive.*



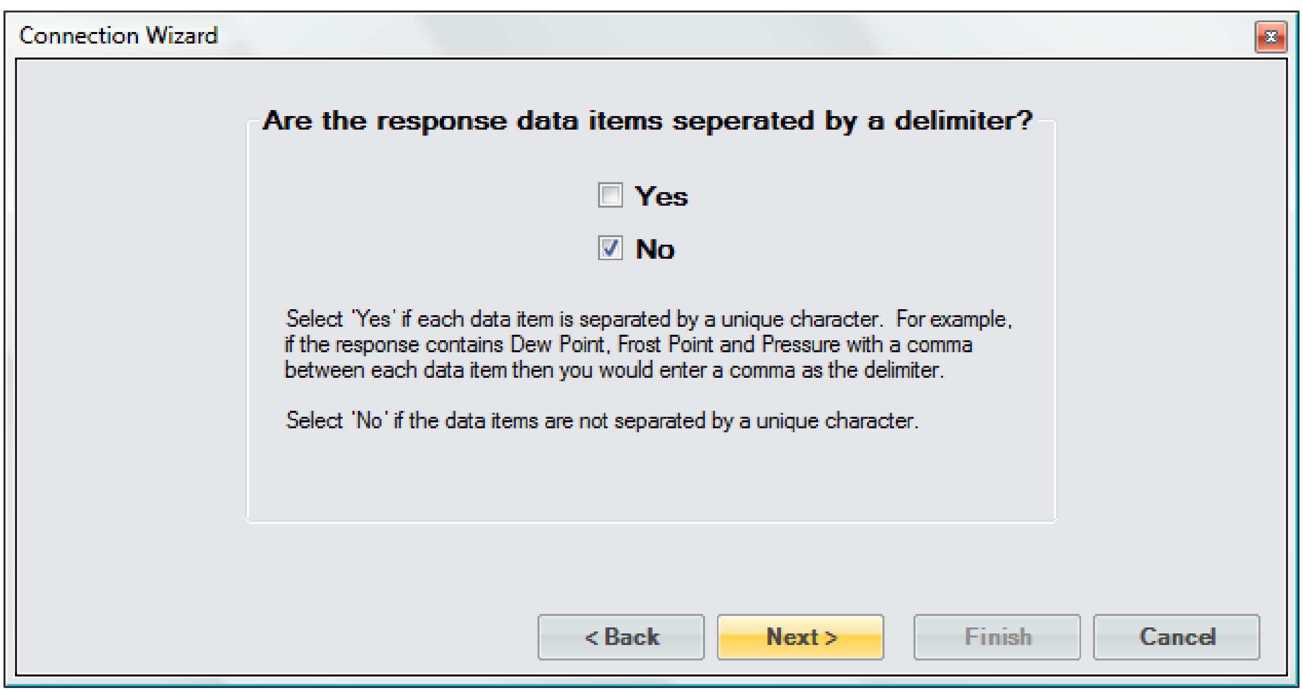
A “Test Terminal” button may appear on systems with a terminal emulator installed. Clicking this button opens the terminal emulator program. The terminal emulator program can aid the user in determining the correct format of a command or the format of a response with a connected device.



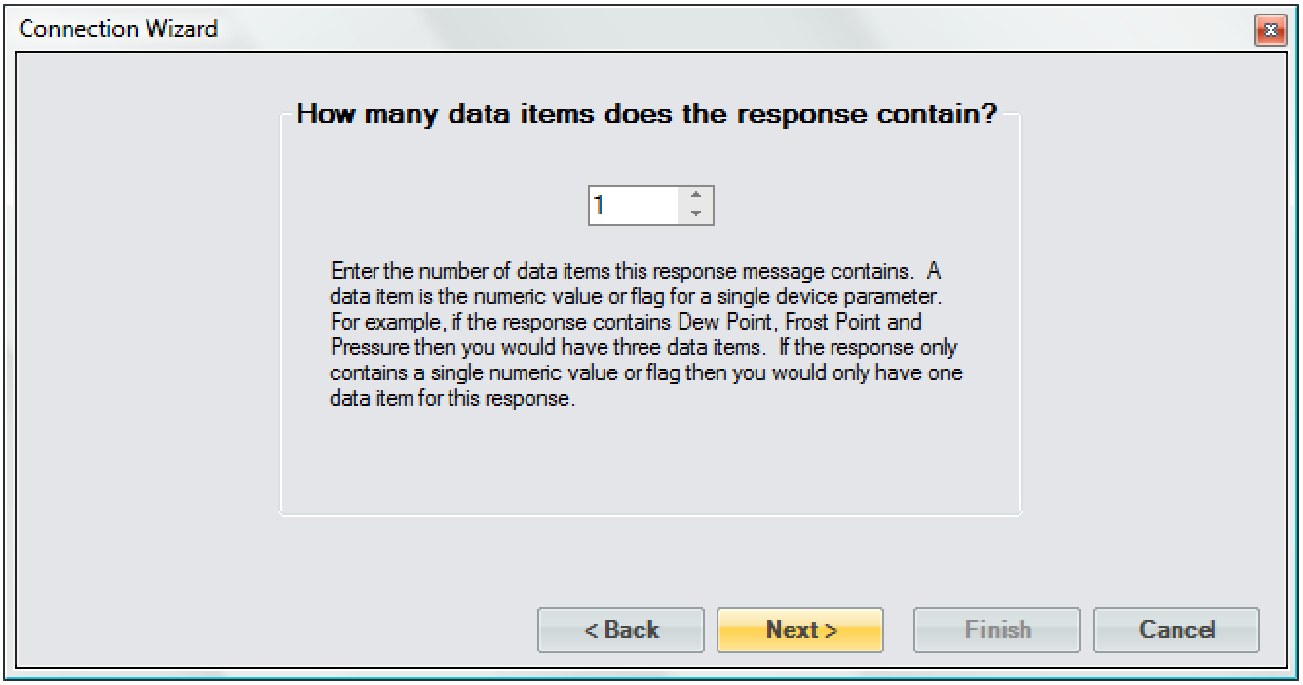
Select the ASCII identification used to identify the response if no command is required, but the device automatically sends messages periodically. The identification is the unique characters at the beginning of the message that identifies the response received. This is often used on devices that automatically transmit multiple data messages without a command to request data.



Select whether the response has a delimiter that separates each data item. For example, if the response contains Dew Point, Frost Point, and Pressure with a comma between each data item, then each item is separated by a comma delimiter.

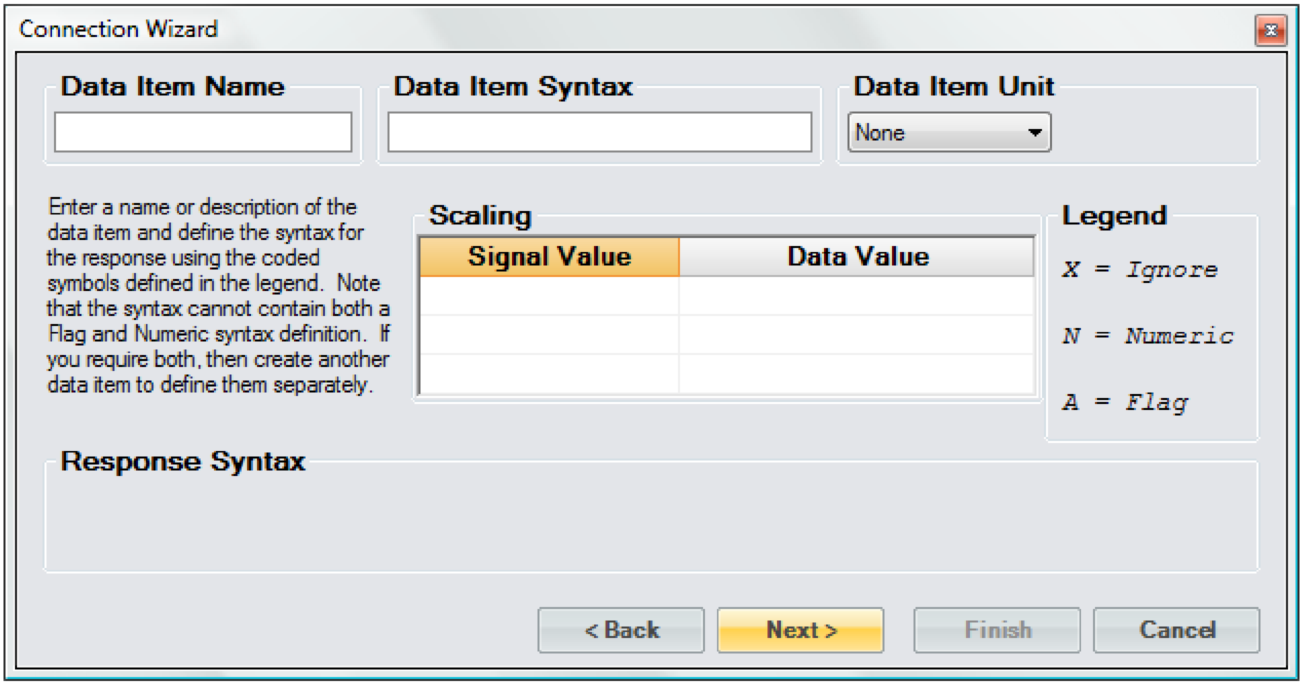


Enter the number of data items the response message contains. A data item is the numeric value or flag portion for a single device parameter within the response message. For example, if the response contains Dew Point, Frost Point, and Pressure, you would have three data items. If the response only contains a single numeric value or flag, then you would only have one data item for this response.



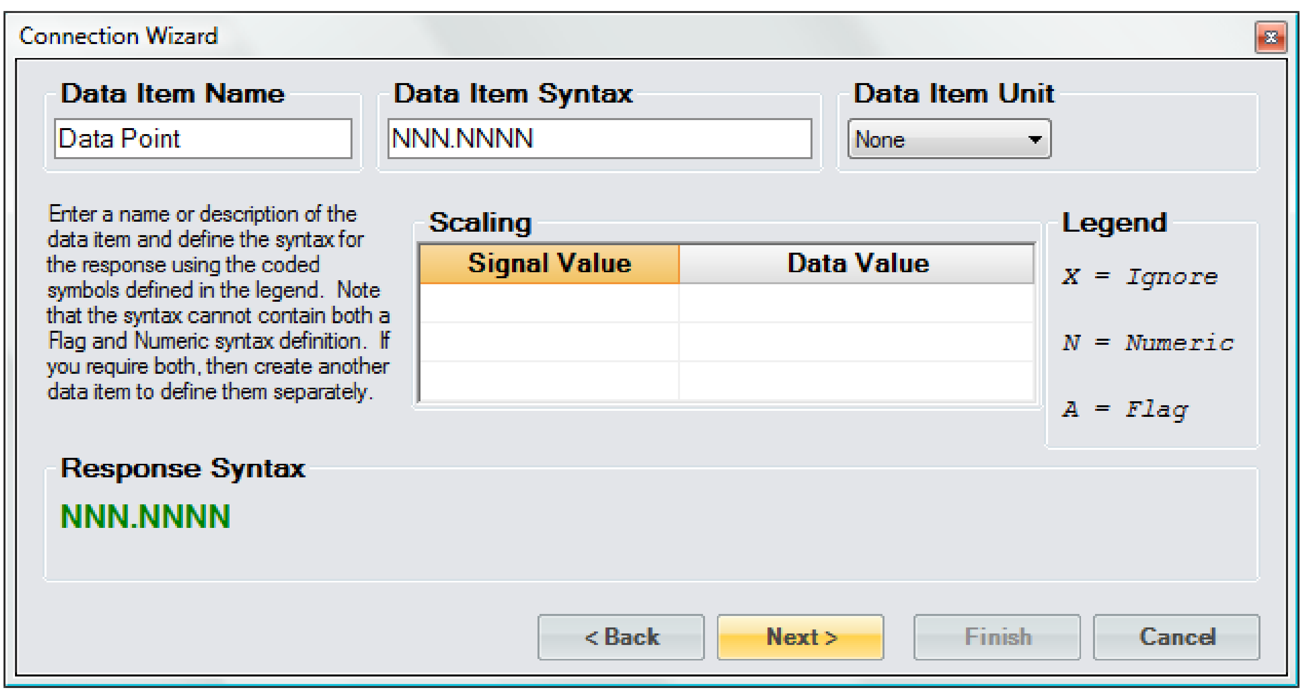
Enter a name or description for the data item and define the syntax, unit, and scaling. The data item syntax is defined using the symbols in the Legend. Use the "X" symbol to indicate a character that should be ignored, use the "N" symbol to represent a numeric ASCII character, and the "A" symbol to indicate a flag or any ASCII character. This dialog repeats for each data item in the response.

> **Note** – *The syntax cannot contain a Flag and a Numeric syntax definition. If the user requires both, create another data item to define them separately.*



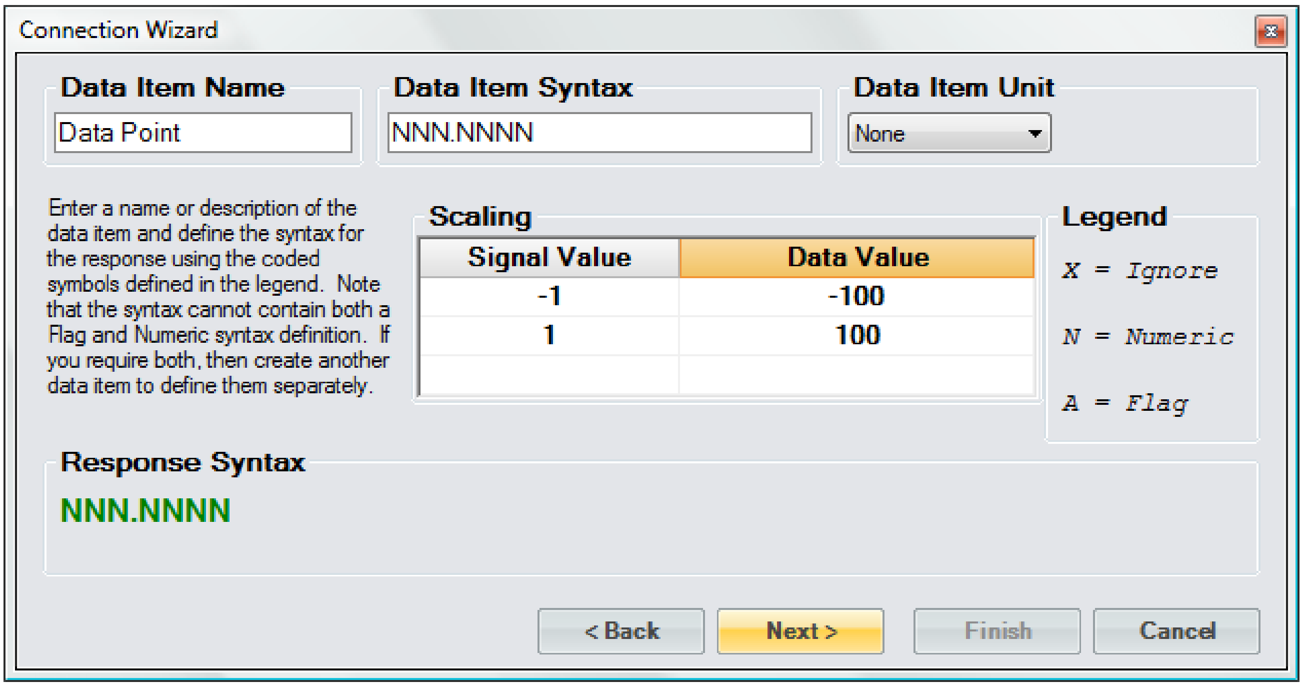
When defining a numeric syntax, enter an "N" for each possible digit in the response. For example, if you know the device returns a six-digit numeric value, you would enter "NNN.NNN." The decimal point is not required, and its location is not essential. Decimal points, plus signs, and minus signs are treated the same as an "N" and are allowed merely to help make the syntax resemble a number value.

> **Note** – *It is important to have sufficient numeric definition to ensure all possible numeric responses are covered, primarily when a device responds with scientific notation or varying precession.*

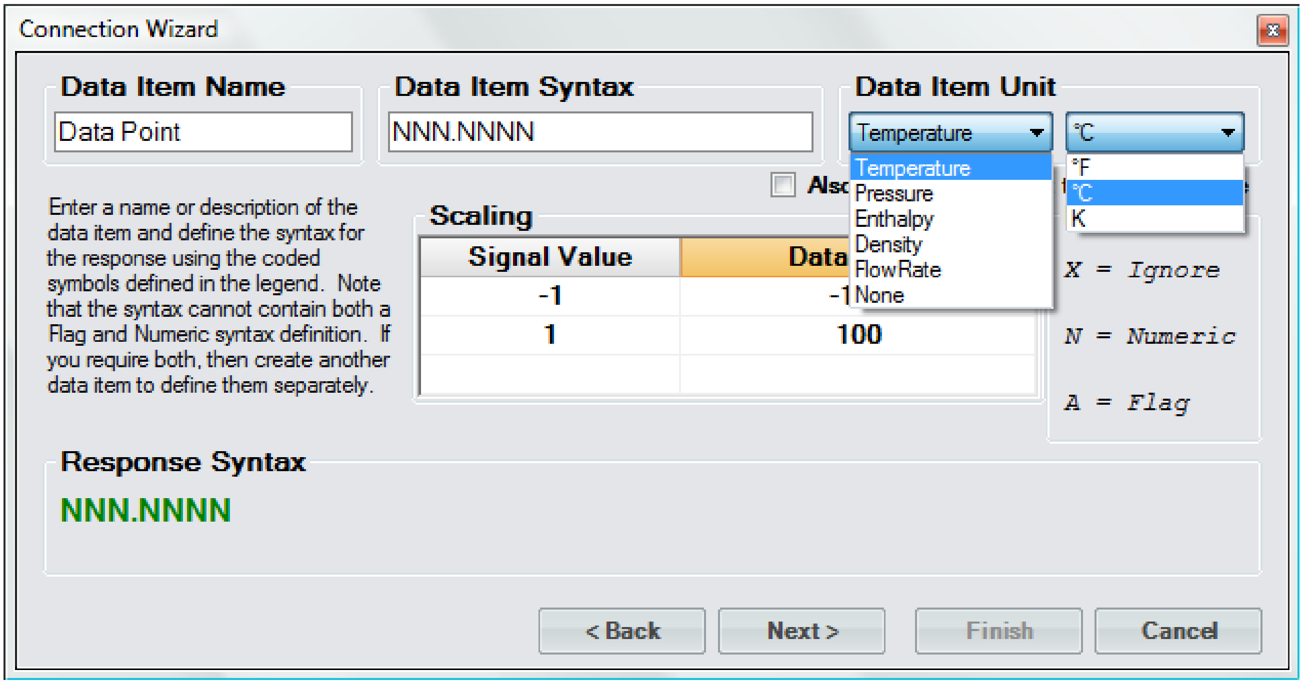


It is possible to scale a numeric data item response. The scaling consists of a two-point definition for linear scaling or a three to five-point definition for polynomial fit scaling. The number of points determines the degree of the polynomial used to scale the data item response. A Singular Value Decomposition (SVD) algorithm determines the polynomial coefficients. Each point definition consists of a signal value and a data value. The signal value represents the "raw" output signal from the device. The data value represents the actual or real-world value at the given signal value.

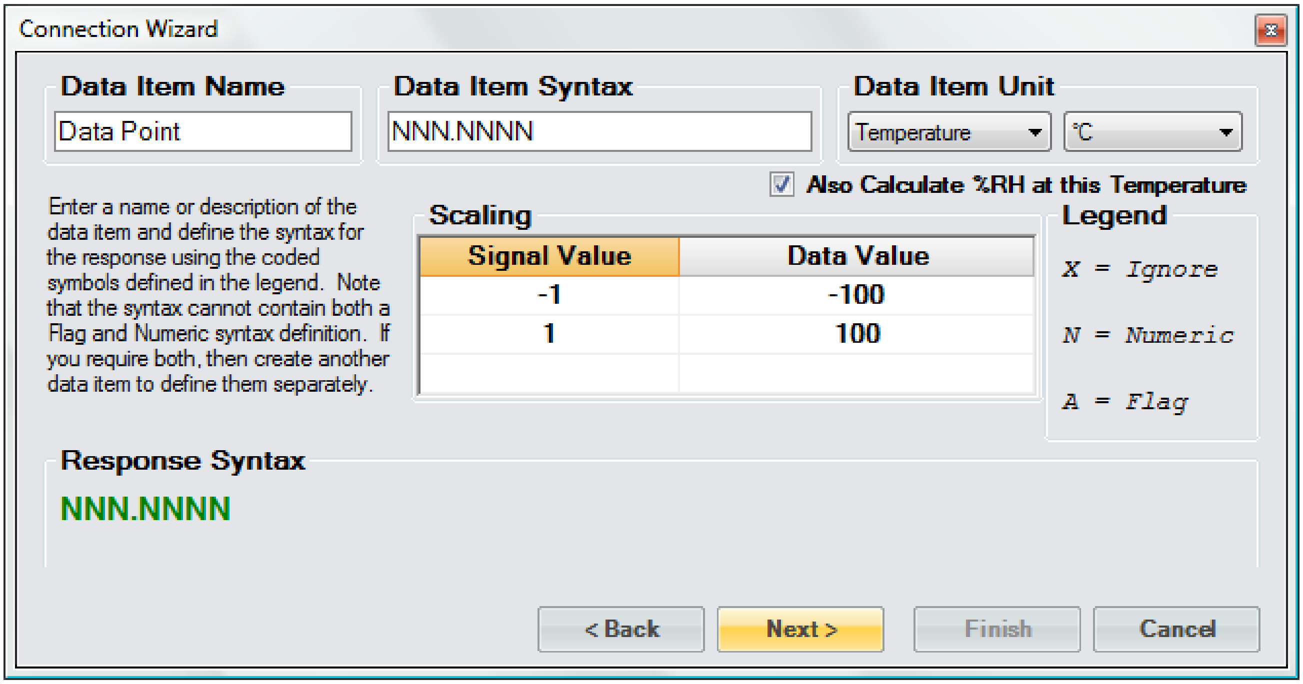
Scaling allows the user to scale a numeric data item response into a given humidity value. For example, if you have a numeric data item response that ranges from -1 to 1 and it is known that 0 corresponds to -100 and 1 corresponds to 100. The user can then enter these scaling values, and ControLog automatically applies the scaling to the data item whenever it is displayed or logged.



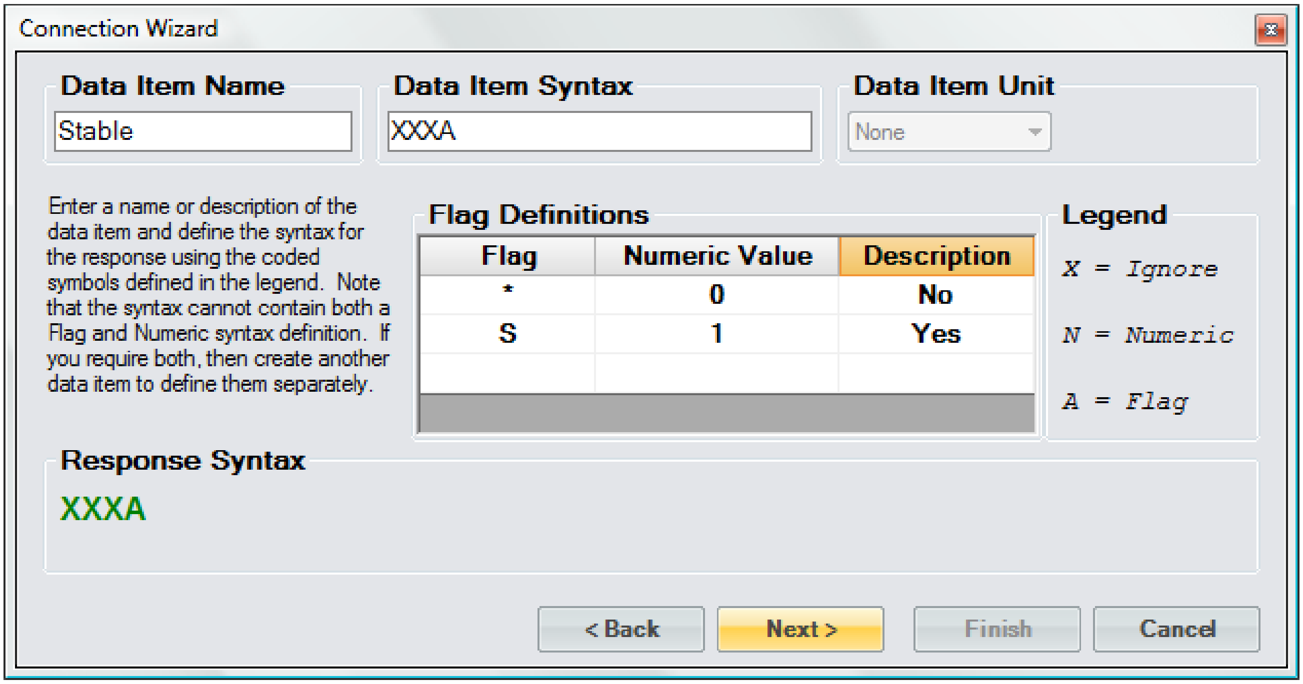
Selecting the unit for the data item allows ControLog to convert the value to the selected system units for display in the parameter tab and record the value in the default SI units in the data tab. Remember, this is the unit the device is sending the data item in, not the unit you wish to display the data item as. If "None" is selected, then ControLog treats the data item as a simple number and displays and records the value exactly as it is received.



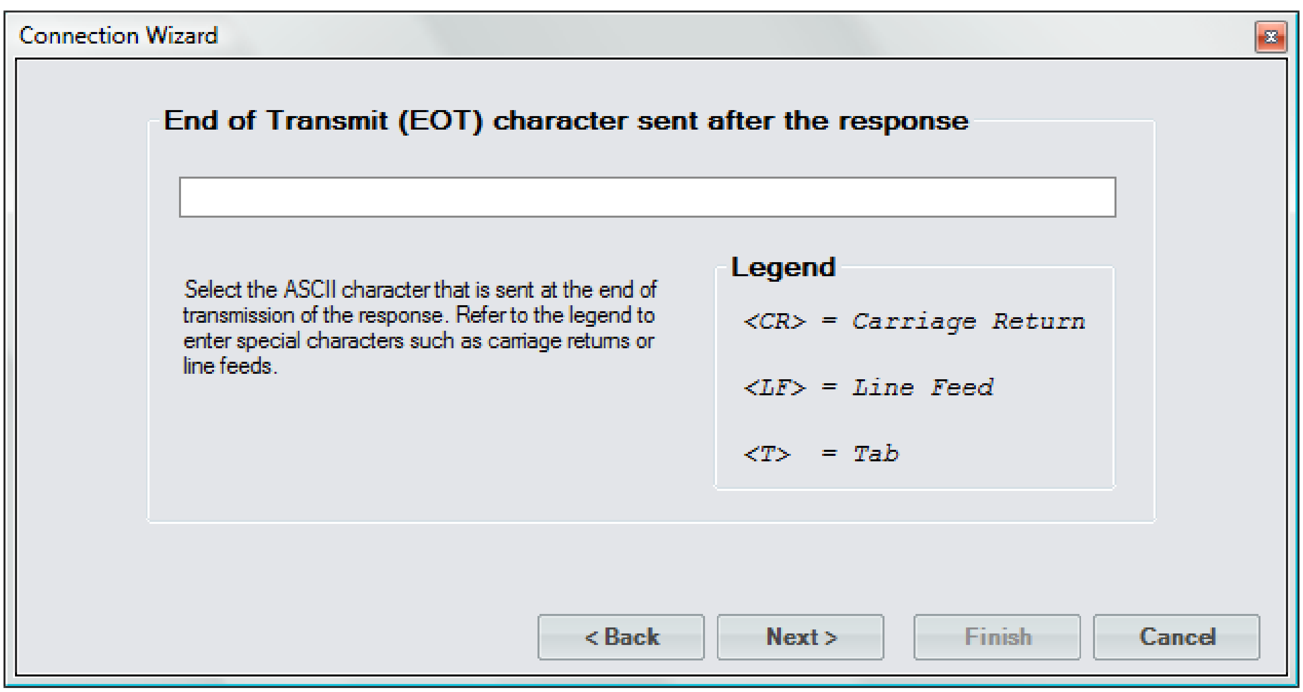
In addition to reading a temperature, ControLog can compute a percent relative humidity (%RH) at the temperature. This is useful when compensating for temperature gradients within the chamber. To have ControLog automatically calculate the relative humidity at the temperature, simply select the corresponding checkbox. The newly calculated %RH has the same name as the specified Data Item Name but is preceded by “%RH@.” In the below example, the calculated %RH appears as “%RH@Data Point.”



When defining flag type syntax, enter an "A" for each character in the response that represents the flag. The Flag Definitions define what each possible ASCII flag represents. The user must enter a numeric value for each flag definition recorded in the data tab and a description for the flag shown in the parameters tab.



Enter the End of Transmit (EOT) character sent after the response. This is the ASCII character that is sent at the end of transmission of the response. Refer to the legend to enter special characters such as carriage returns and/or line feeds.



Select the name and location to save the new serial connection. Selecting the “Browse” button opens a save file dialog that allows the user to specify the name and browse to the desired location to save the file. All device connection files are saved in XML format with a (*.device) extension.

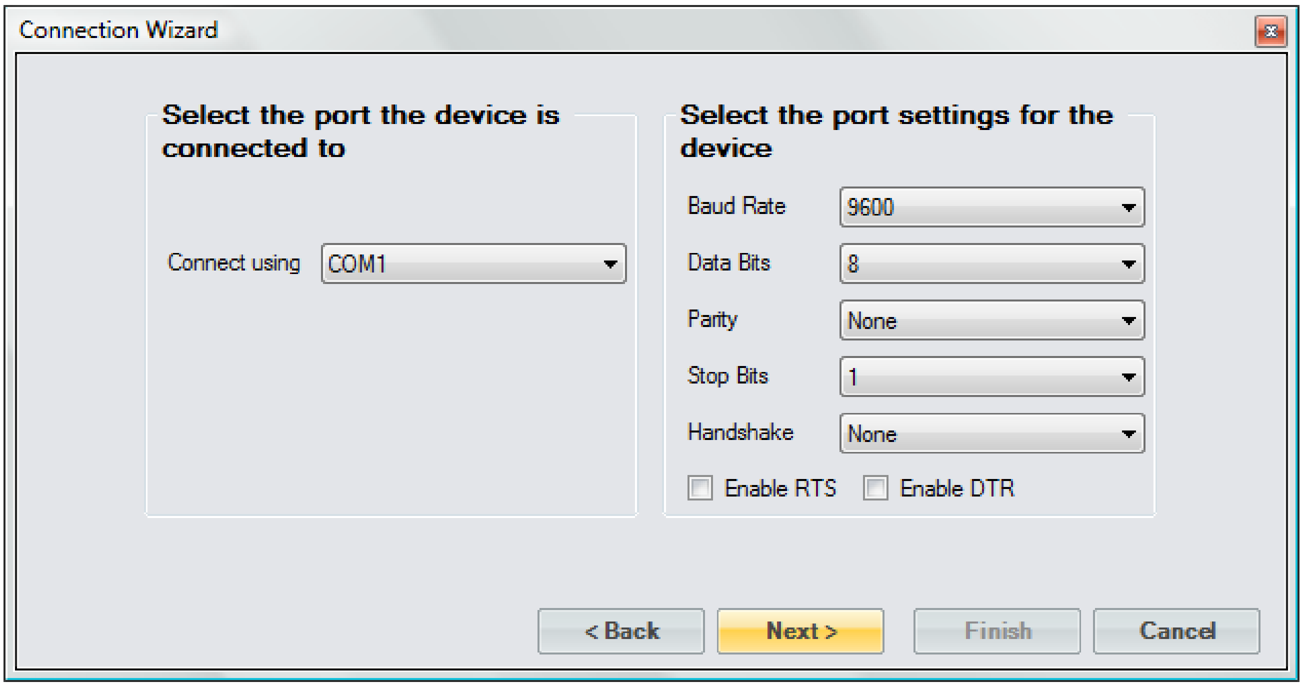
Next, the user can select whether to connect to the device or exit without connecting.

Note – *The user can connect anytime by loading the device from the Connections menu.*

Select the communication port that the device is connected to and select the port settings for the device.

CAUTION!

INCORRECT RTS AND DTR SETTINGS CAN PROHIBIT COMMUNICATION. REFER TO THE DEVICE MANUFACTURER'S DOCUMENTATION TO VERIFY ALL DEVICE PORT SETTINGS.

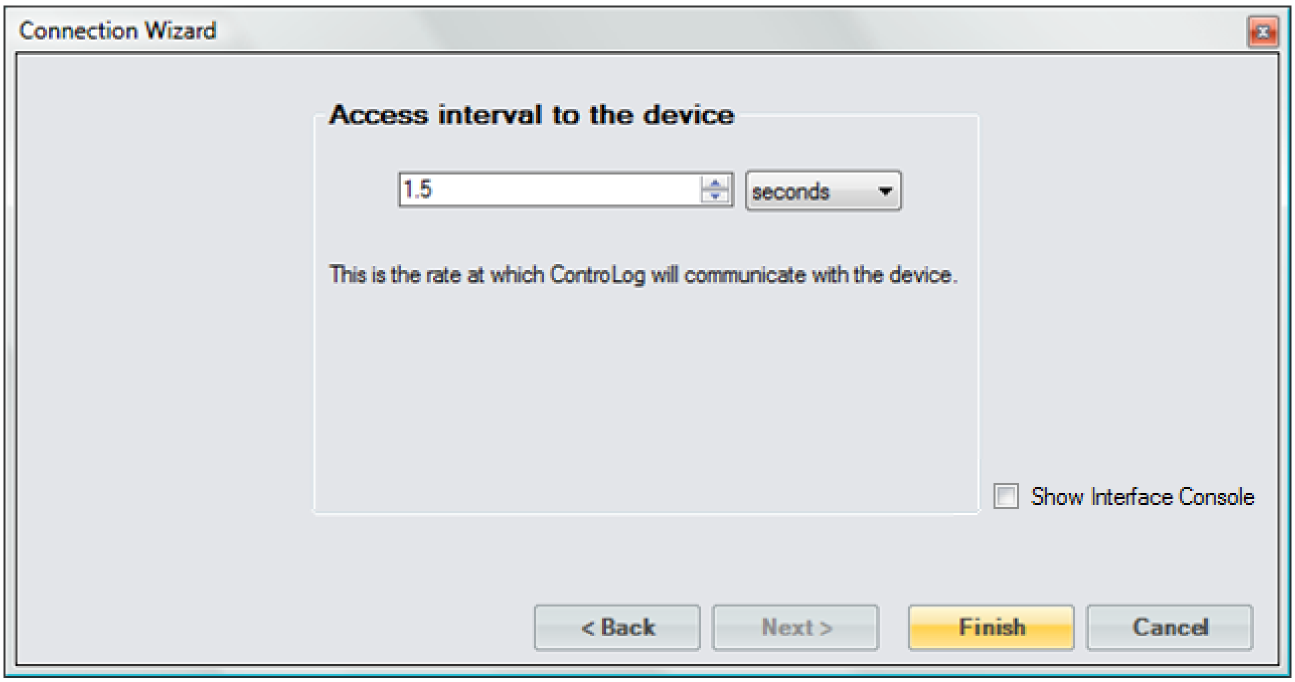


Select the access rate at which ControLog communicates with the device.

> **Note** – *It is always recommended to start with the default 1.5 second access interval and modify it later.*

CAUTION!

DO NOT SET THE ACCESS INTERVAL TOO SMALL. IF THE DEVICE IS NOT CAPABLE OF COMMUNICATING AT THE SET INTERVAL, THEN CONTROLOG MAY INADVERTENTLY THINK COMMUNICATION HAS BEEN LOST WHEN THE DEVICE DOES NOT REPLY WITHIN THE DESIRED ABOUT OF TIME.

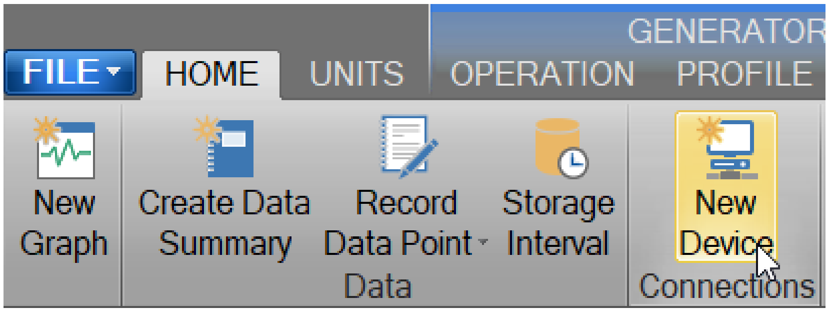


Select "Show Interface Console" to automatically open a Device Interface Console tab once communication has been established with the device.

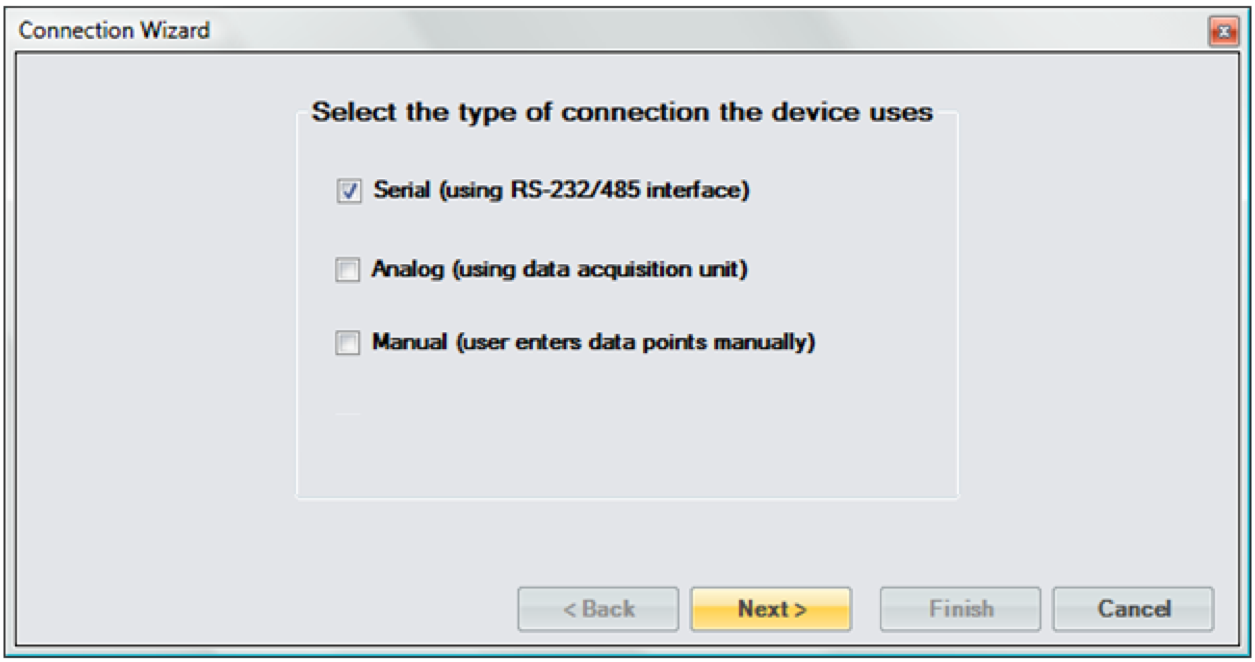
10.1.1 Serial Connection Example 1

This example demonstrates the creation of a serial connection to an RH Systems® 373 Dew Point Mirror. We will request the Frost Point Temperature and Atmospheric Pressure from the mirror as data items.

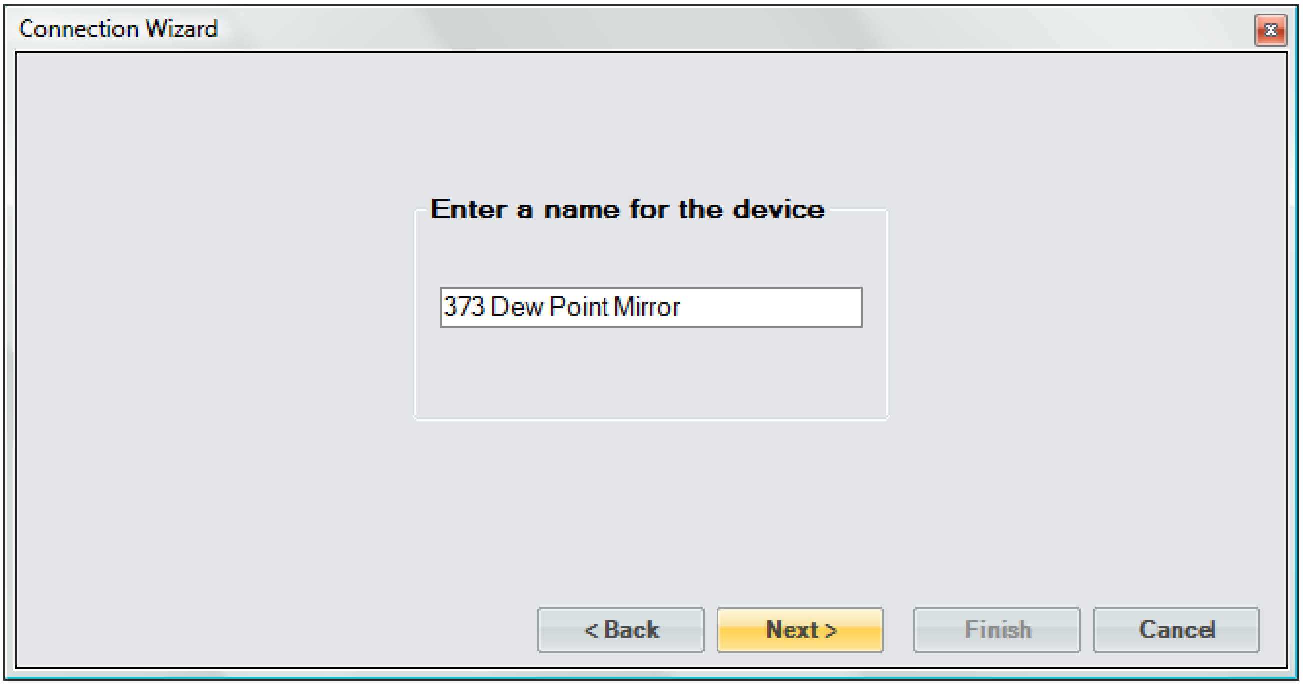
Start by selecting "New Device" from the Home menu tab.



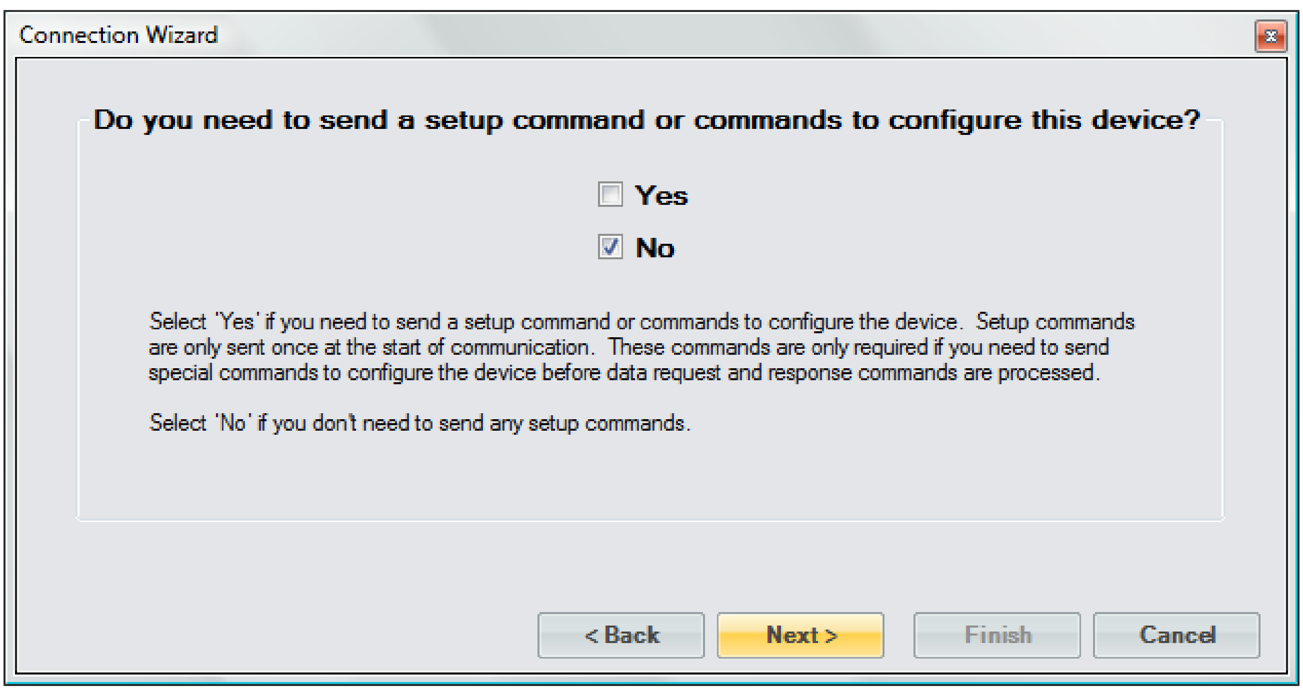
Select "Serial" as the type of device connection.



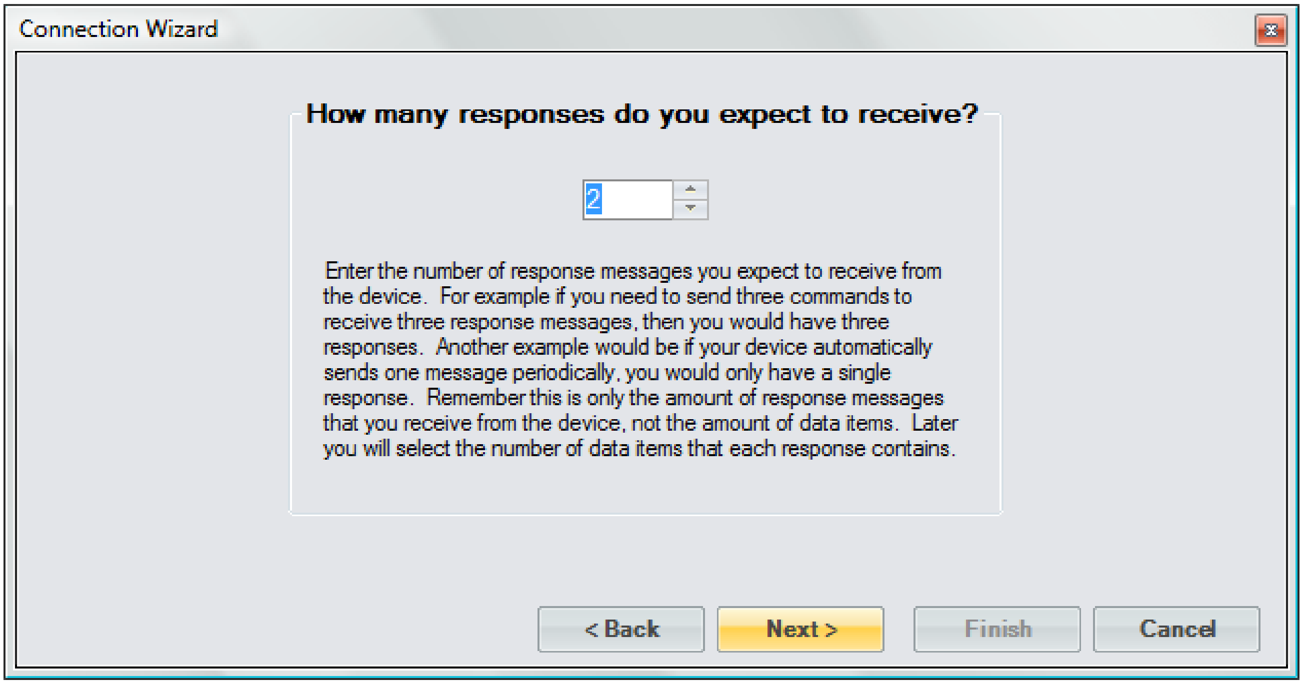
Enter “373 Dew Point Mirror” as the name for the device.



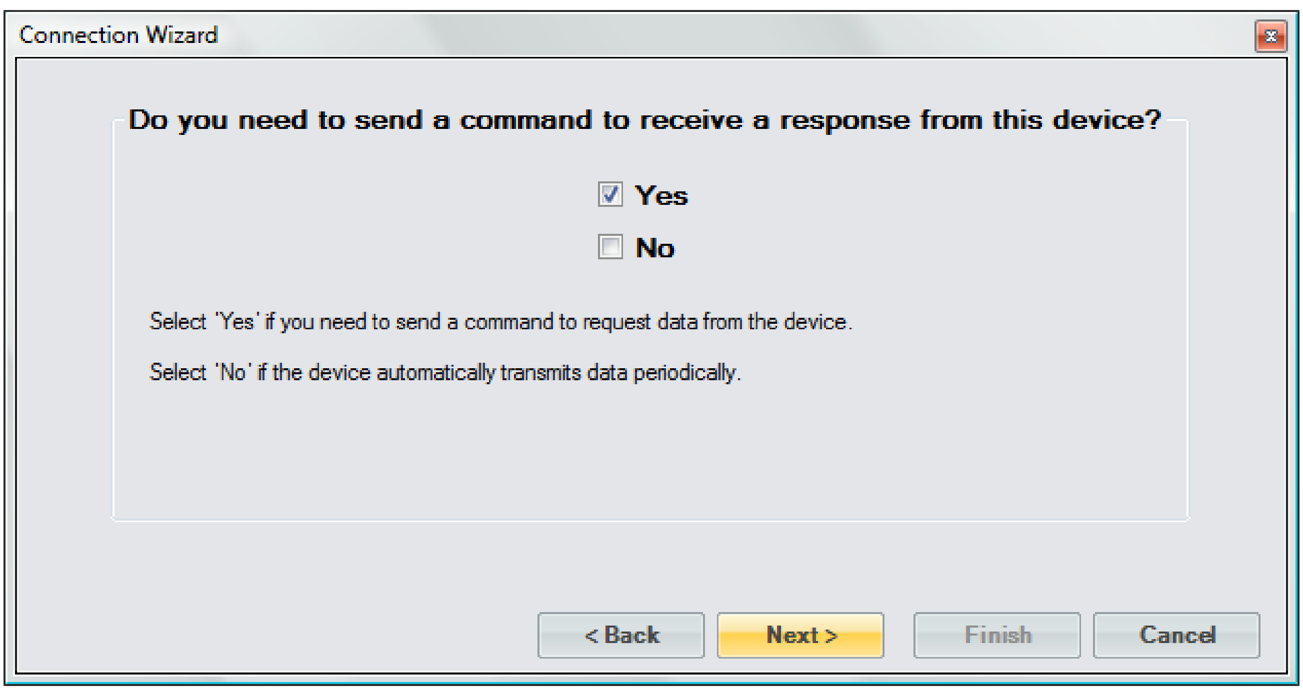
For the 373, we do not need to send any setup commands.



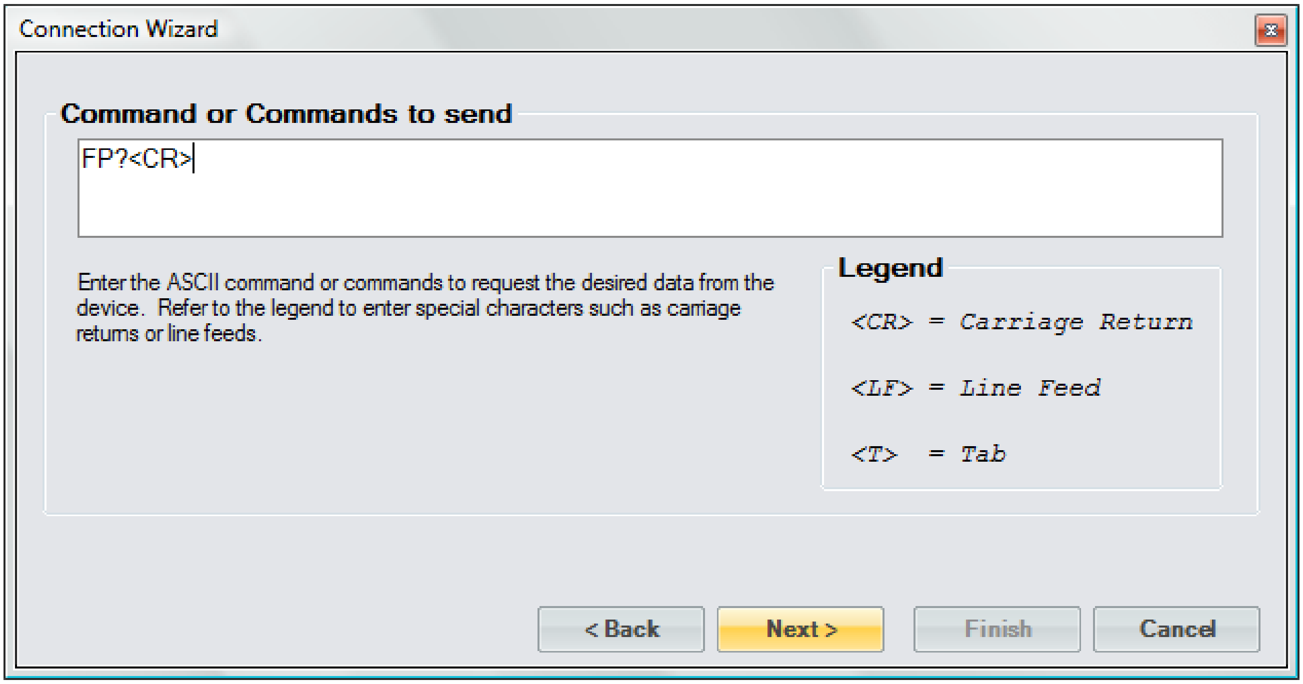
The 373 sends two responses: one with the requested Frost Point value and the other with the requested Atmospheric Pressure value.



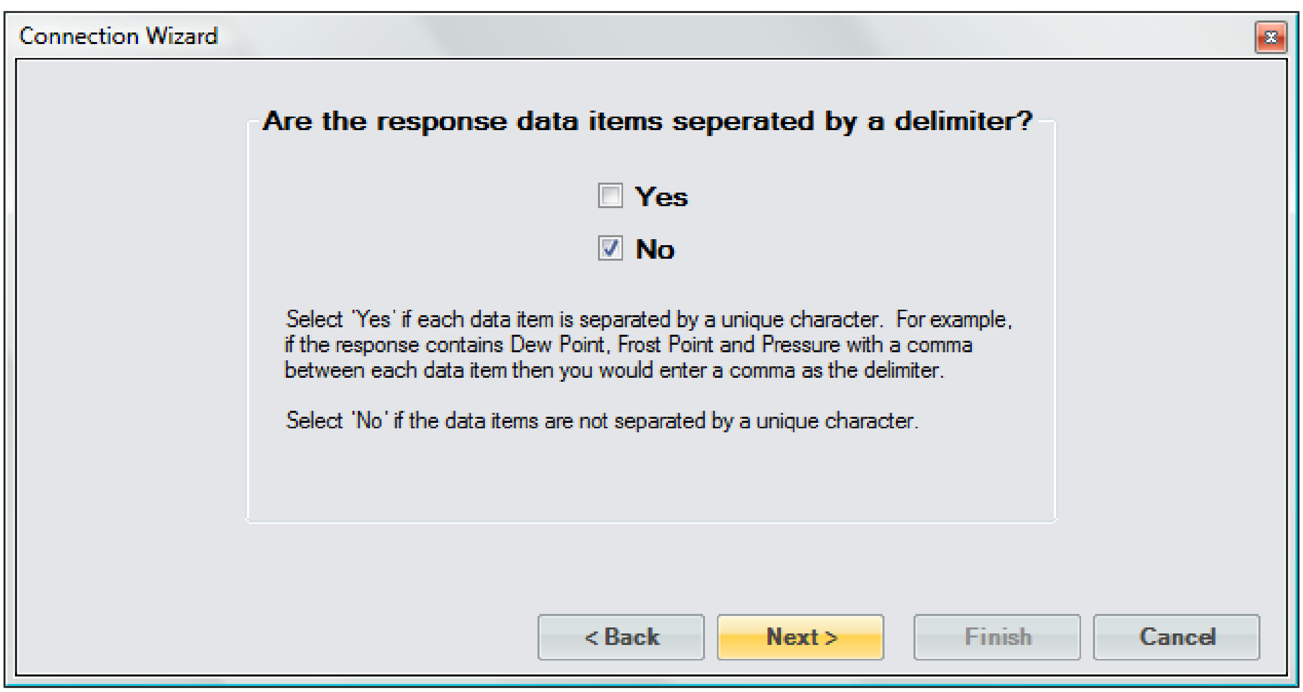
The 373 requires a request command to be sent to receive either the Frost Point value or the Atmospheric Pressure value.



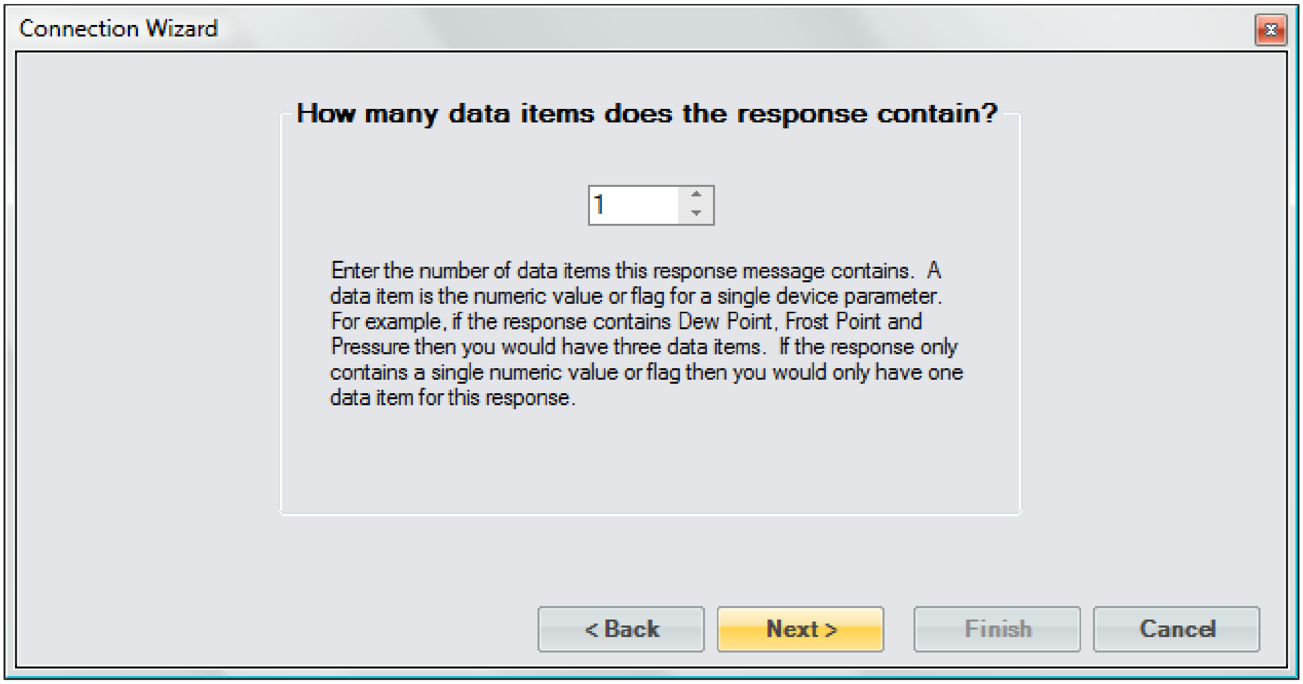
The 373 documentation tells us we need to send the frost point command to receive the Frost Point value. The documentation also states that the command must be terminated with a carriage return or a carriage return line feed combination.



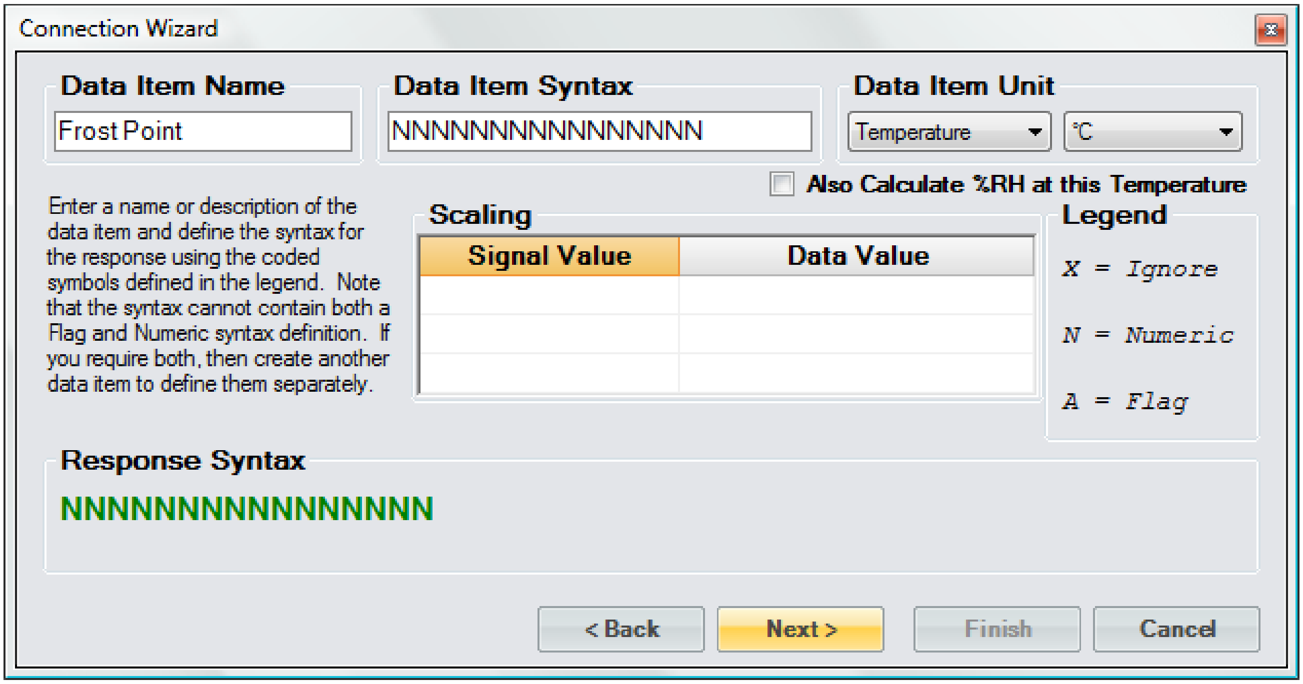
The 373 responds to the frost point command with a single numeric value; therefore, no delimiter is used.



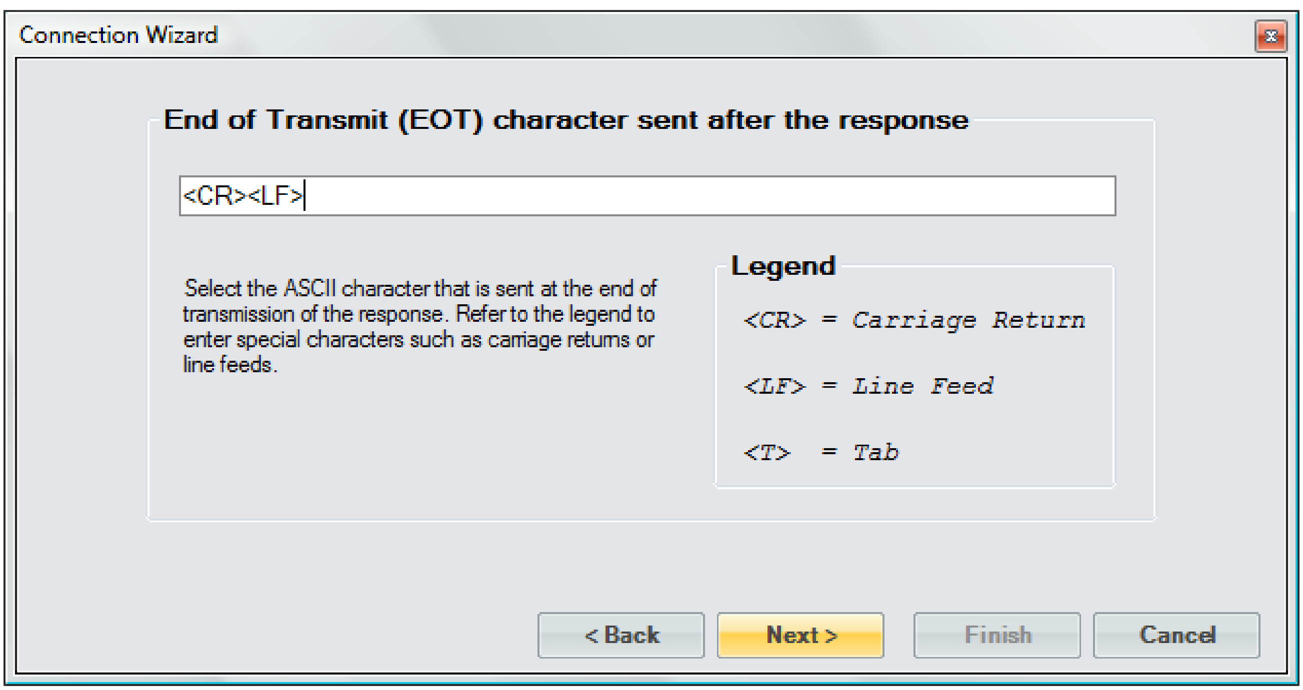
The response from the frost point command only contains a single numeric value.



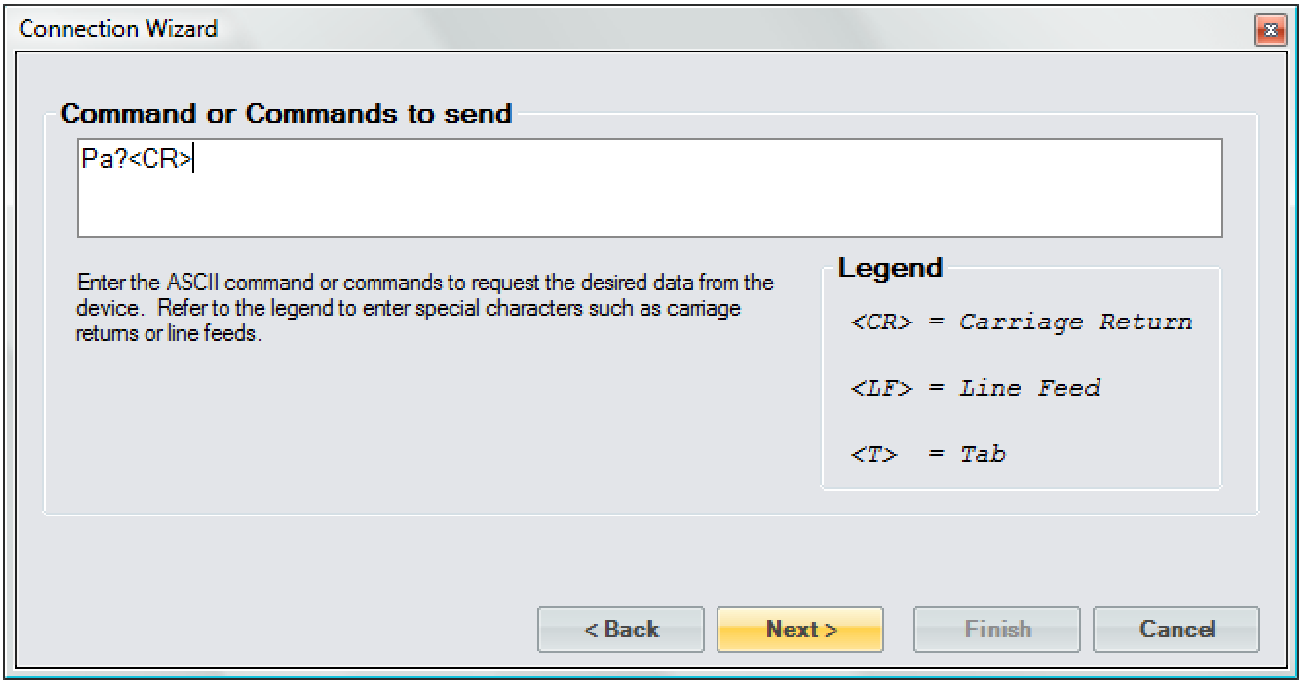
The first item is given the name Frost Point. The 373 can respond with a high precision numeric value, so the Data Item Syntax was defined with the maximum digits possible that the 373 can respond with. The Data Item's Unit was defined as a temperature in degrees Celsius as stated in the documentation for the 373. The response value is the actual value, so there is no need to define any type of scaling.



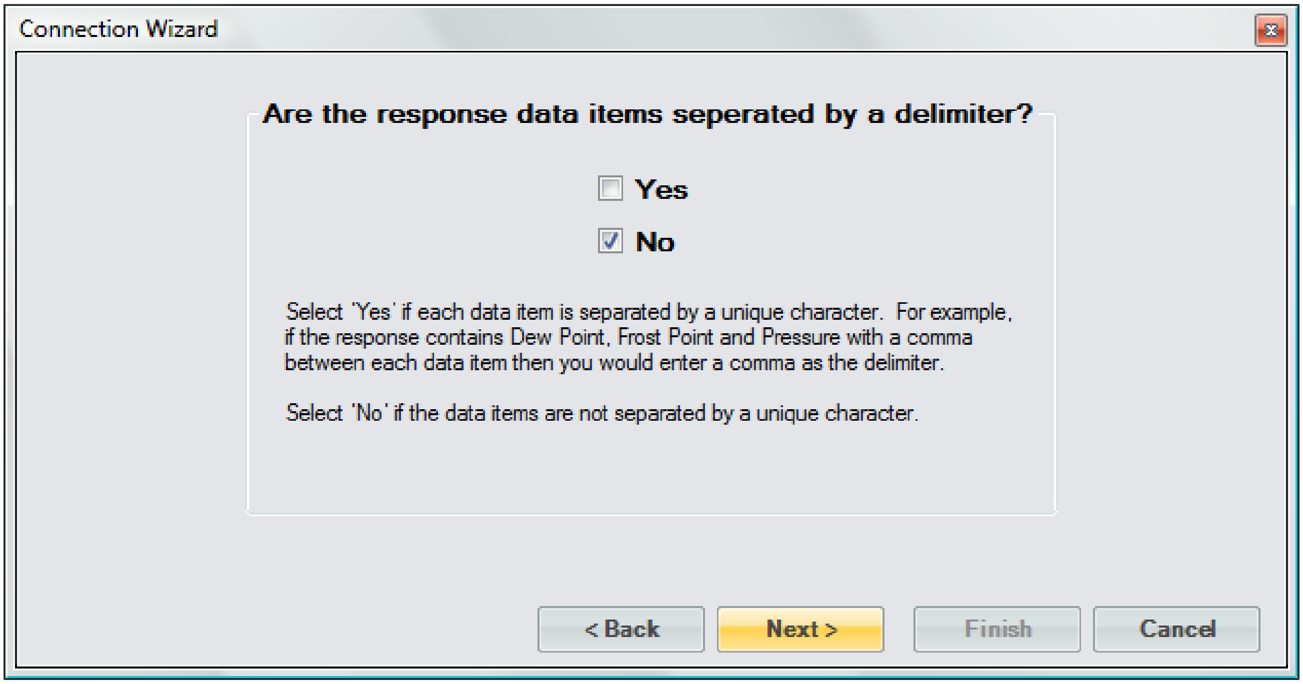
According to the 373 documentation, each response is terminated with a carriage return and line feed.



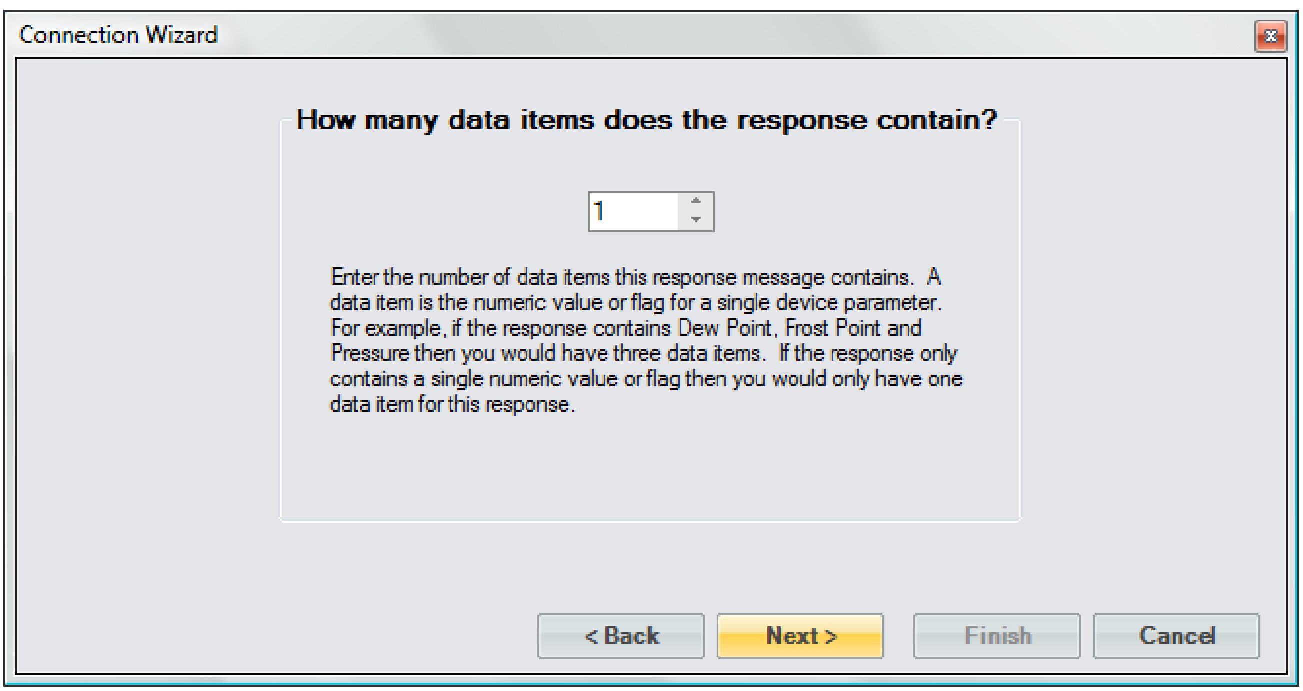
Next, we define the command for the second response. Referring to the 373 documentation, we enter the command for atmospheric pressure. Again, the command must be terminated with a carriage return or carriage return line feed combination.



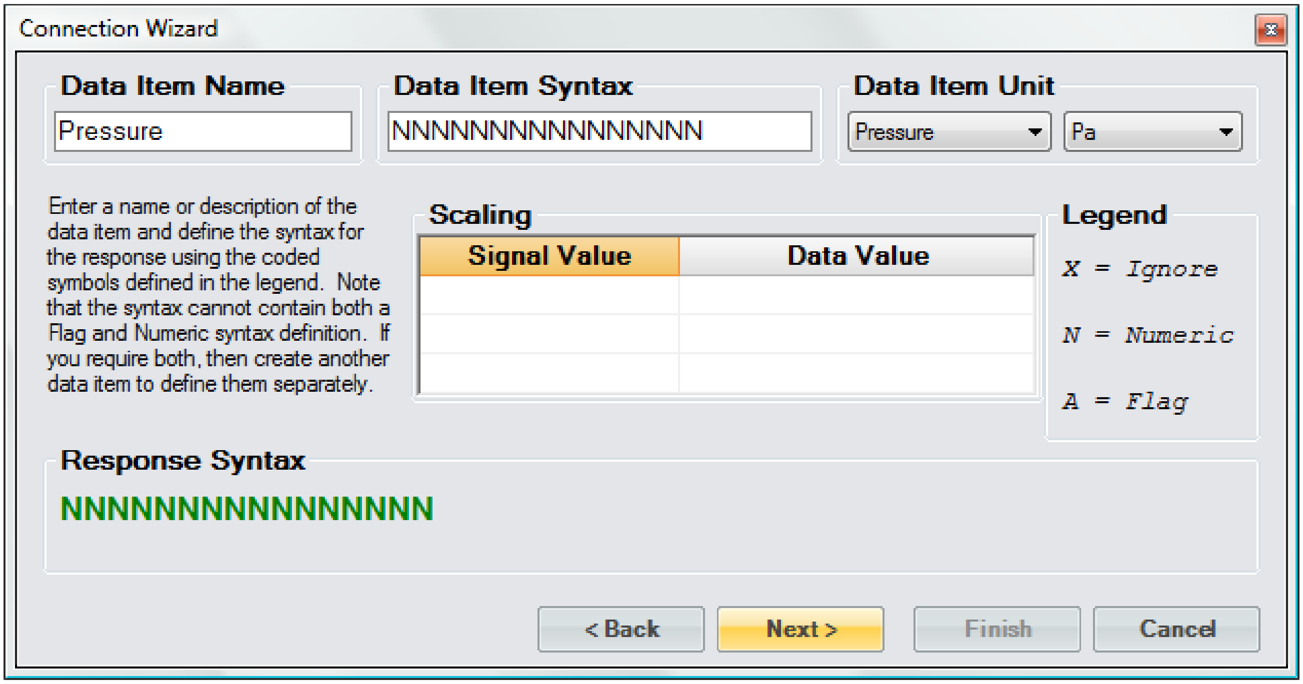
The 373 responds to the atmospheric pressure command with a single numeric value; therefore, no delimiter is used.



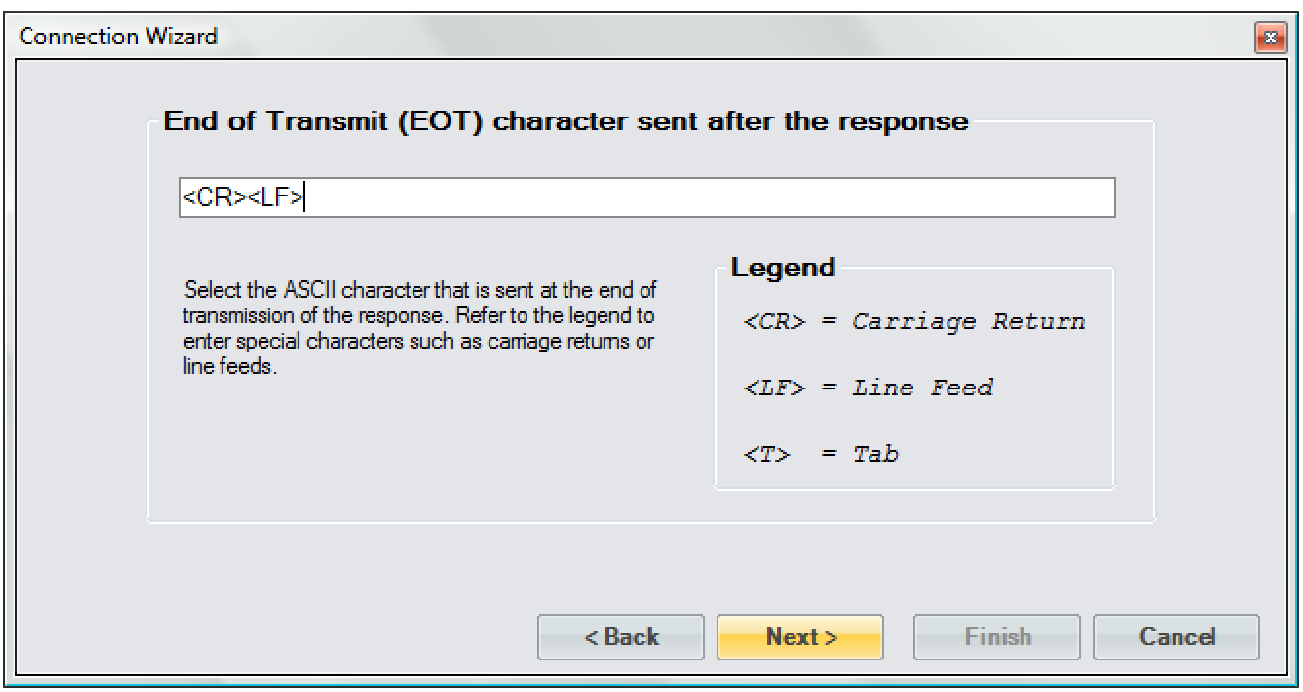
The response from the atmospheric pressure command only contains a single numeric value.



The second item is given the name, Pressure. Again, the Data Item Syntax was defined with the maximum possible digits the 373 can respond with. As stated in the documentation, the Data Item's Unit was defined as a pressure in Pascal. The response value is the actual value, so there is no need to define any scaling.



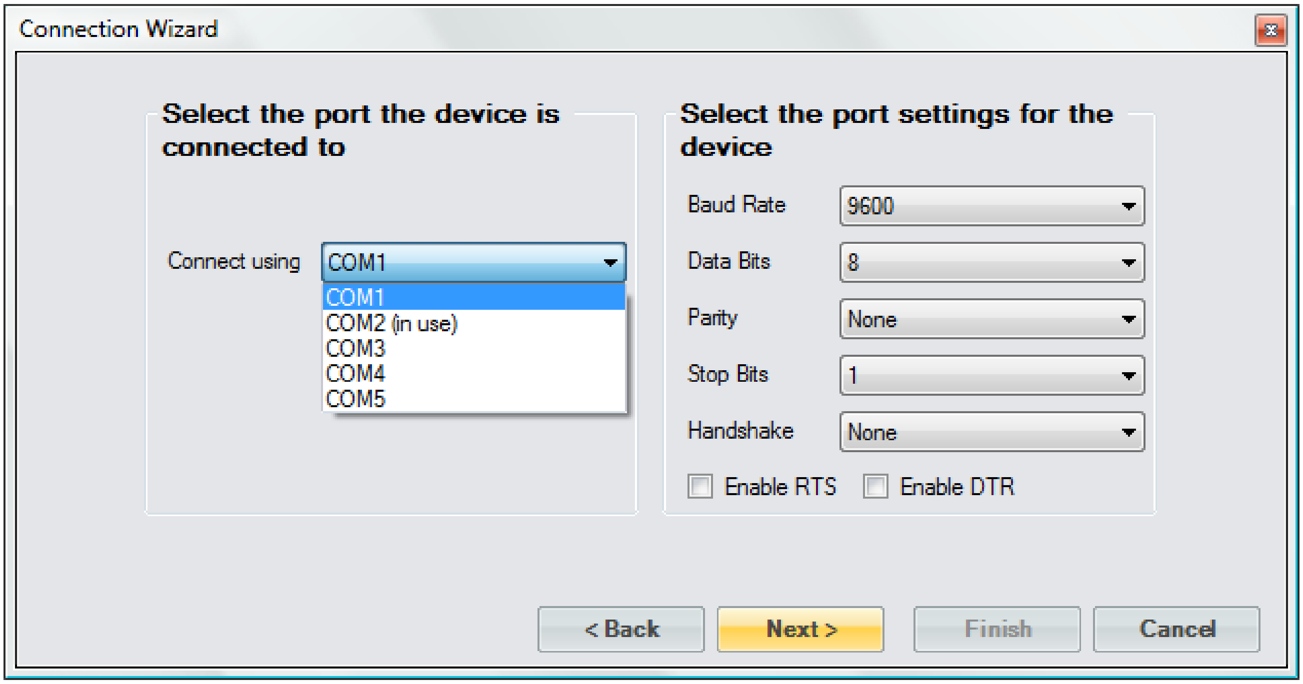
The response is terminated with a carriage return and line feed.



Save the newly created device to a file so that it can be recalled at a later time.

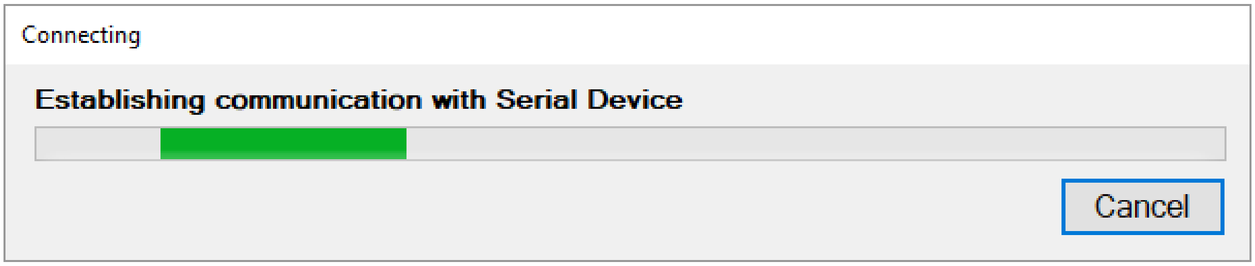
Select to connect to the device now.

Select the port to which the 373 is connected. Notice that ControLog indicates which ports are in use. Refer to the 373 documentation for specific port settings:

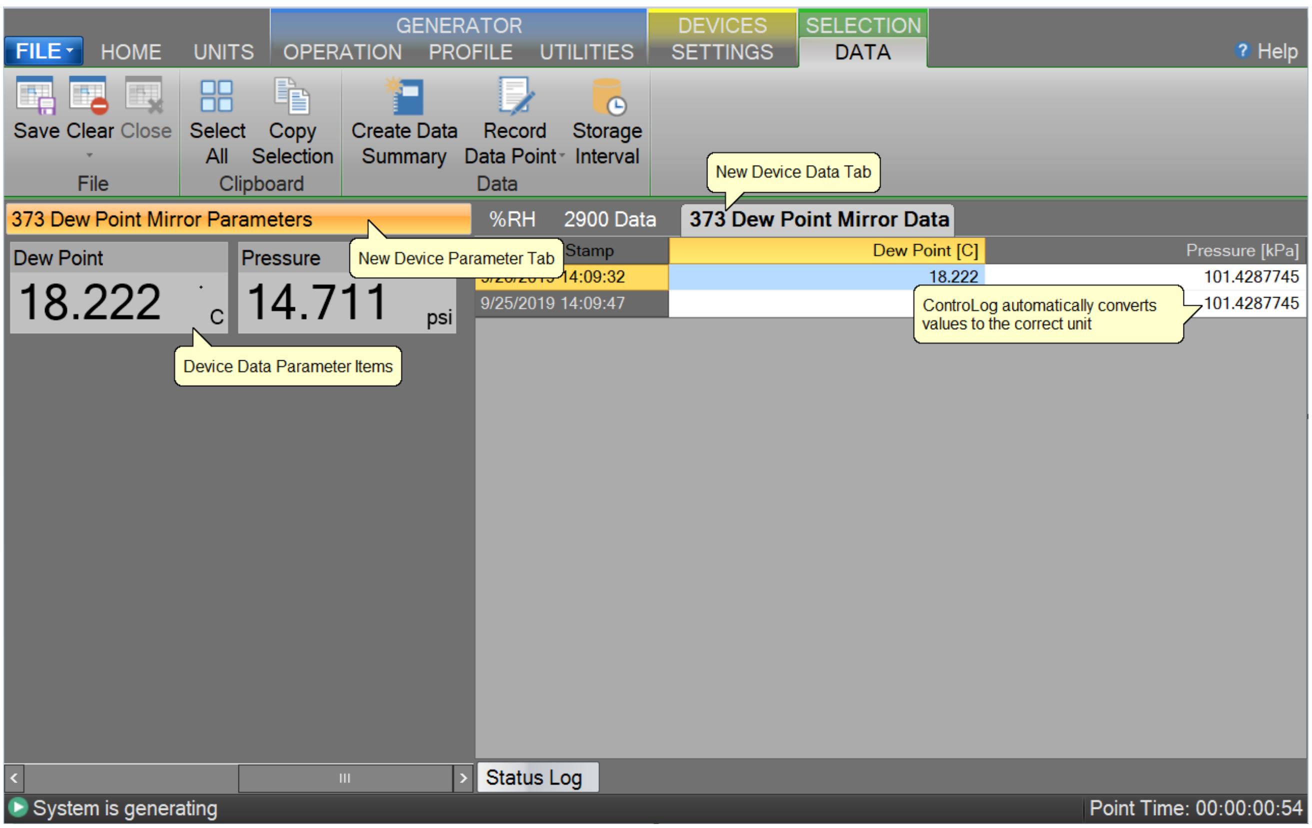


The default access interval of 1.5 seconds is entered.

Once completed, ControLog attempts to establish communication with the 373.



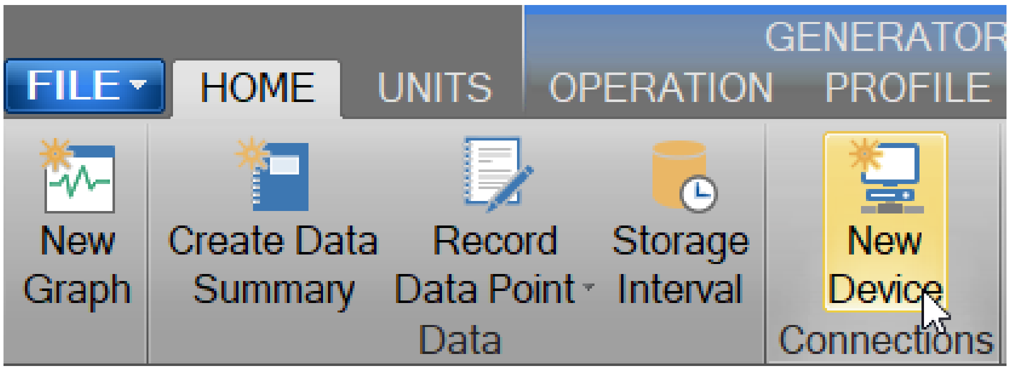
Once communication is successfully established with the 373, a new parameter tab and data tab are created. Note that the parameter and data tab have the two data items we defined. Notice that since we defined which unit the data items were received in, ControLog can convert the values into the selected units for easy reading.



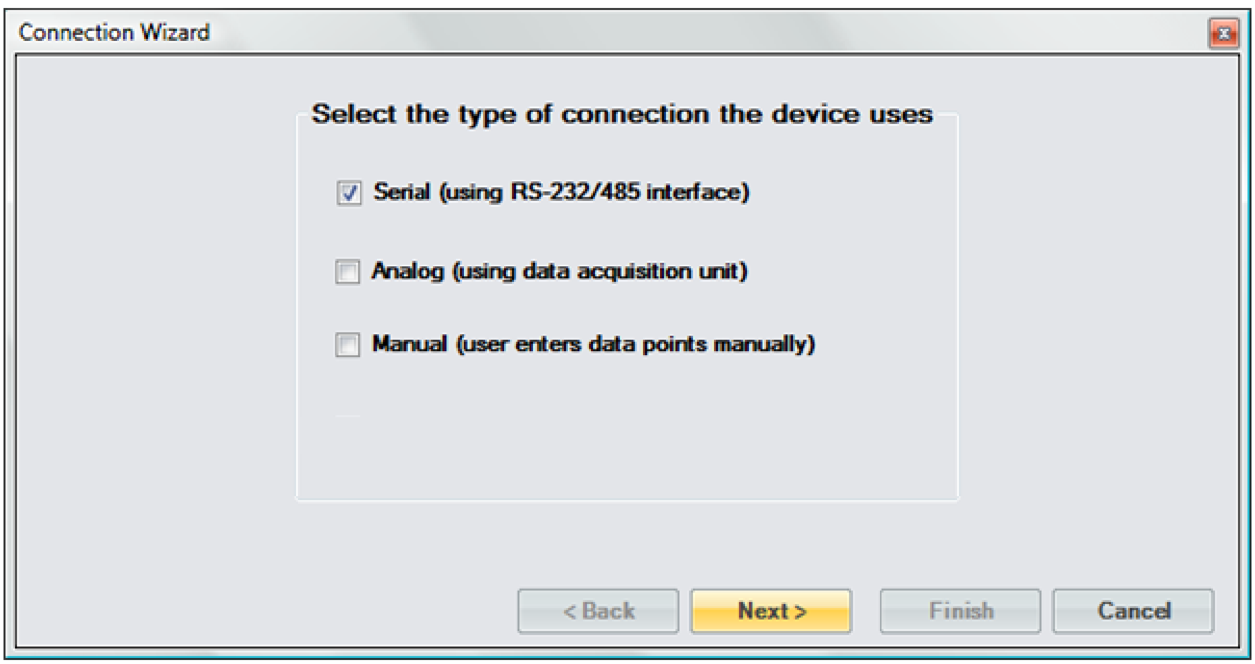
10.1.2 Serial Connection Example 2

This example demonstrates the creation of a serial connection to an MBW® DP-30 Precision Dew Point Hygrometer. This example is working with a DP-30 that has the temperature and pressure option. The DP-30 does not require any request to receive data. Instead, it constantly outputs three data messages at a periodic rate.

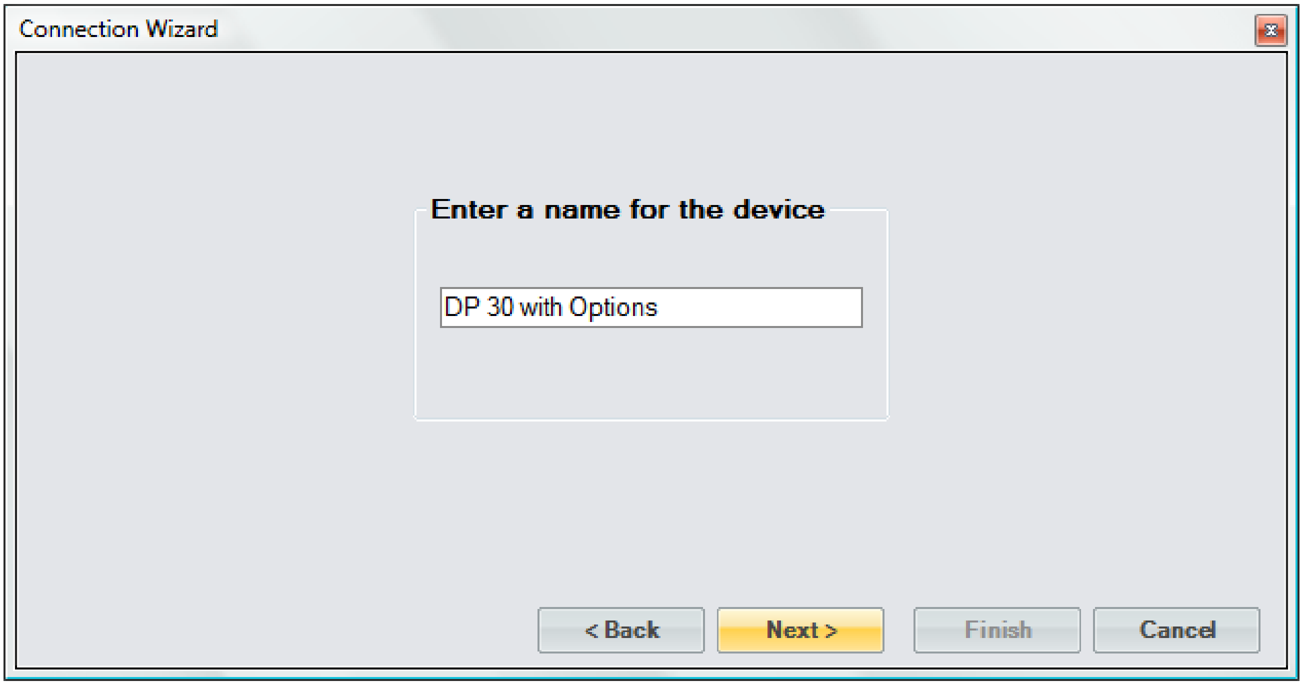
Start by selecting "New" from the Connections menu.



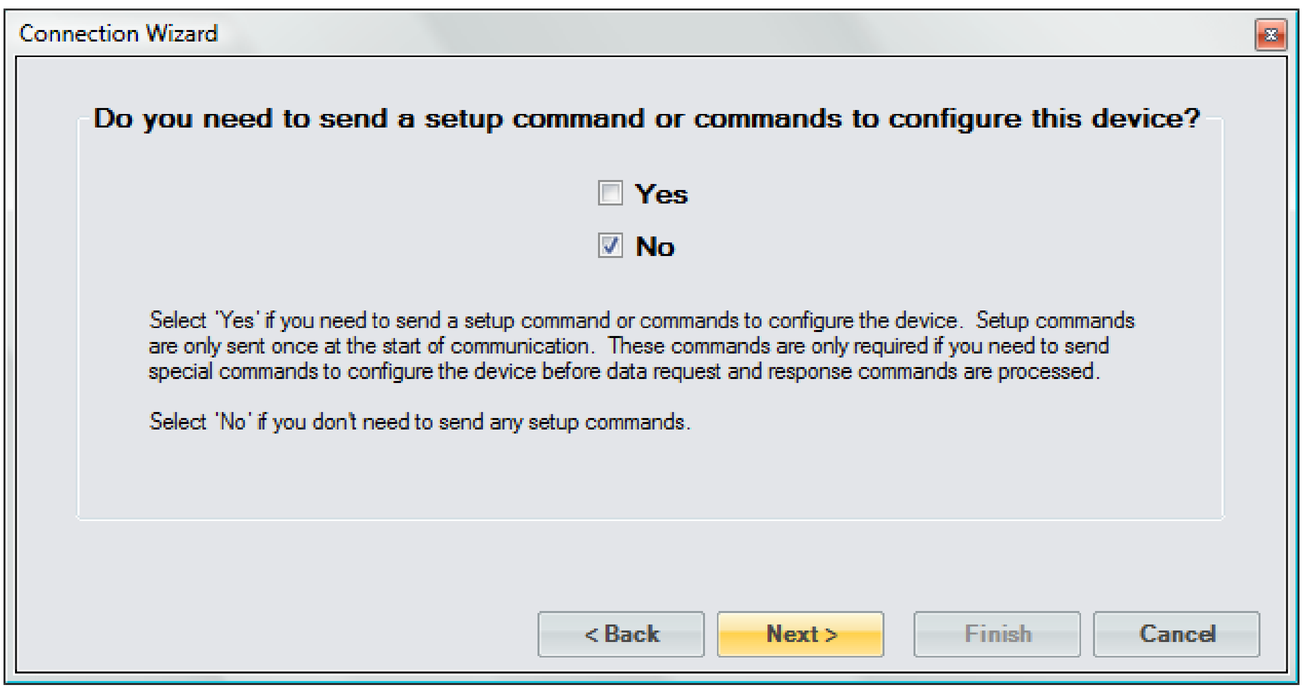
Select "Serial" as the type of device connection.



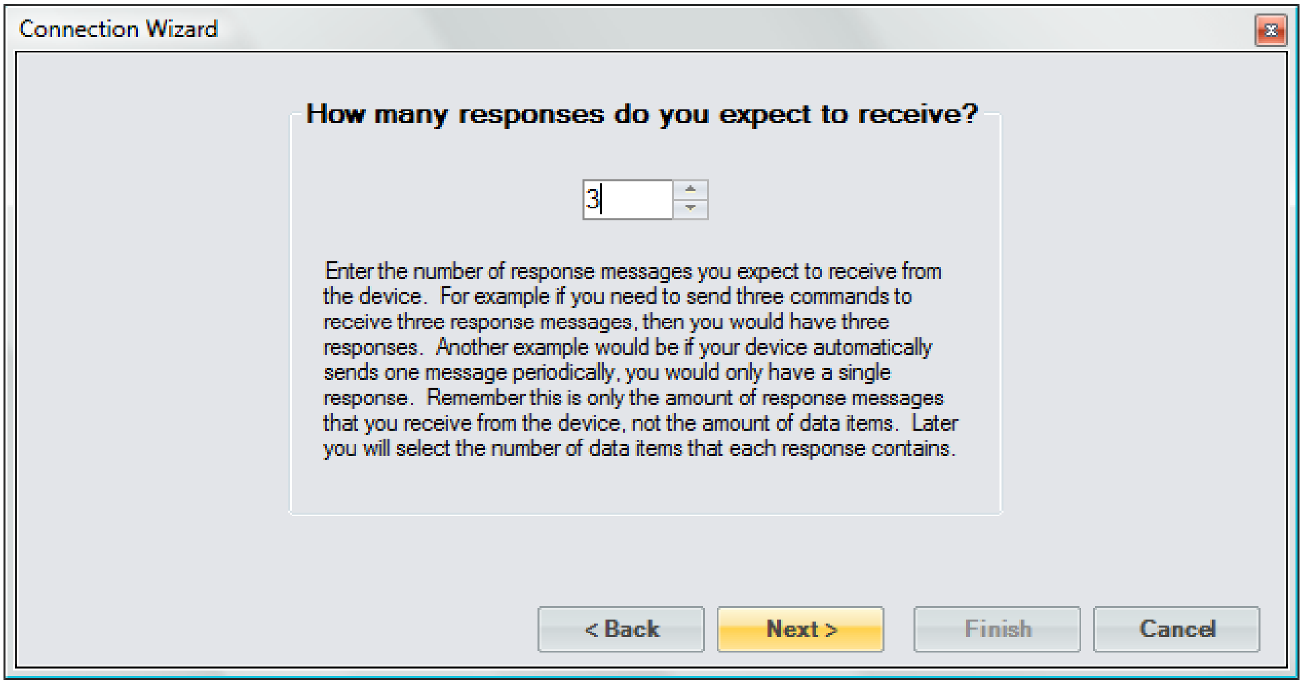
Enter “DP 30 with Options” as the name for the device.



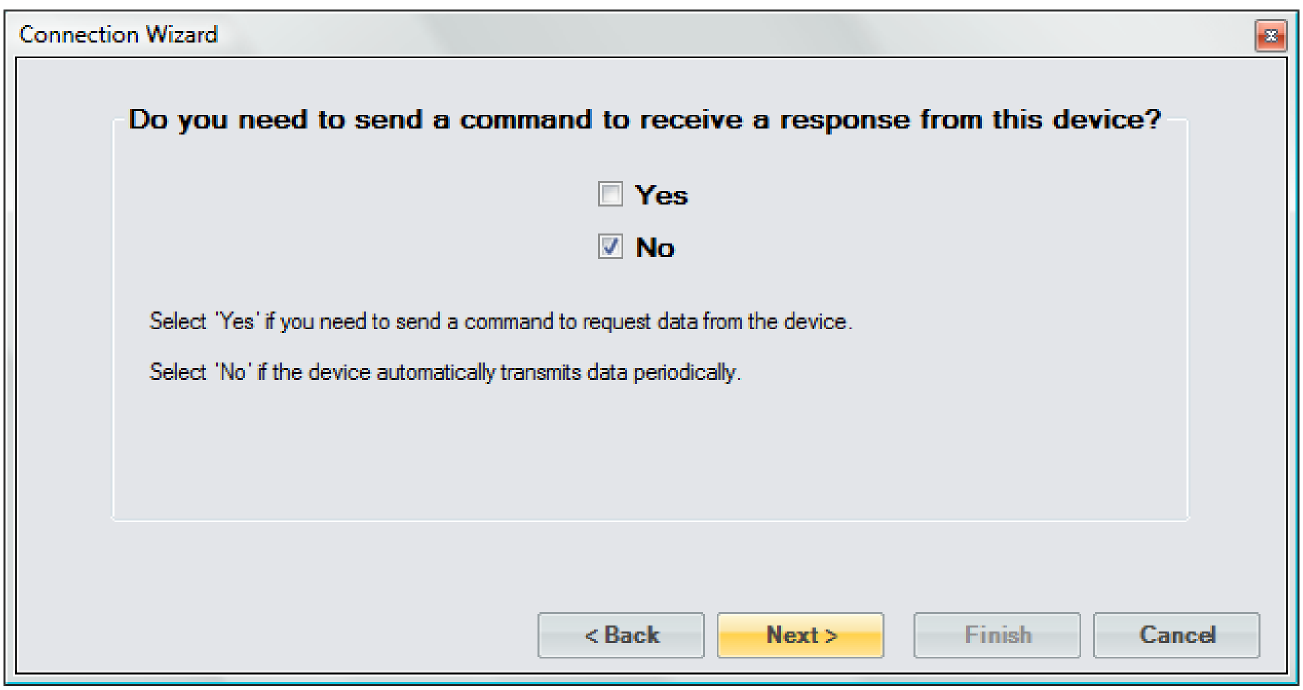
For the DP-30, we do not need to send any setup commands.



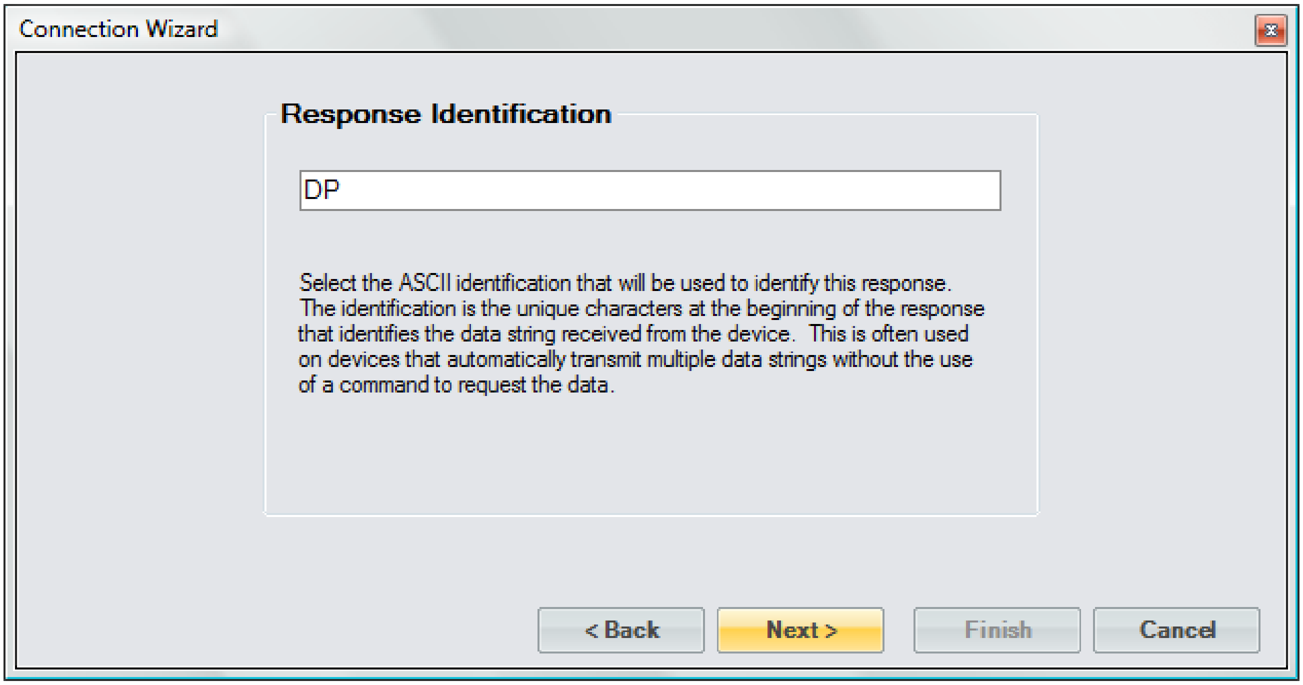
We receive three responses from the DP-30: one with the Dew Point Temperature value and Status, one with the Dry Temperature value, and one with the Pressure value.



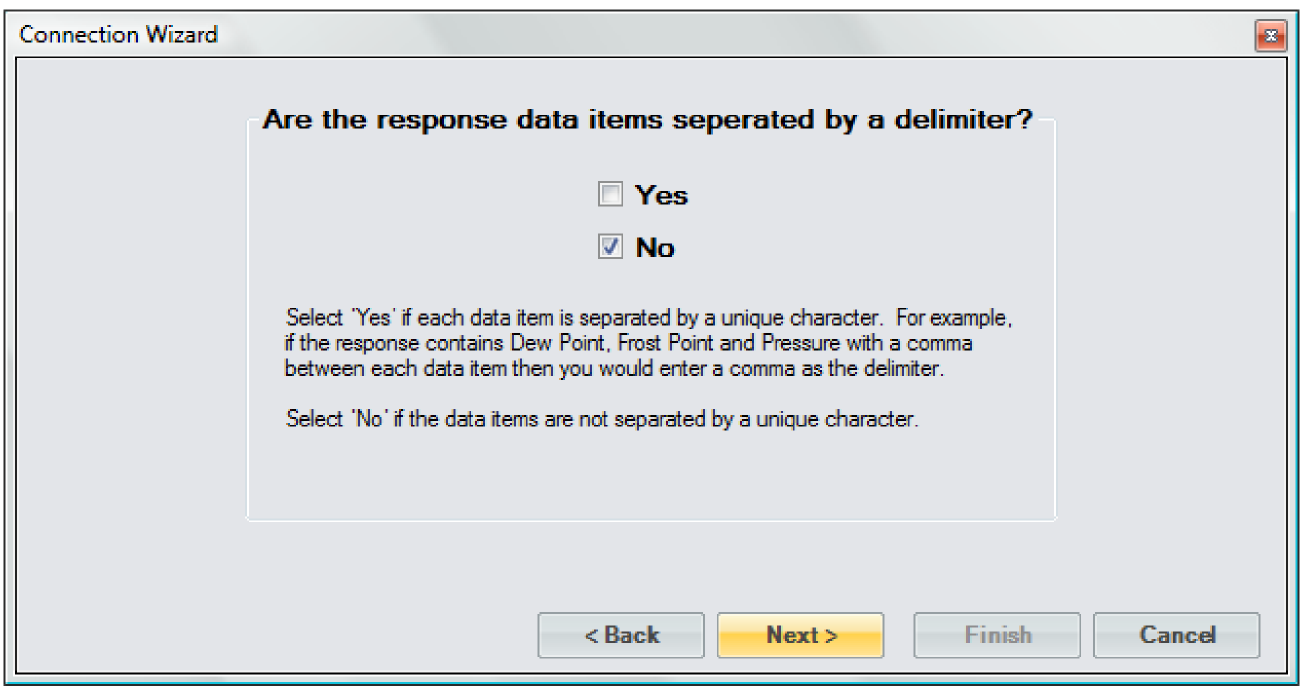
The DP-30 does not require any command to be sent to receive a response. The DP-30 automatically transmits the messages.



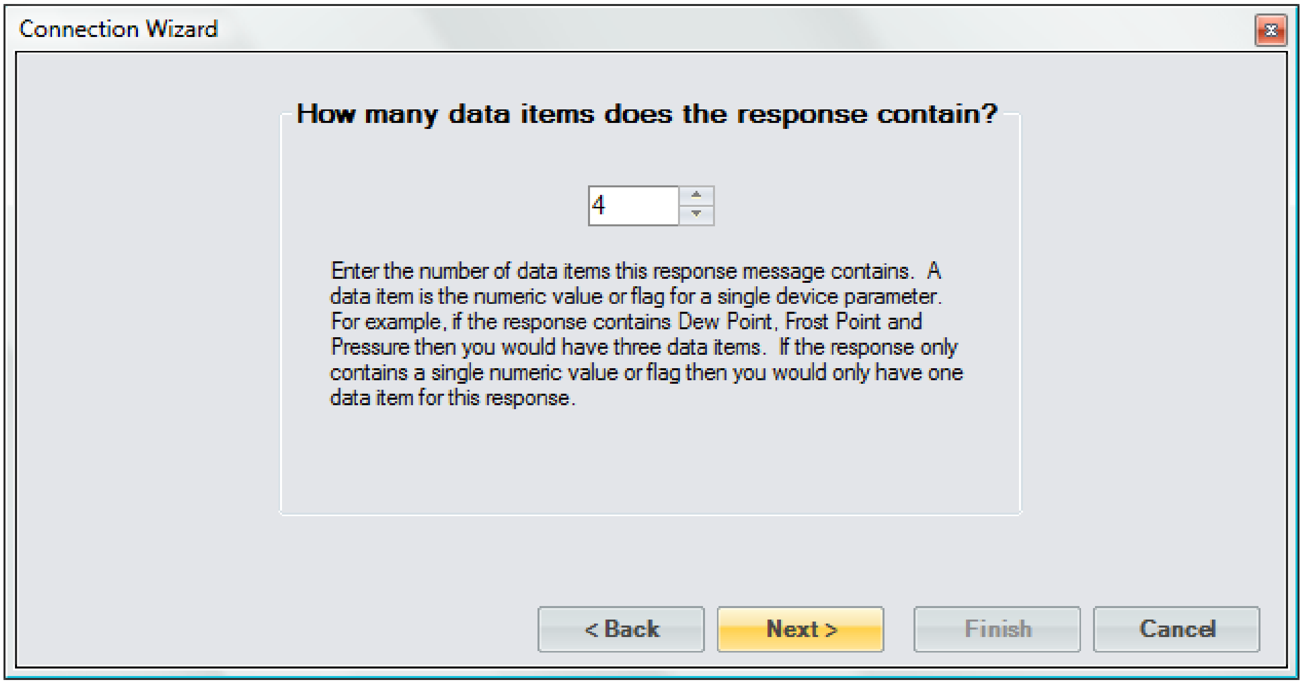
For the first message, we enter the response identification of the Dew Point Temperature message.



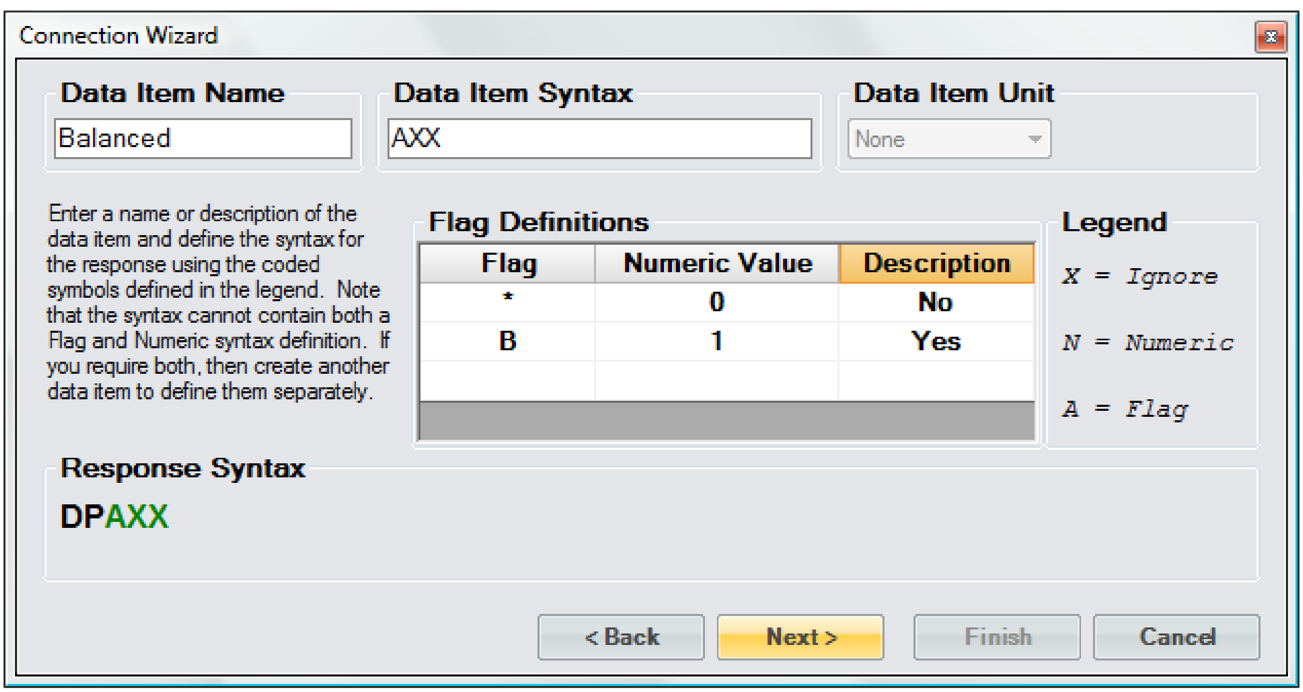
The DP-30 Dew Point Temperature message is of a fixed format and does not use any delimiter.



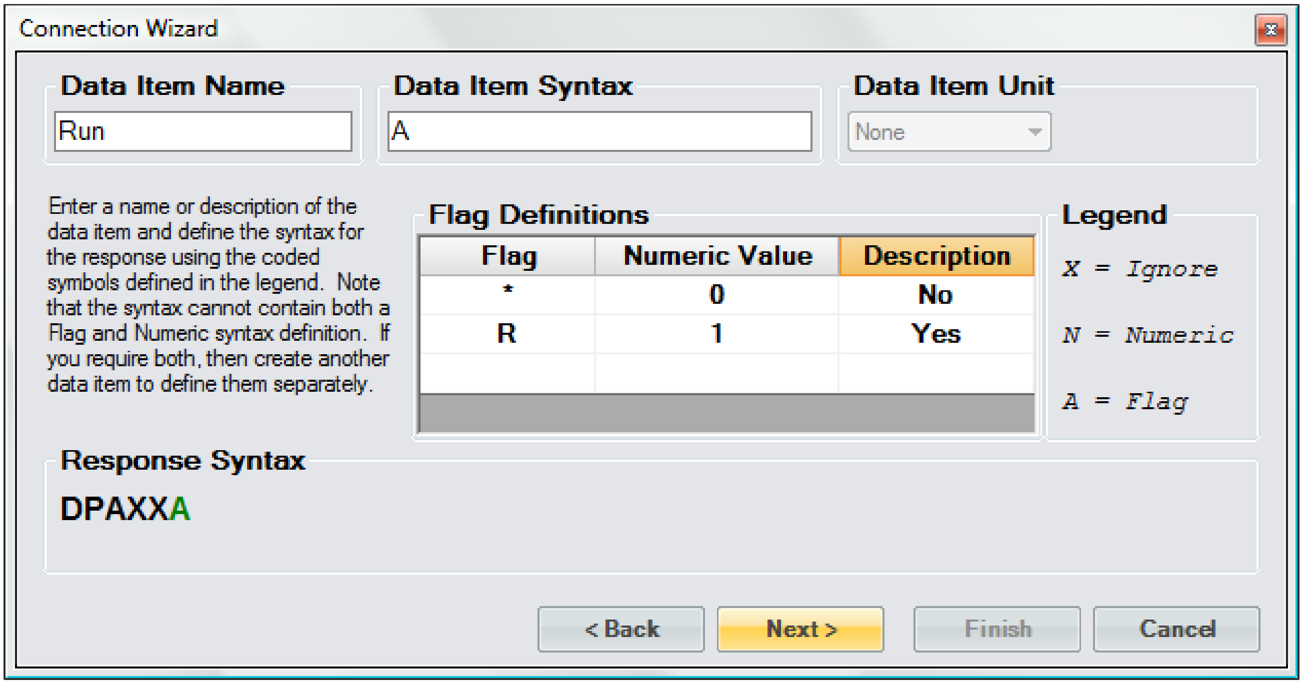
The Dew Point Temperature message contains three flags and one value, resulting in four data items for this response.



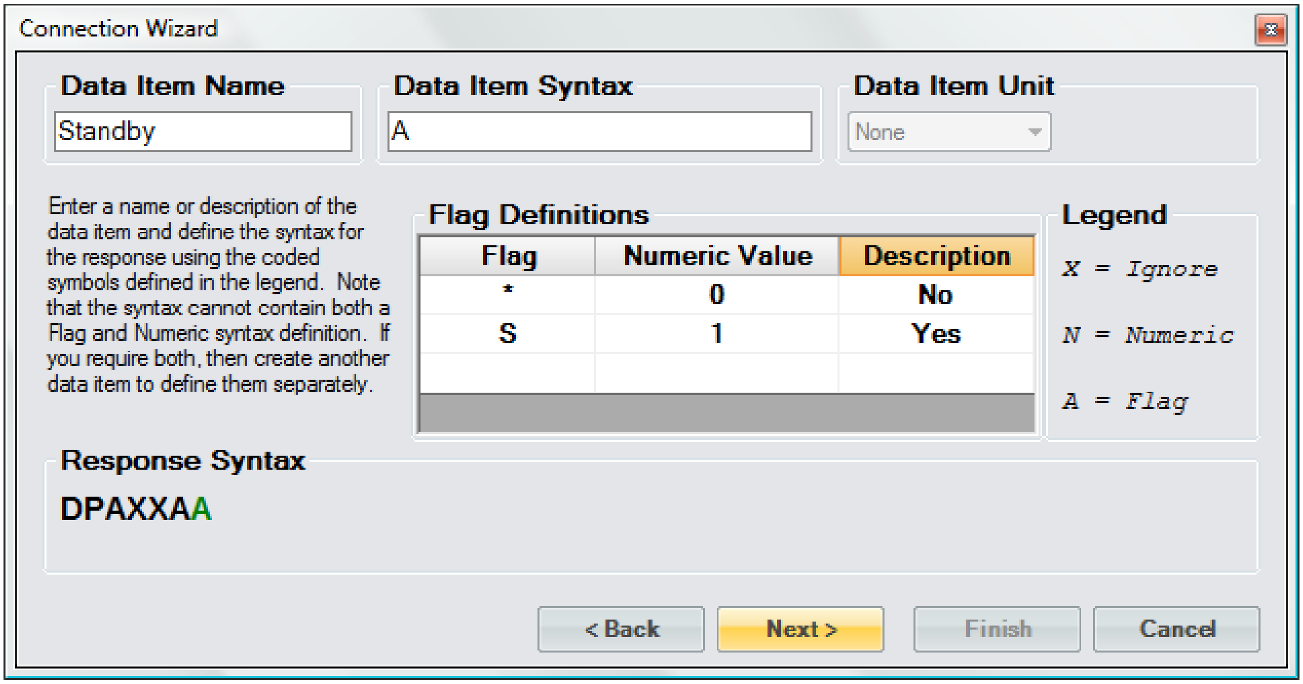
The first data item is a flag indicating whether the DP-30 is balanced. The DP-30 sends a "*" indicating that it is not balanced or a "B" indicating it is balanced. Since we are not interested in the following two characters after this flag in the message, we tell ControLog to ignore them by adding two "X"s after the flag symbol. Next, we define these flag definitions and give them a simple "Yes" or "No" description to quickly allow the user to determine their state in the parameter tab.



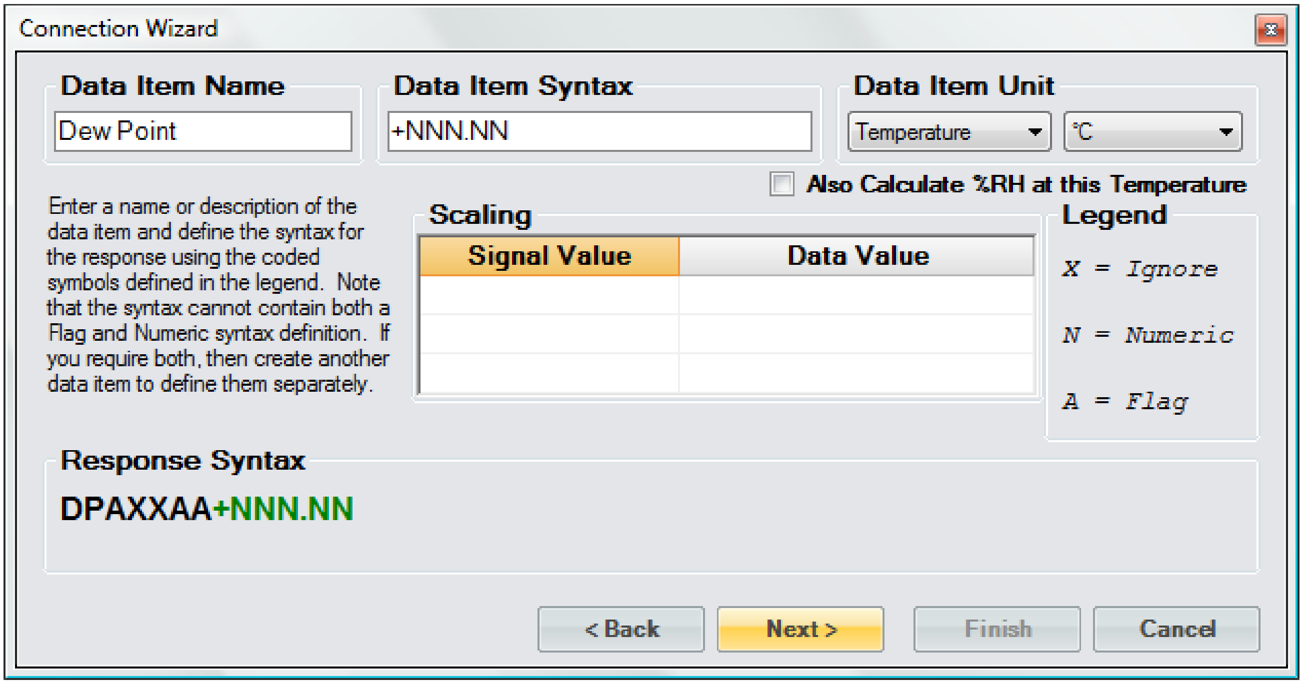
The second data item is a flag indicating whether the DP-30 is running. The DP-30 sends a “*” indicating that it is not running or an “S” indicating it is running. We again define these flag definitions and give them a simple “Yes” or “No” description to allow the user to determine the state in the parameter tab quickly.



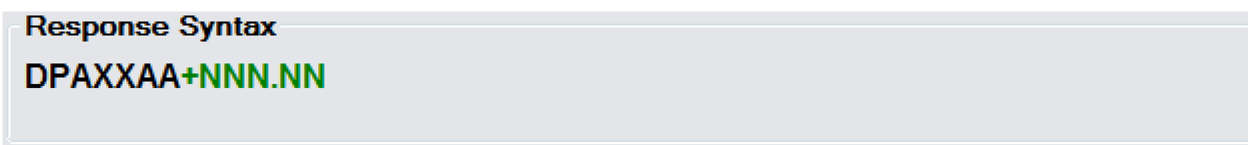
The third data item is a flag indicating whether the DP-30 is in standby. The DP-30 sends a "*" indicating that it is not in standby or an "S" indicating it is in standby. We again define these flag definitions and give them a simple "Yes" or "No" description to allow the user to determine the state in the parameter tab quickly.



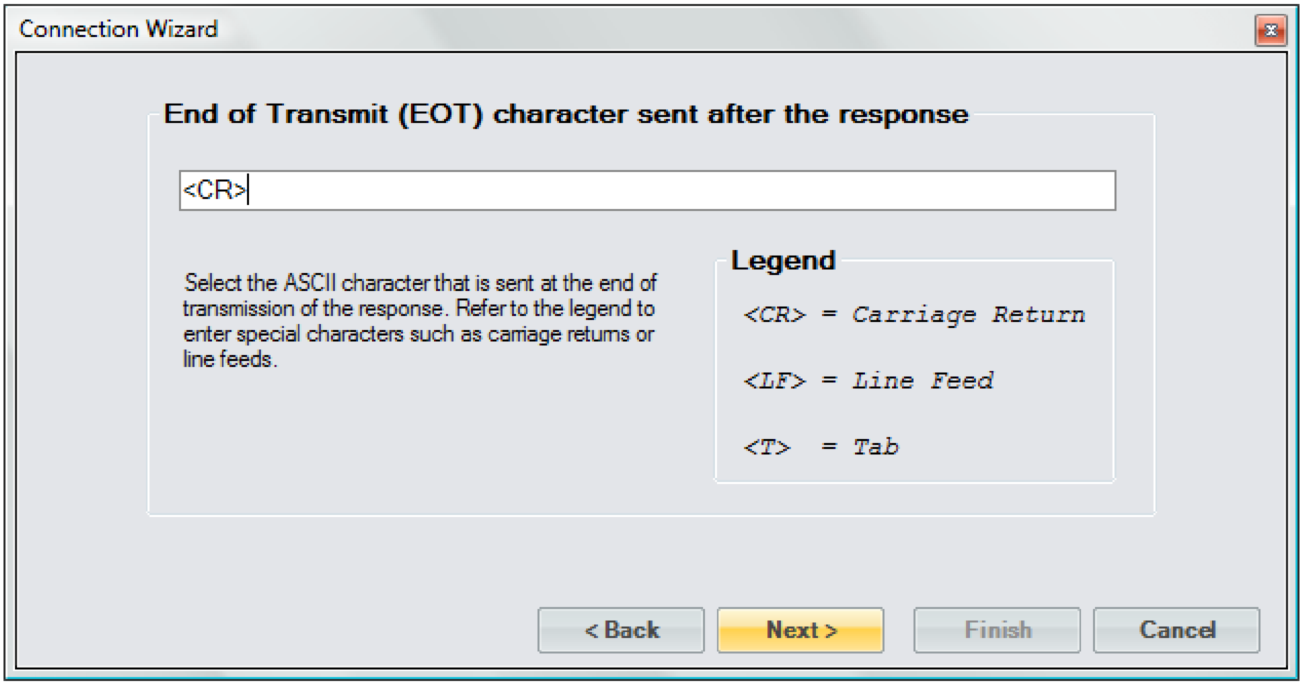
The fourth data item is the dew point temperature value. The DP-30 sends a numeric value indicating the dew point temperature in degrees Celsius. We define the syntax exactly as the DP-30 documentation specifies. The response value is the actual value, so there is no need to define any type of scaling.



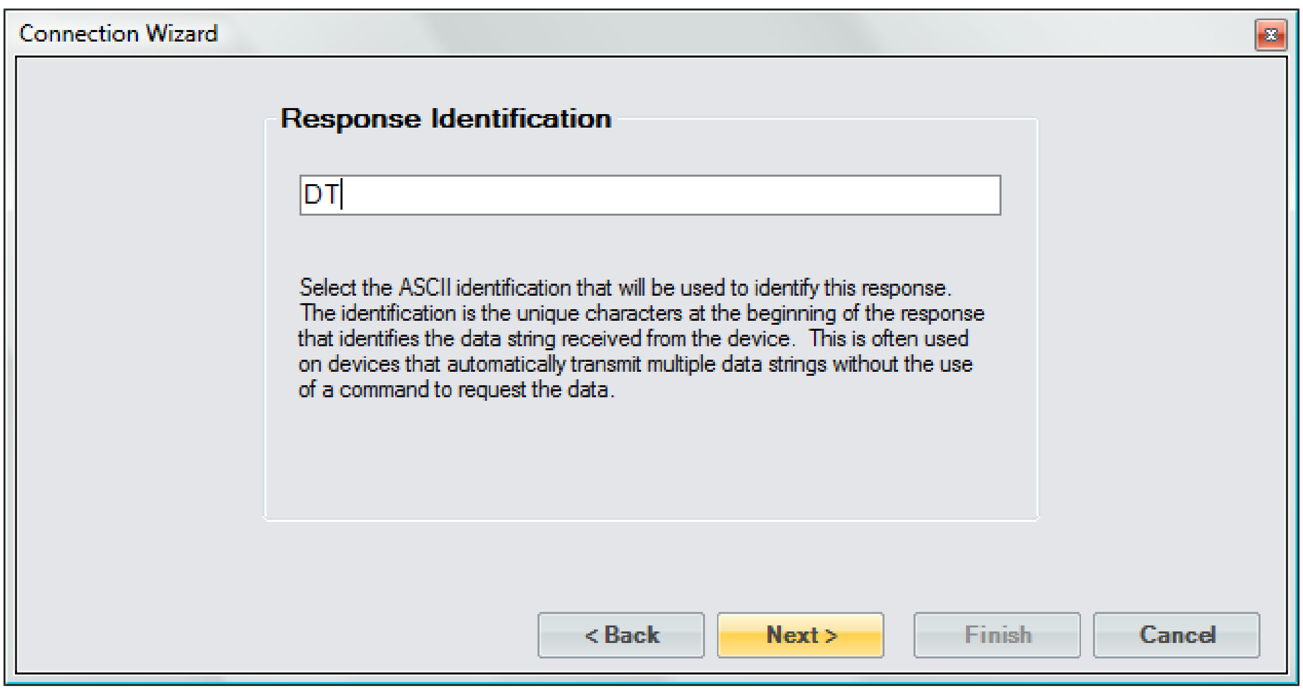
Notice that ControLog shows the combined response syntax for this message at the bottom of the form. This syntax closely resembles the syntax defined in the DP-30 documentation for the dew point temperature message. The Green portion of the syntax is the current data item's syntax within the response message.



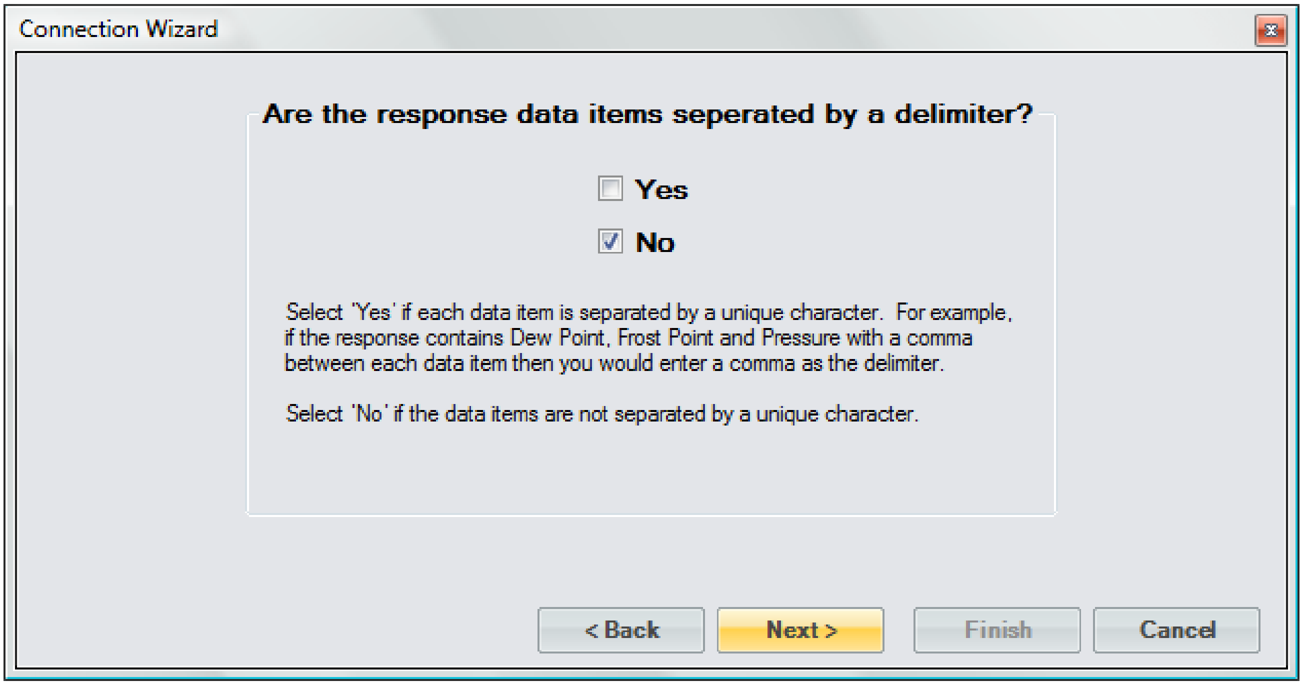
The Dew Point Temperature message is terminated with a carriage return.



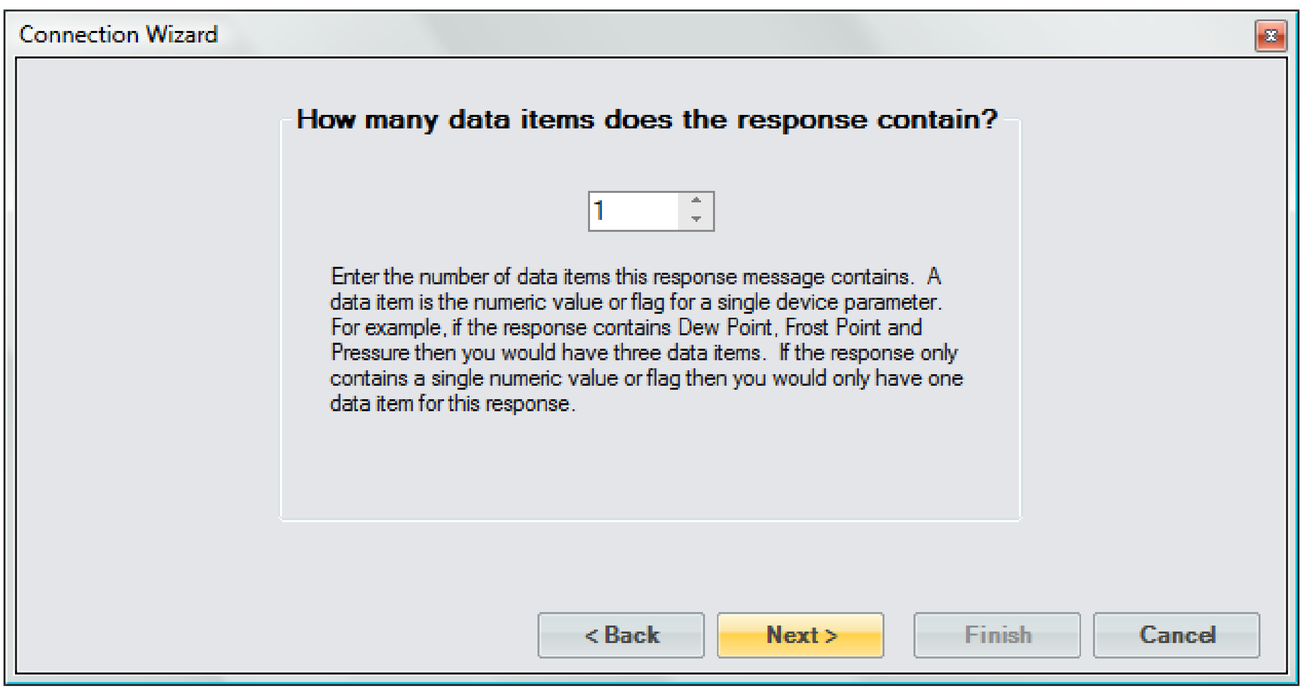
Next, we define the response identification for the second message. Referring to the DP-30 documentation, we enter the identification for the Dry Temperature message.



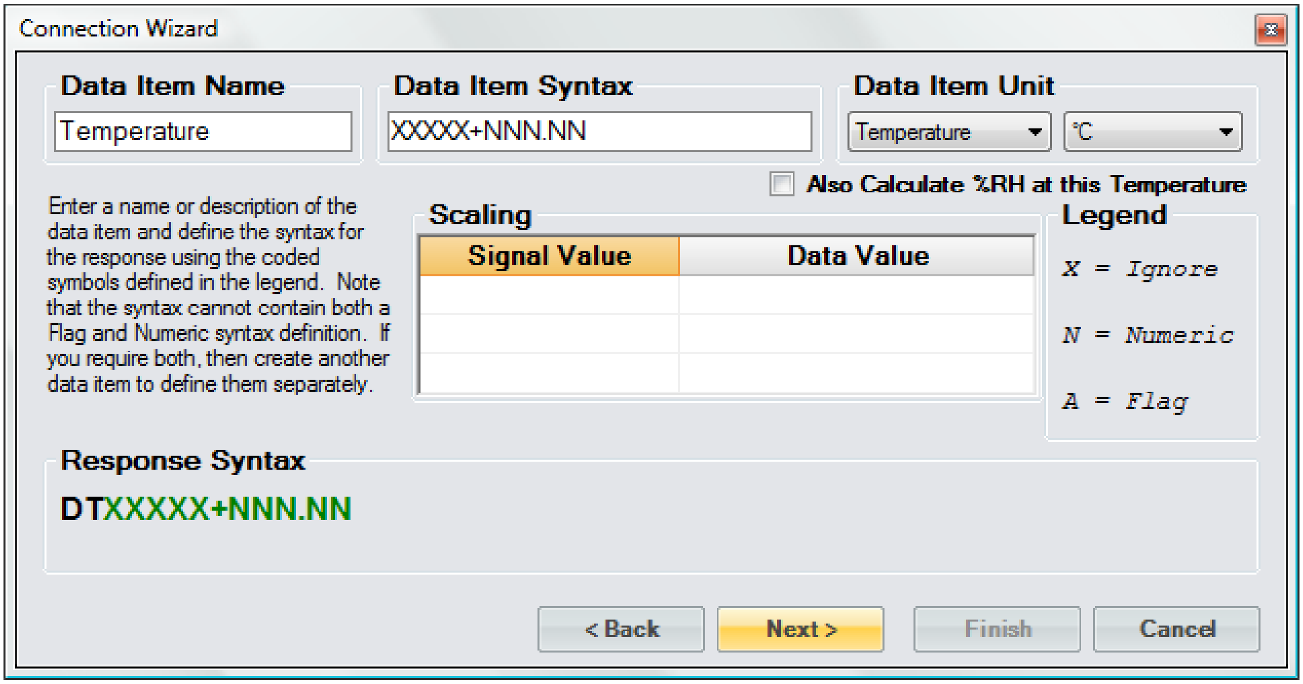
The DP-30 Dry Temperature message is of a fixed format and does not use any delimiter.



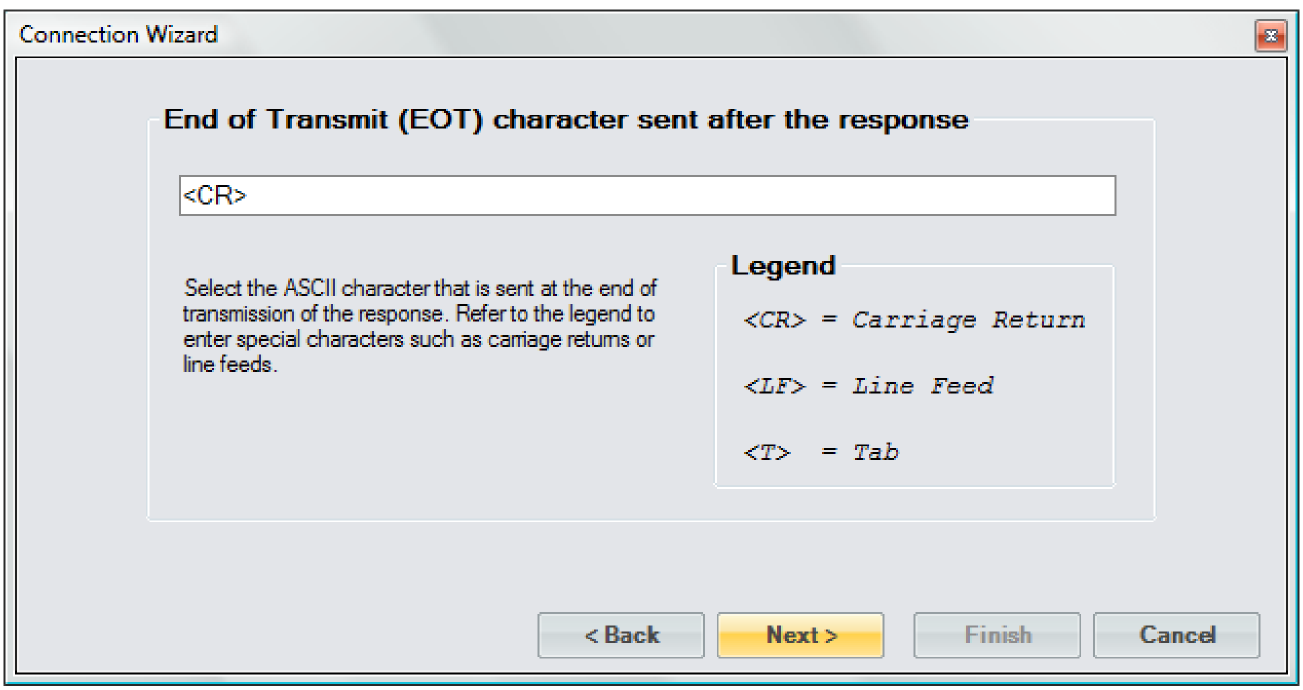
The Dry Temperature message contains only one numeric value; therefore, there is only one data item for this response.



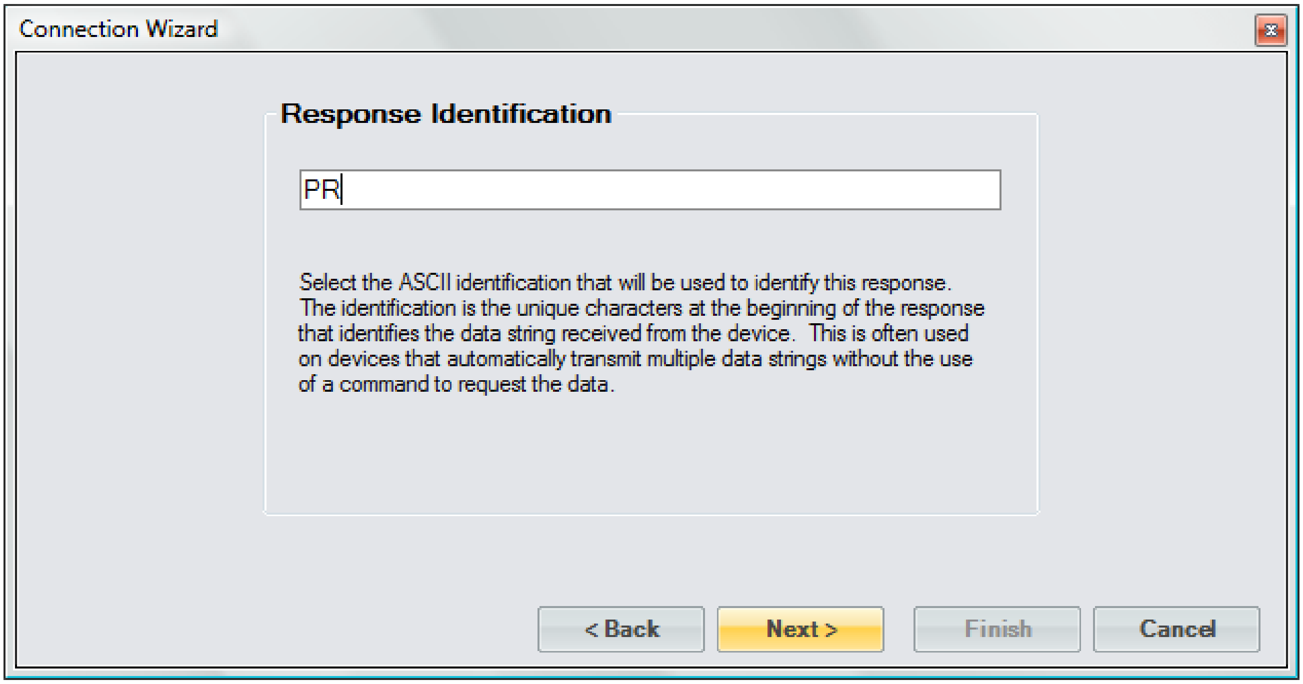
The message is led by several ASCII characters we are not interested in. We tell ControLog to ignore these leading characters by defining the syntax with five "X" characters and then the numeric syntax. We define the numeric syntax exactly as the DP-30 documentation specifies. Again, the response value is the actual value, so there is no need to define any type of scaling.



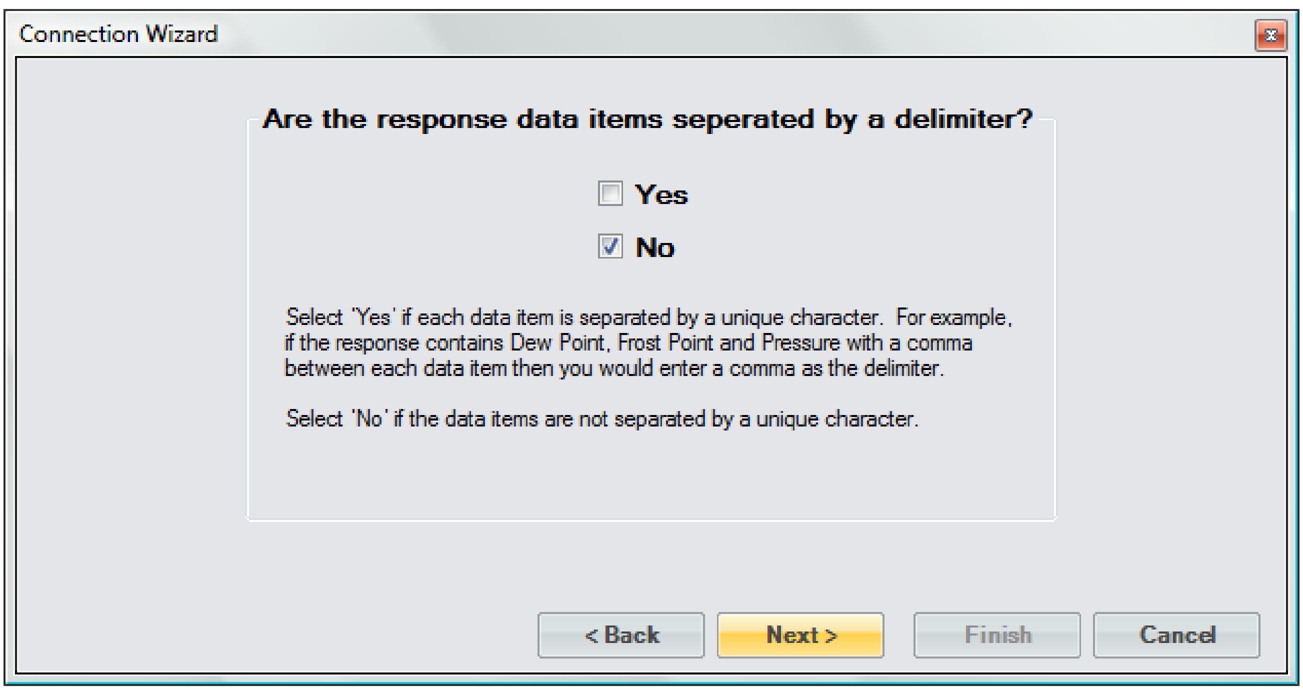
The Dry Temperature message is terminated with a carriage return.



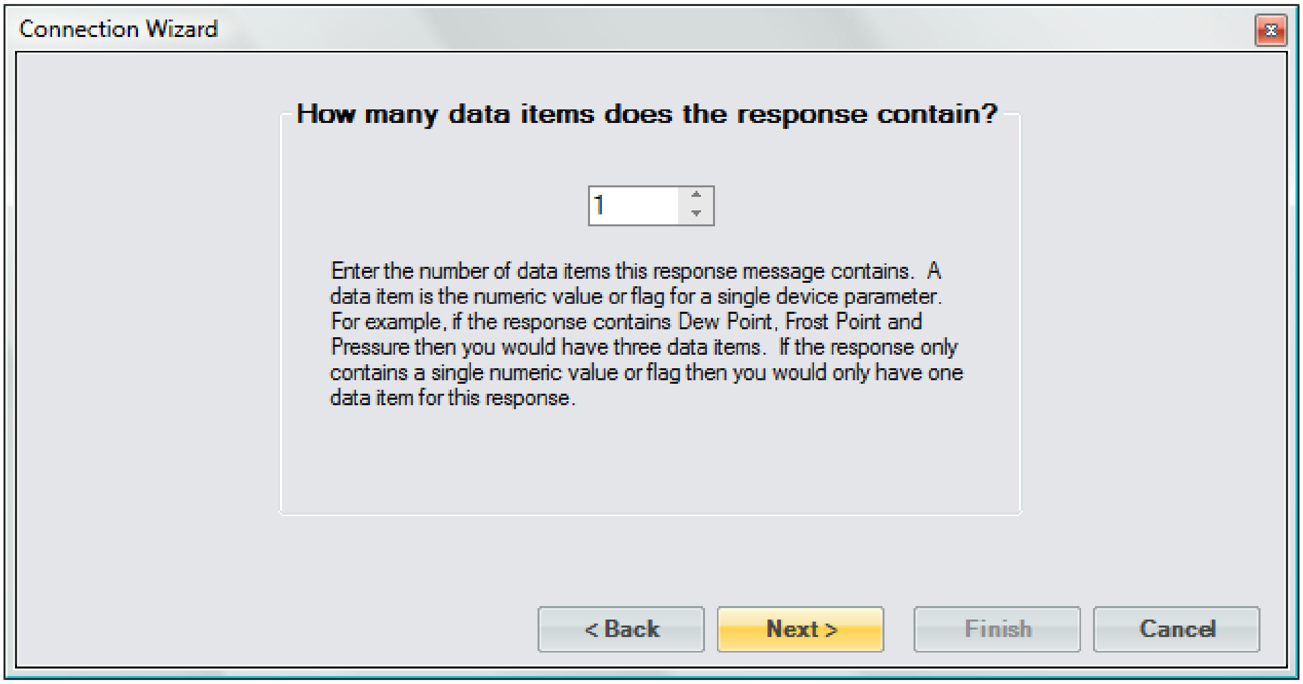
We now define the response identification for the third and last message. Referring to the DP-30 documentation, we enter the identification for the Pressure message.



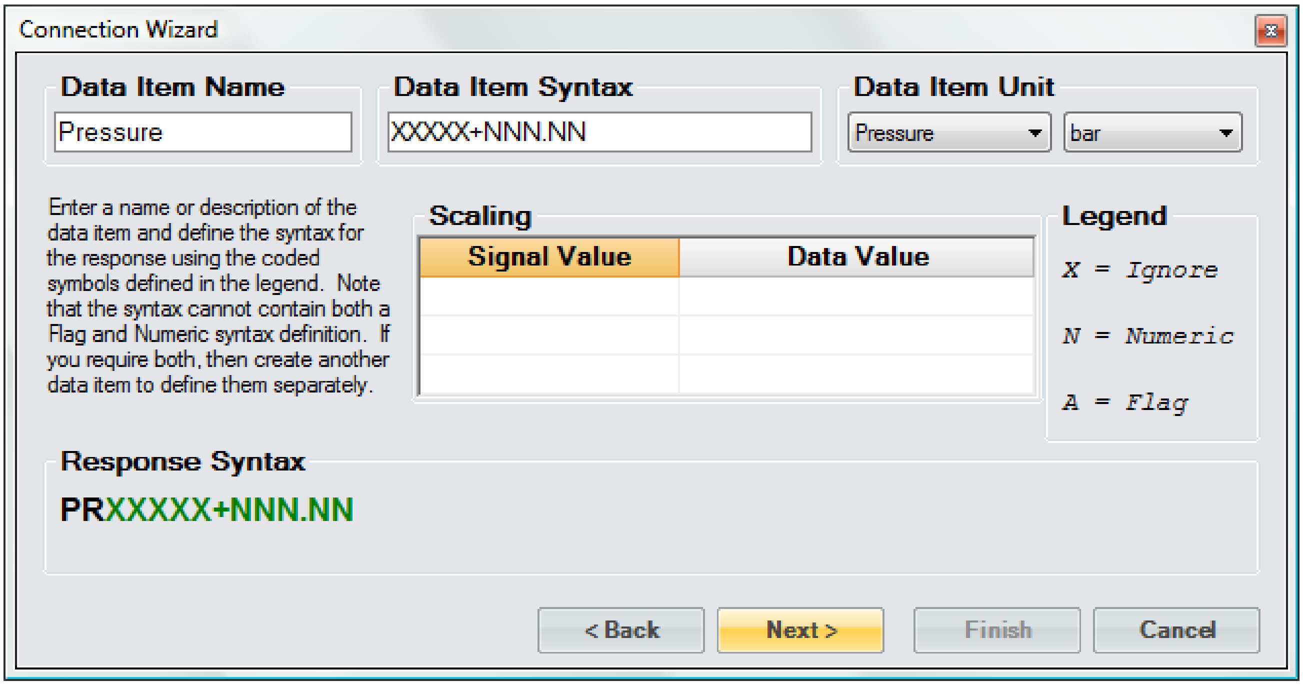
The DP-30 Pressure message is of a fixed format and does not use any delimiter.



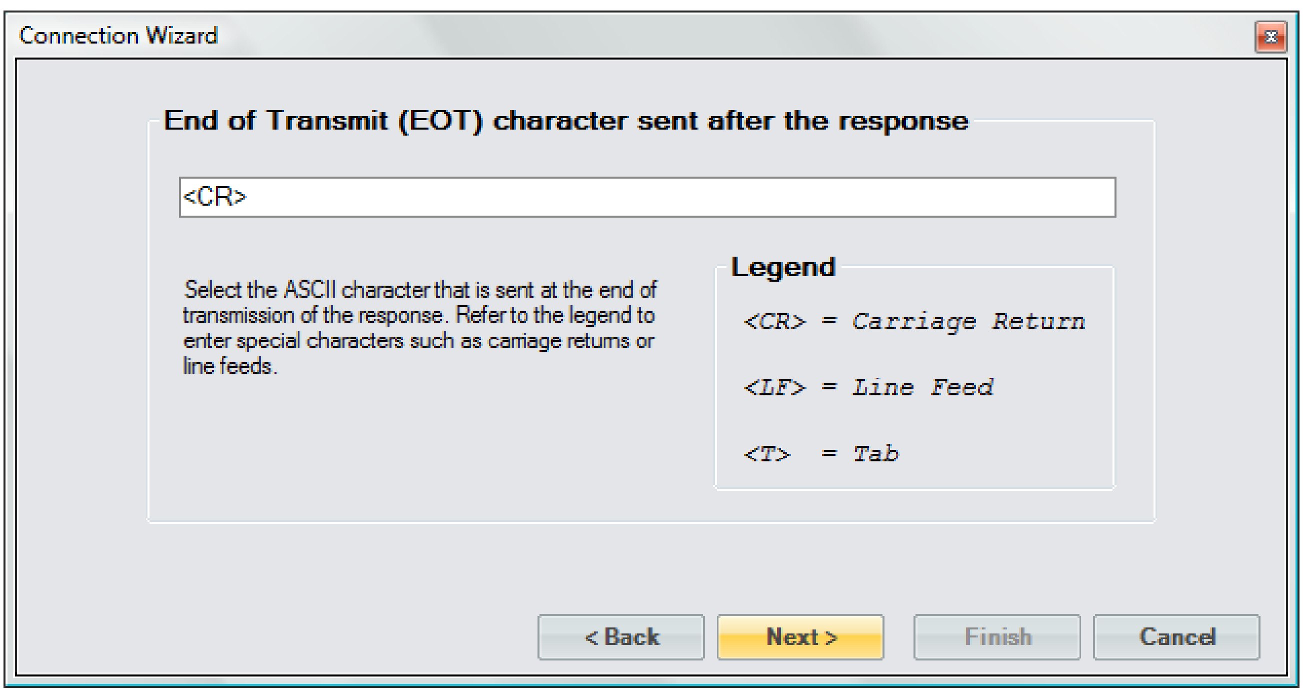
The Pressure message contains only one numeric value; therefore, there is only one data item for this response.



Again, the message is led by several ASCII characters that we are not interested in. We tell ControLog to ignore these leading characters by defining the syntax with five "X" characters and then the numeric syntax. We define the numeric syntax exactly as the DP-30 documentation specifies. Note that we set the data item unit to the unit specified in the DP-30 documentation. This allows ControLog to convert the reading into a more desired unit if needed. Again, the response value is the actual value, so there is no need to define any type of scaling.



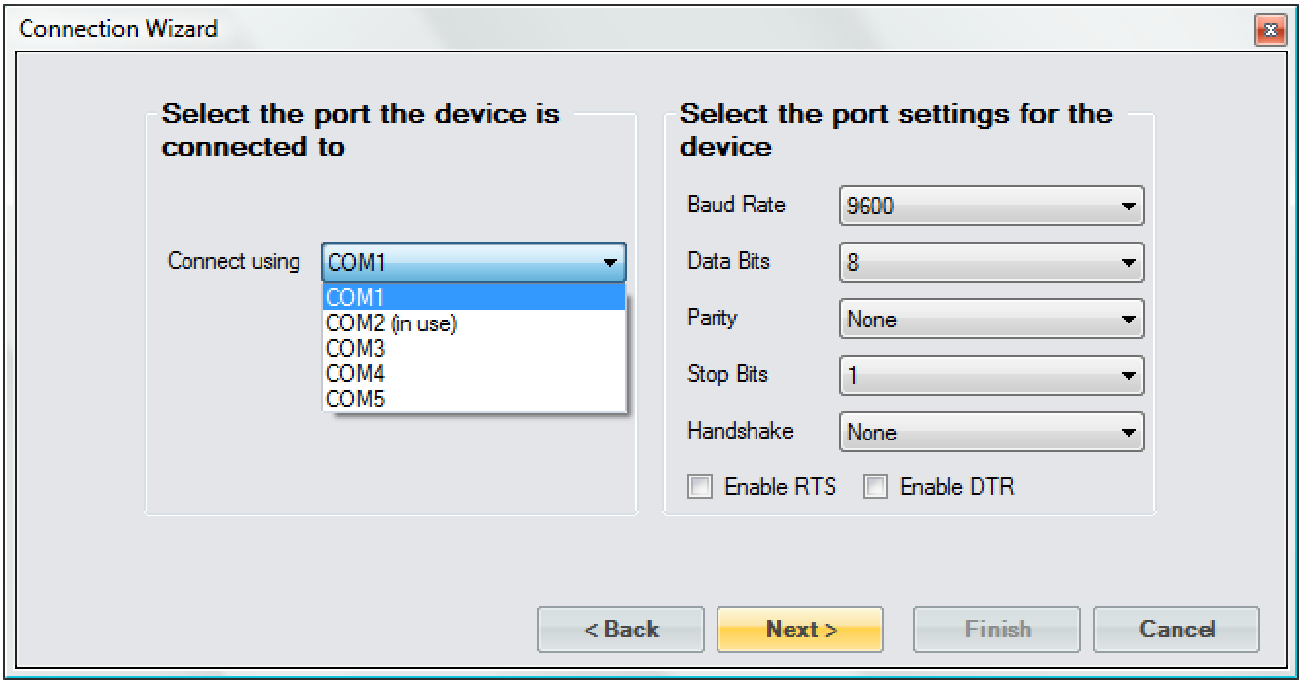
The Pressure message is terminated with a carriage return.



Save the newly created device to a file so that it can be recalled at a later time.

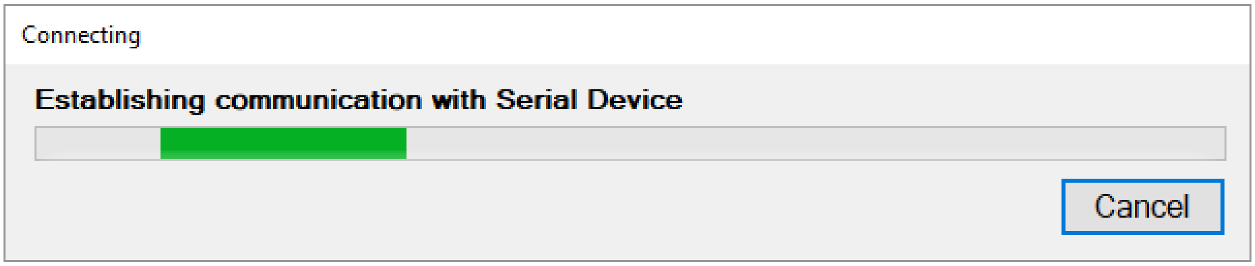
Select to connect to the device now.

Select the port the DP-30 is connected to. Notice that ControLog indicates which ports are in use. Refer to the DP-30 documentation for the RS-232 port settings:

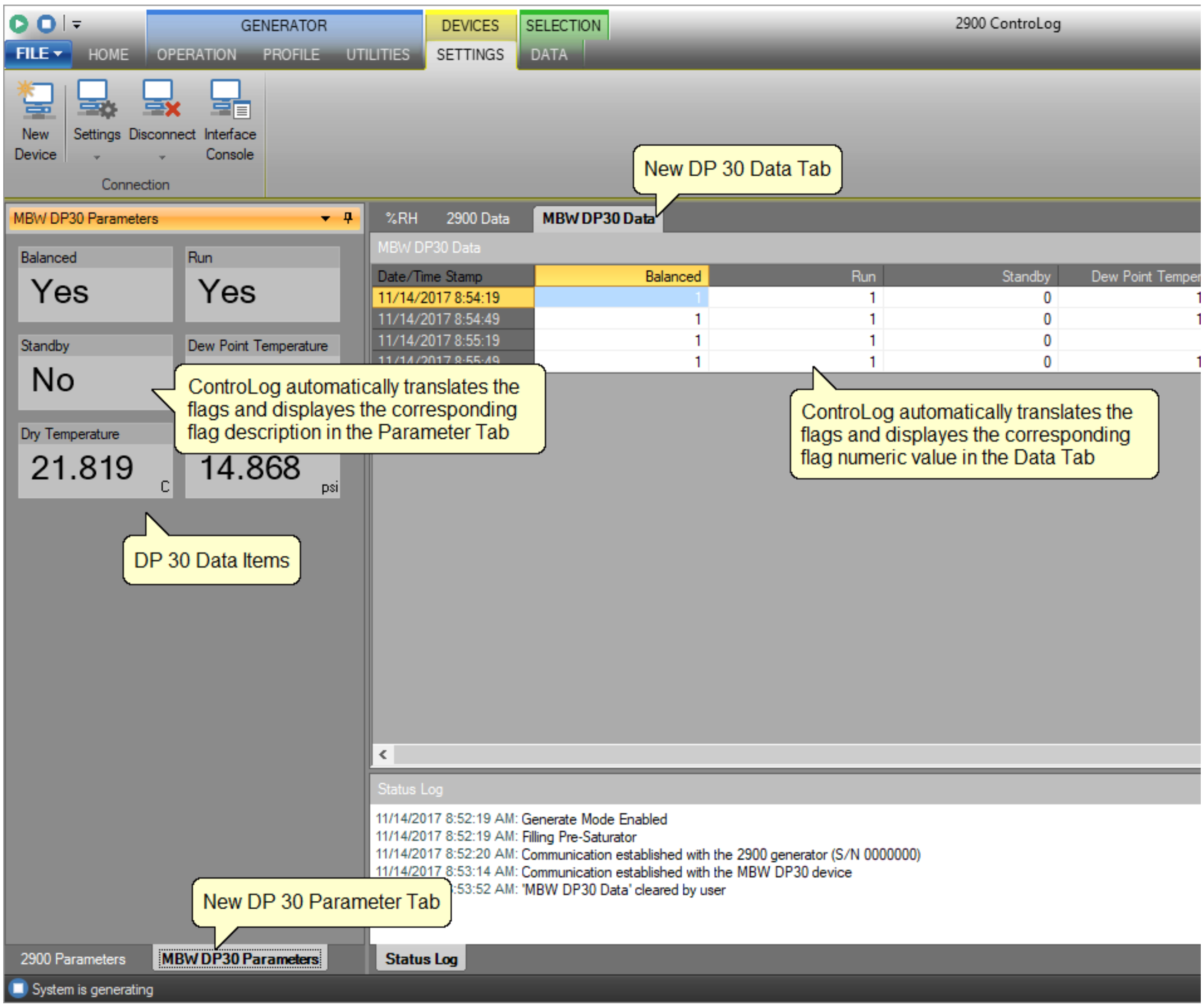


Use the default access rate of 1.5 seconds.

Once completed, ControLog attempts to establish communication with the DP-30.



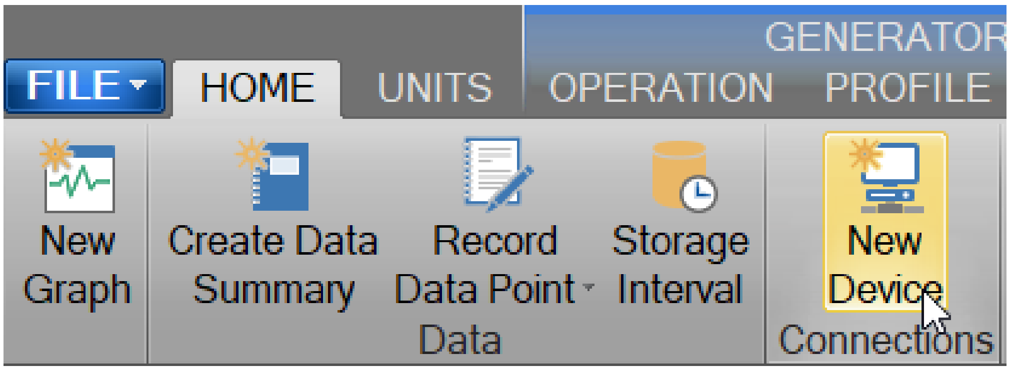
Once communication is successfully established with the DP-30, a new parameter tab and data tab are created. Notice that ControLog automatically translates the ASCII flags based on the definitions described when creating the data items for the connection.



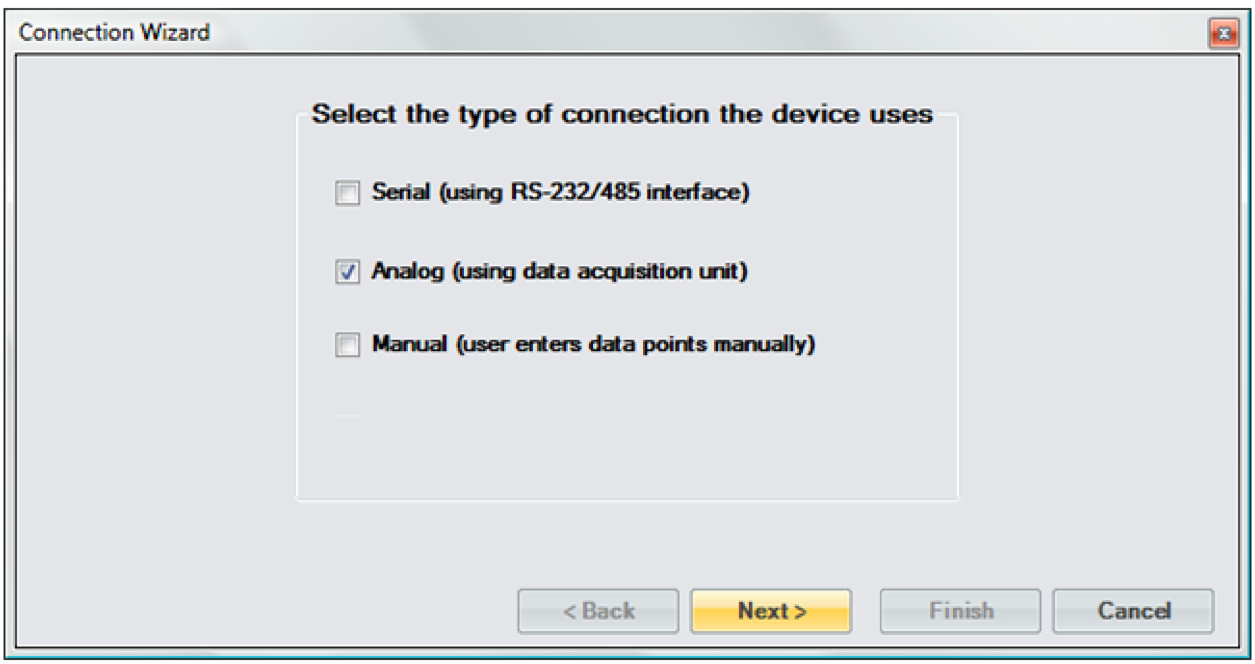
10.2 Analog Connection

An Analog Connection uses the Keysight Technologies® 34970A Data Acquisition/Switch Unit to acquire data from single or multiple analog devices. The customizable interface provided by ControLog allows the user to define different analog types and scales to read various analog signals. Refer to the Keysight Technologies® documentation for more information on connecting analog devices to the Data Acquisition Unit.

Select "New" from the Connections menu to create a new analog connection. This opens a "Connection Wizard" dialog that steps the user through the connection definition process.

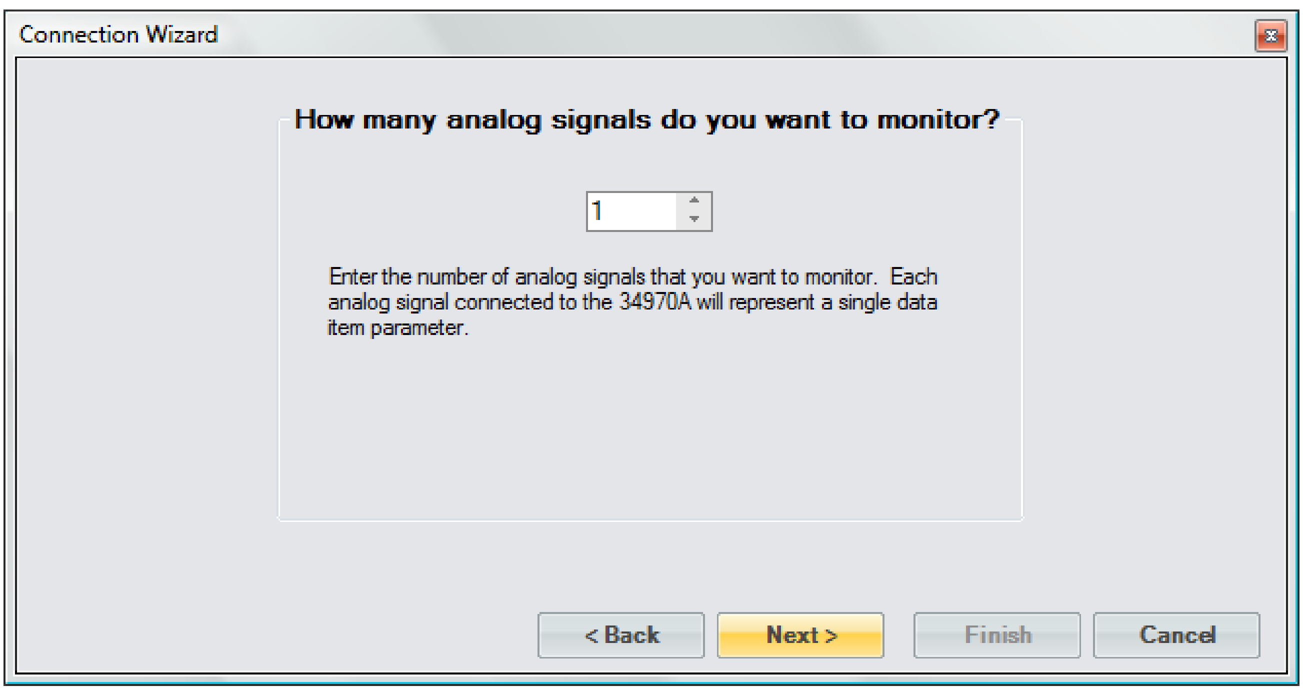


Select "Analog" as the type of connection the device uses.

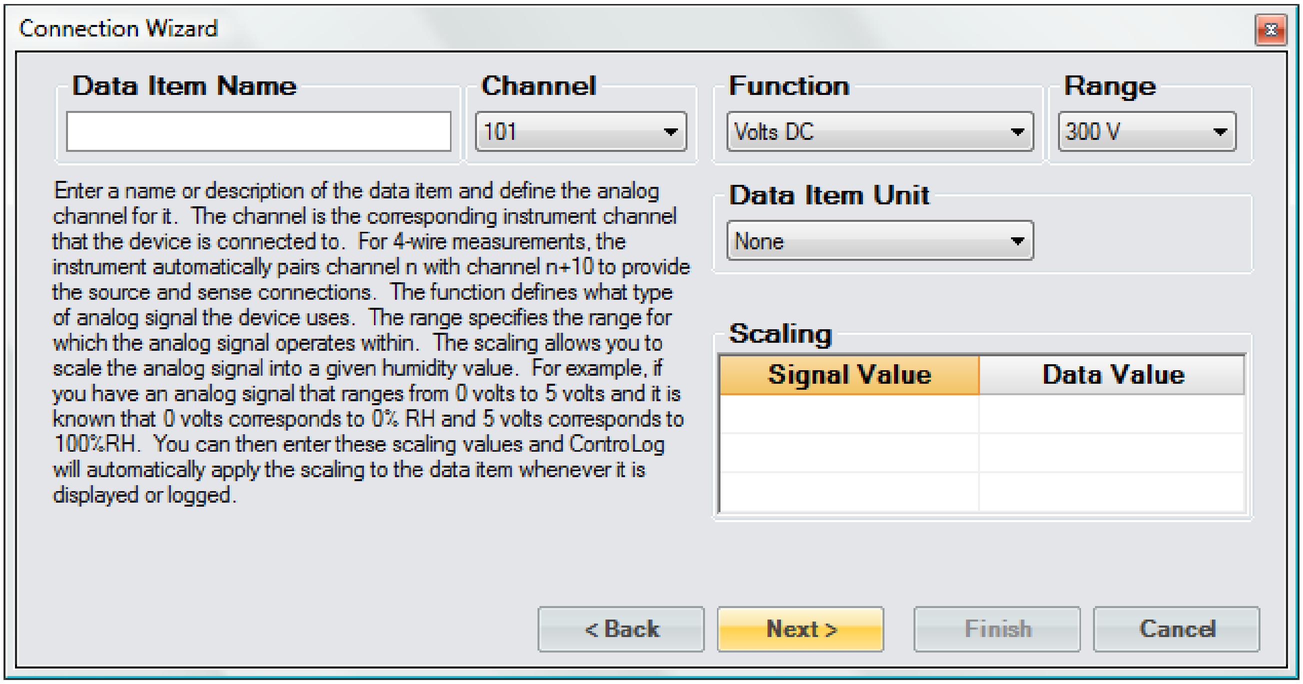


Enter a unique name for the analog device or devices.

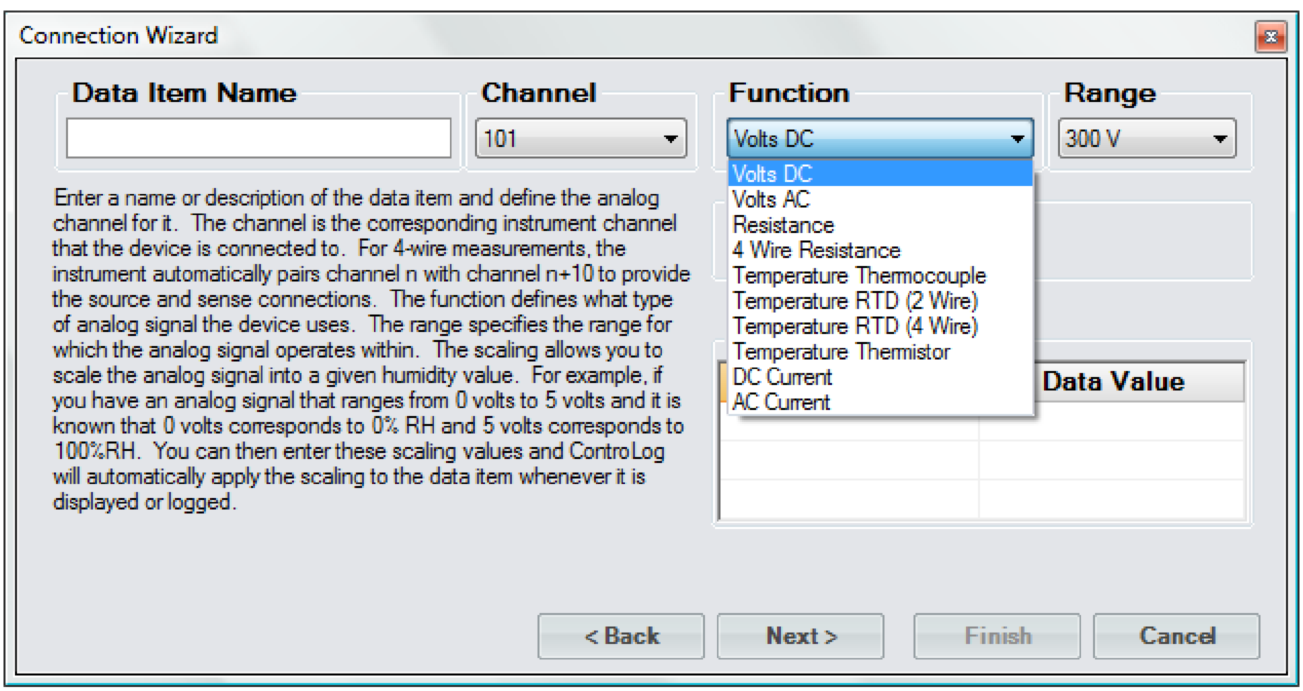
Enter the number of analog signals you want to monitor. This is the combined number of analog signals from each device you wish to monitor. Each analog signal connected to the 34970A represents a single data item parameter.



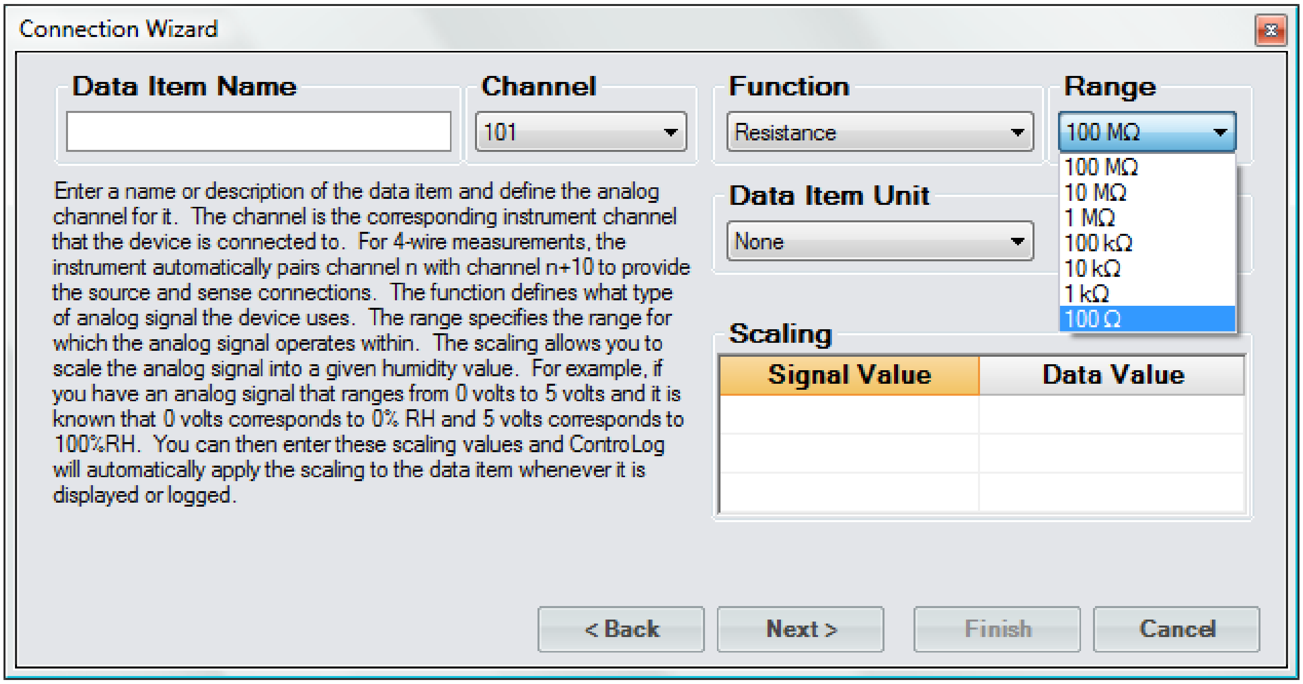
Enter a name or description of the data item and define the analog channel for it. The channel is the corresponding instrument channel the device is connected to. For 4-wire measurements, the instrument automatically pairs channel n with channel n+10 to provide the source and sense connections. This dialog repeats for each monitored signal.



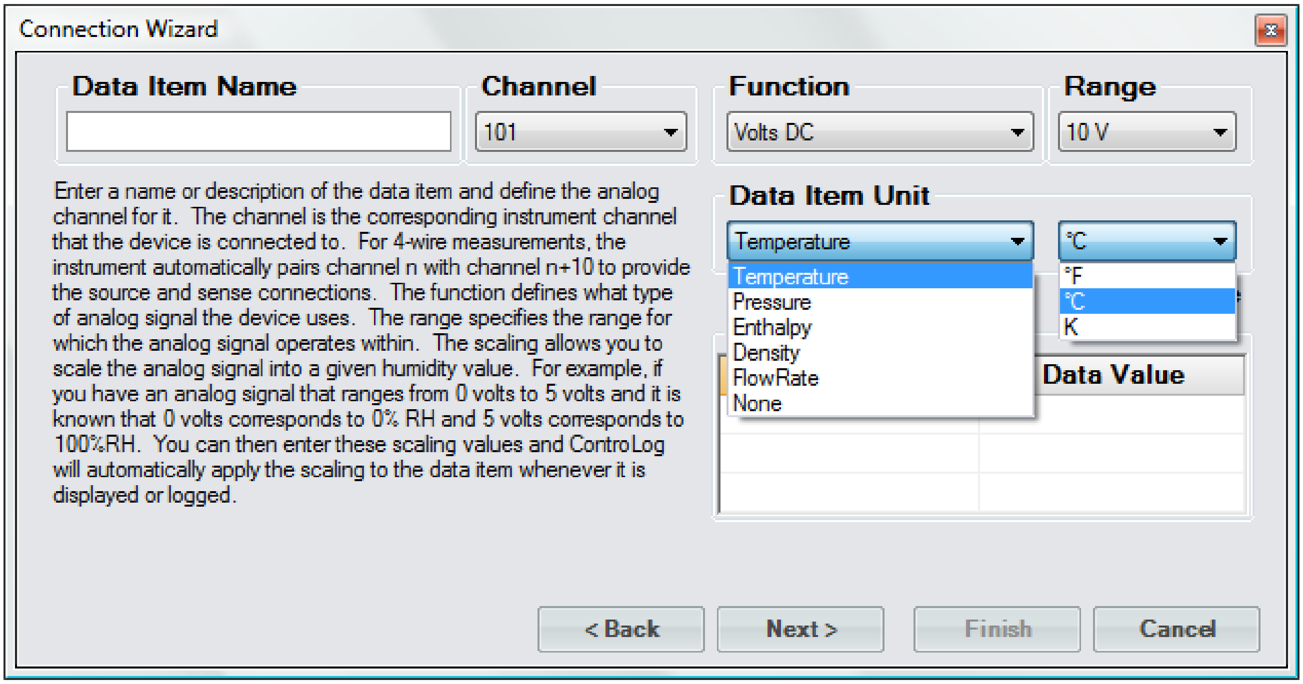
The function defines what type of analog signal the device uses.



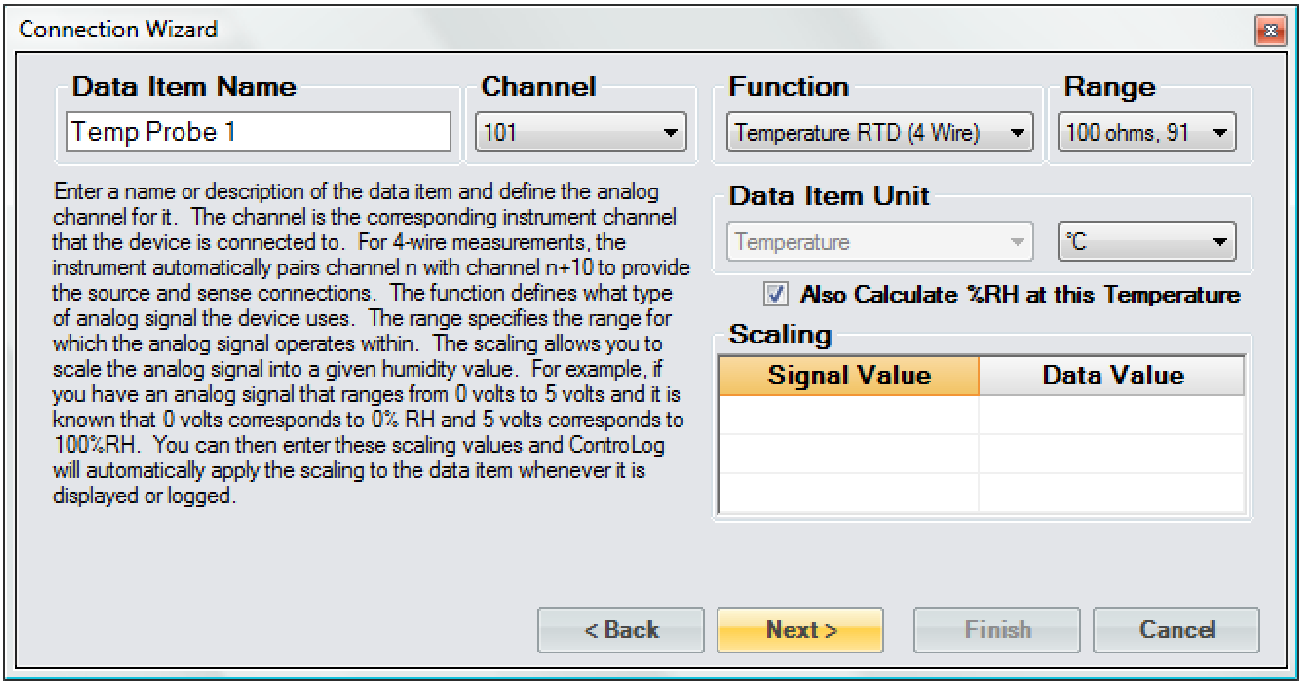
The range specifies the range in which the analog signal operates within. The available range selection changes automatically to reflect what is available for the selected function. For example, the Resistance function ranges from 100 Ohms to 100 Mega Ohms.



Selecting the unit for the data item allows ControLog to convert the value to the selected system units for display in the parameter tab and record the value in the default SI units in the data tab. Remember, this is the unit the device is sending the data item in, not the unit you wish to display the data item as. If "None" is selected, then ControLog treats the data item as a simple number and displays and records the value exactly as it is received.

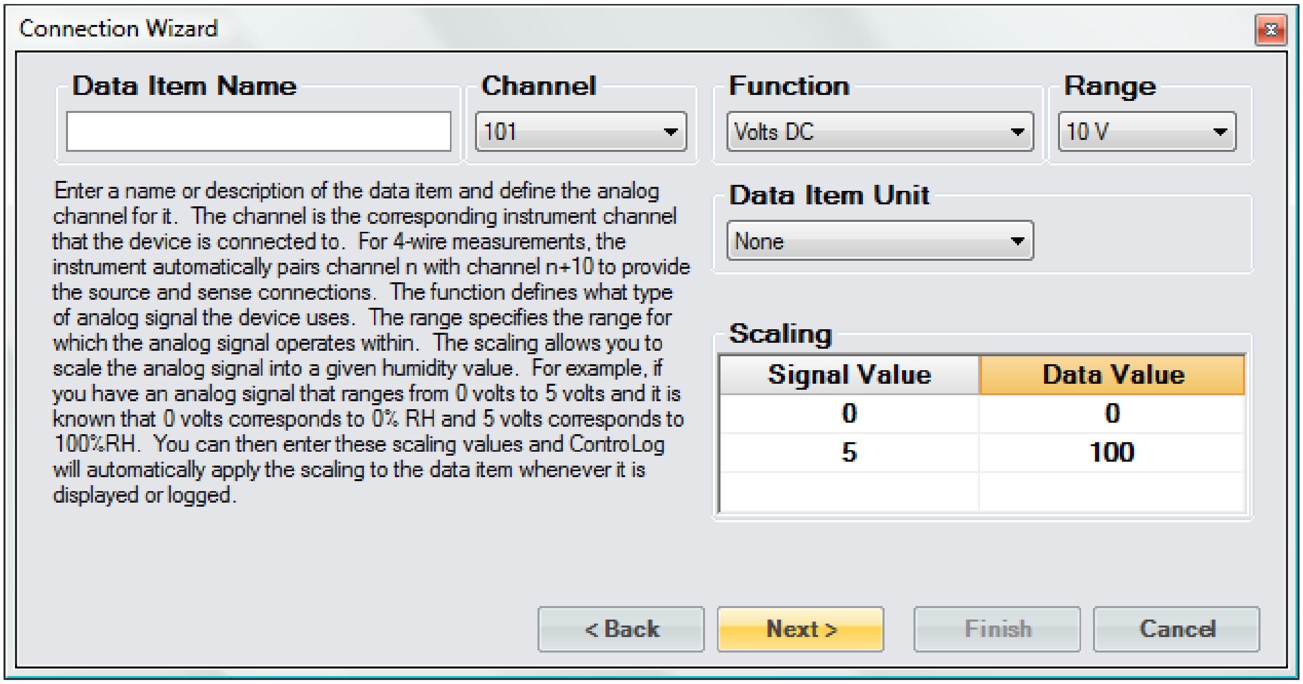


In addition to reading a temperature, ControLog can compute a percent relative humidity (%RH) at the temperature. This is useful when compensating for temperature gradients within the chamber. To have ControLog automatically calculate the relative humidity at the temperature, simply select the corresponding checkbox. The newly calculated %RH has the same name as the specified Data Item Name but is preceded by "%RH@." In the below example, the calculated %RH appears as "%RH@Temp Probe 1".



It is possible to scale an analog signal. The scaling consists of a two-point definition for linear scaling or a three to five-point definition for polynomial fit scaling. The number of points determines the degree of the polynomial used to scale the analog signal. A Singular Value Decomposition (SVD) algorithm determines the polynomial coefficients. Each point definition consists of a signal value and a data value. The signal value represents the "raw" analog signal. The data value represents the actual value or real-world value at the given signal value.

Scaling allows the user to scale an analog signal into a given humidity value. For example, if you have an analog signal ranging from 0 volts to 5 volts, it is known that 0 volts correspond to 0 %RH and 5 volts correspond to 100 %RH. The user can then enter these scaling values, and ControLog automatically applies the scaling to the data item whenever it is displayed or logged.



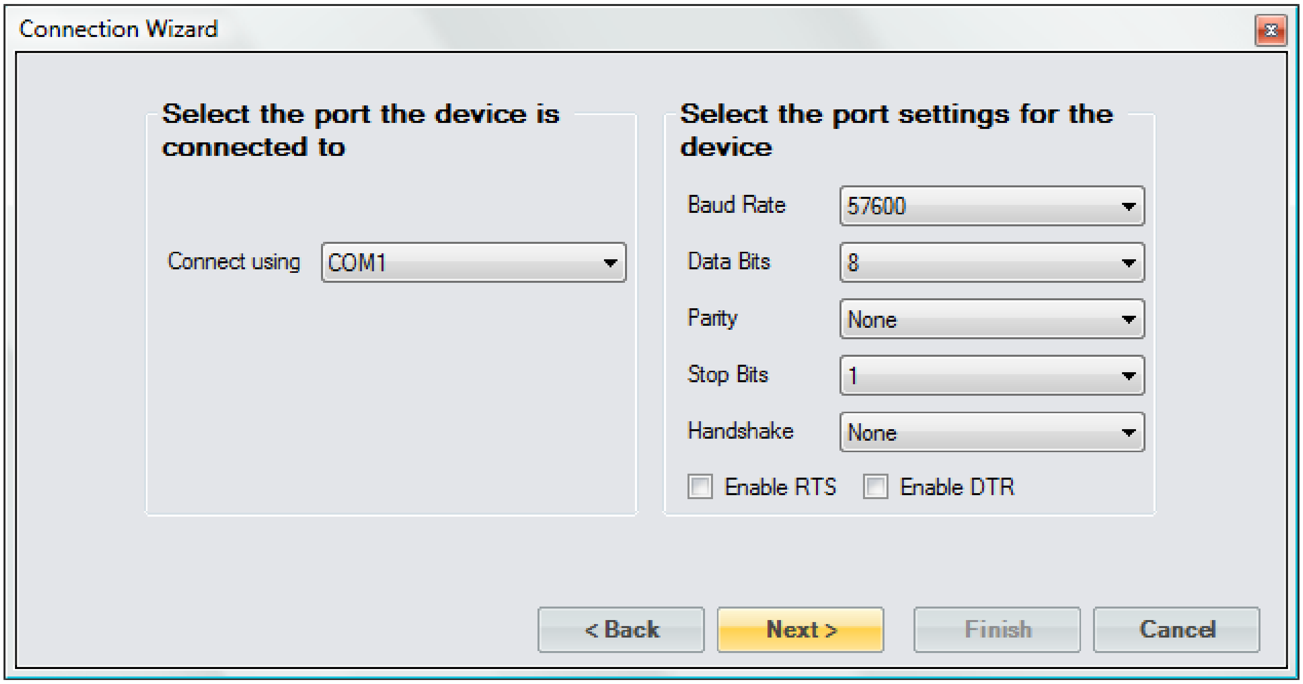
Select the name and location to save the new analog connection. Clicking the “Browse” button opens a save file dialog that allows the user to specify the name and browse to the desired location to save the file. All device connection files are saved in XML format with a (*.device) extension.

Next, the user can select whether to connect to the device or exit without connecting.

Note – *The user can connect anytime by loading the device from the Connections menu.*

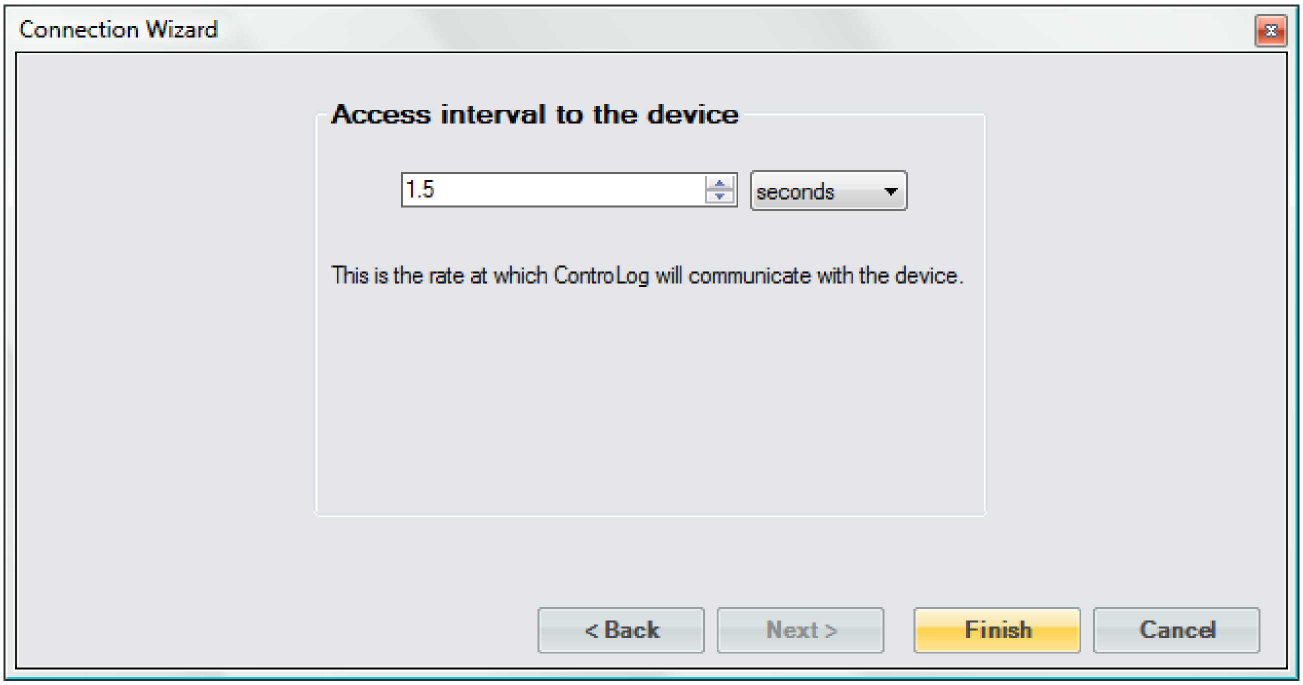
Select the communication port that the Keysight Technologies® 34970A Data Acquisition/Switch Unit is connected to and select the port settings for the 34970A.

> **Note** – *ControLog defaults to the default port settings for the Keysight Technologies® 34970A Data Acquisition/Switch Unit. Refer to the Keysight Technologies® documentation for instructions on viewing or setting the Data Acquisition RS-232 settings.*



Select the access rate to communicate with the Keysight Technologies® 34970A Data Acquisition/Switch Unit.

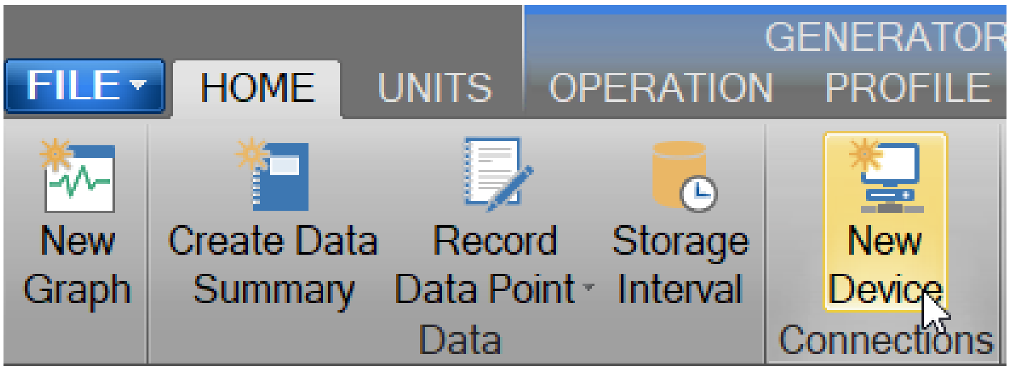
> **Note** – *Because of the nature of the 34970A and how it operates, it is critical to specify an access interval long enough to allow the 34970A to complete its scan list within the specified interval. As a rule of thumb, use 1.5 seconds per every 10 signals connected to the Data Acquisition Unit with a minimum access interval of 1.5 seconds.*



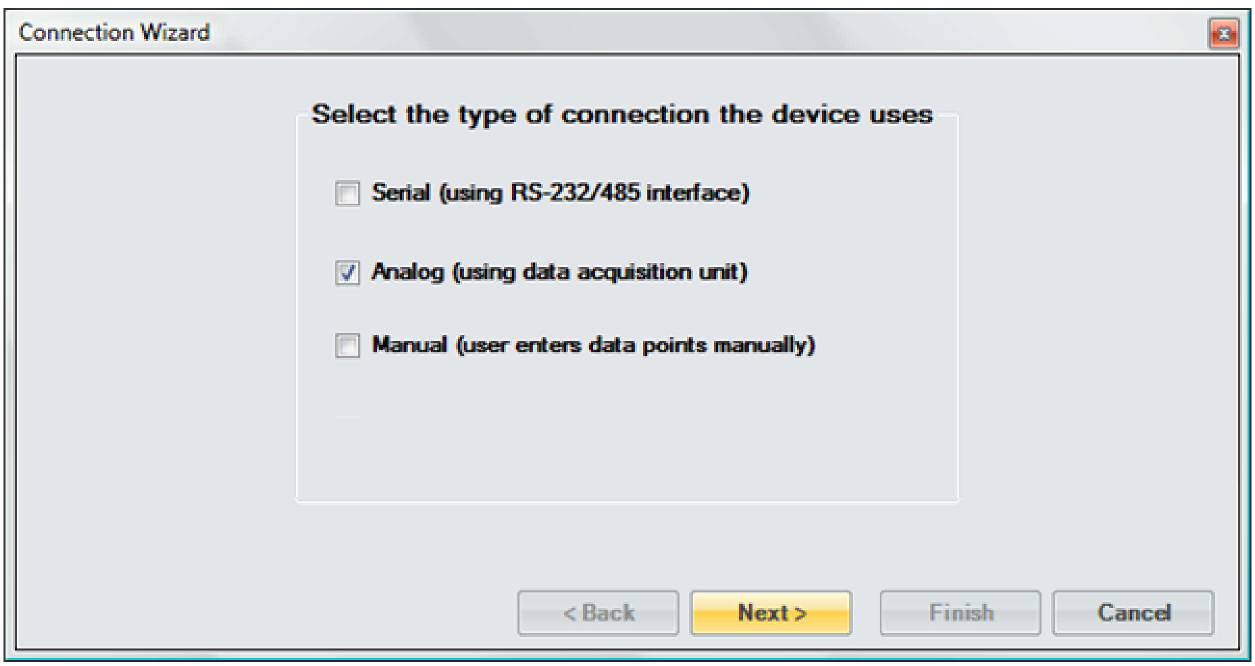
10.2.1 Analog Connection Example

This example demonstrates the creation of an analog connection. This example works with a -10 to +10V input signal scaled to a Dew Point/Frost Point Temperature, a Temperature Thermistor, and a 4-wire Temperature RTD.

Start by selecting "New" from the Connections menu.

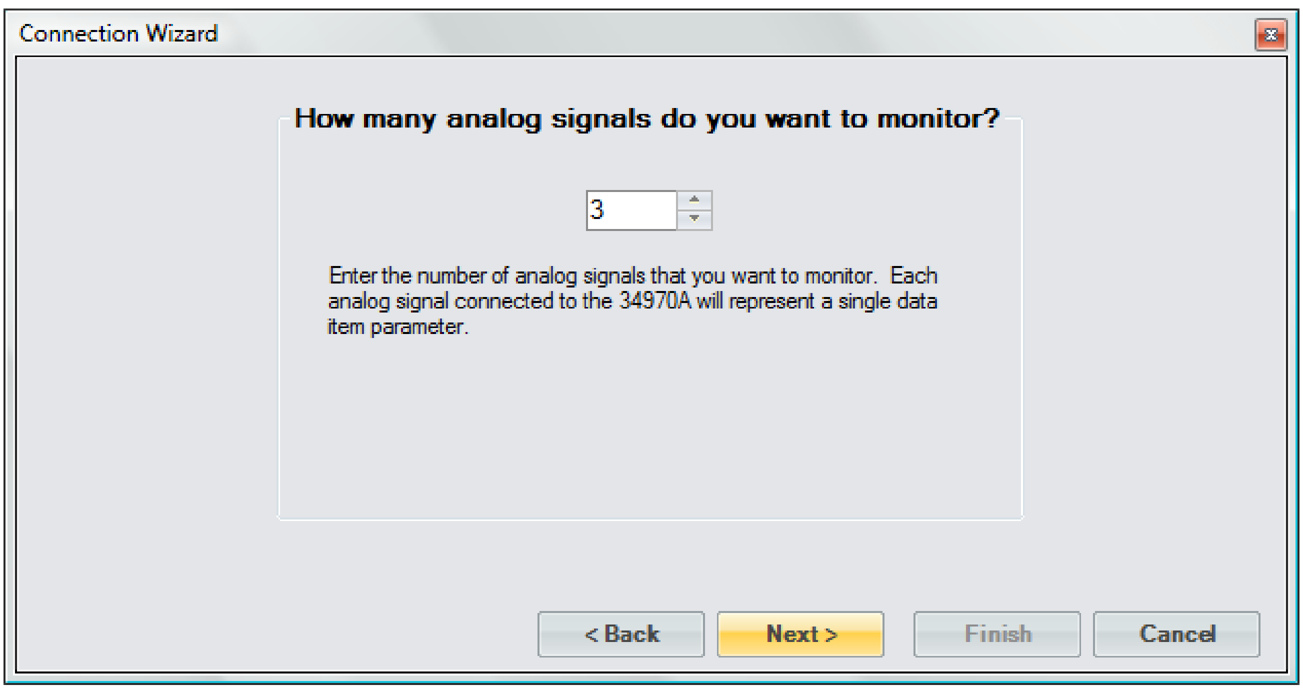


Select "Analog" as the type of device connection.

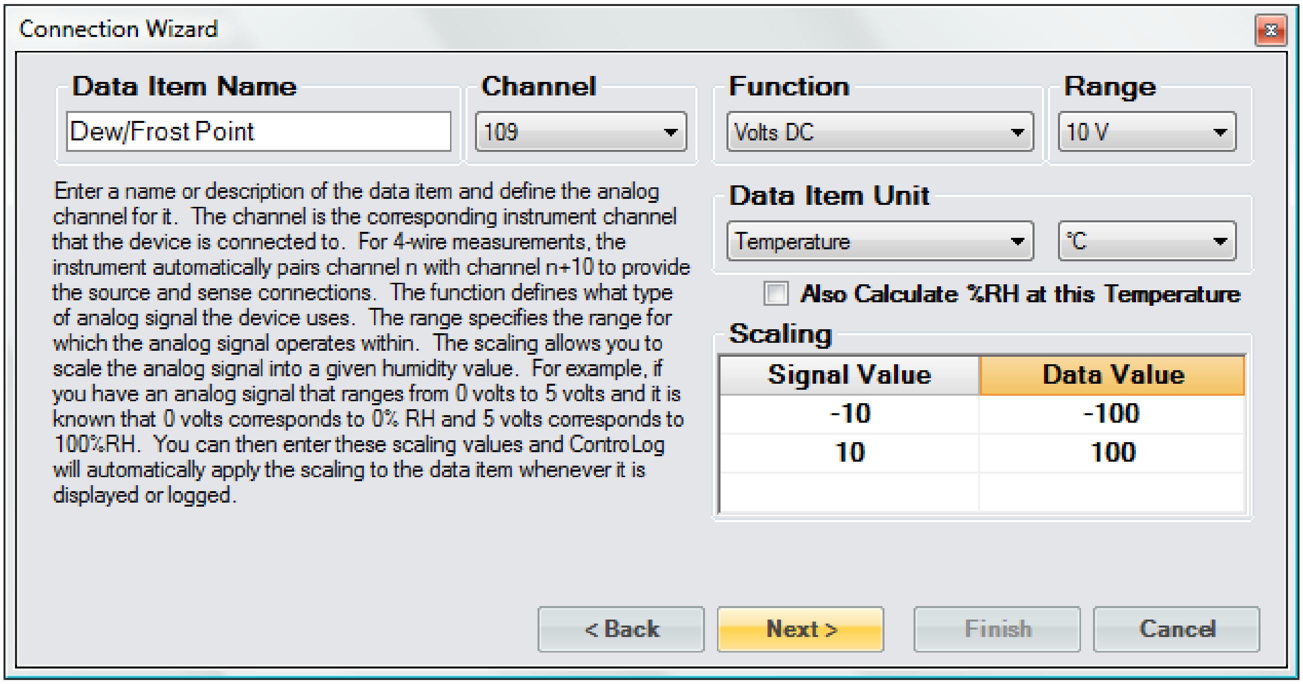


Enter “Analog Dew Point Device” as the name for the device.

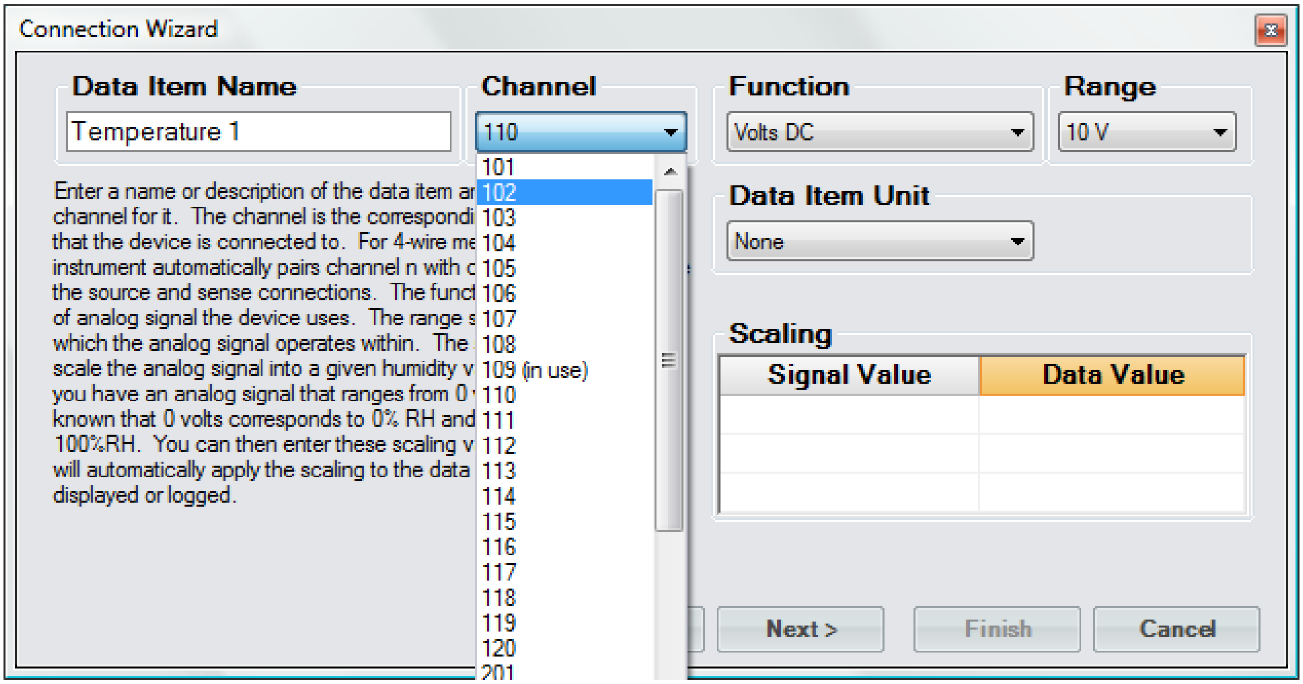
In this example, we have three signals that we want to monitor: a voltage, a thermistor, and an RTD.



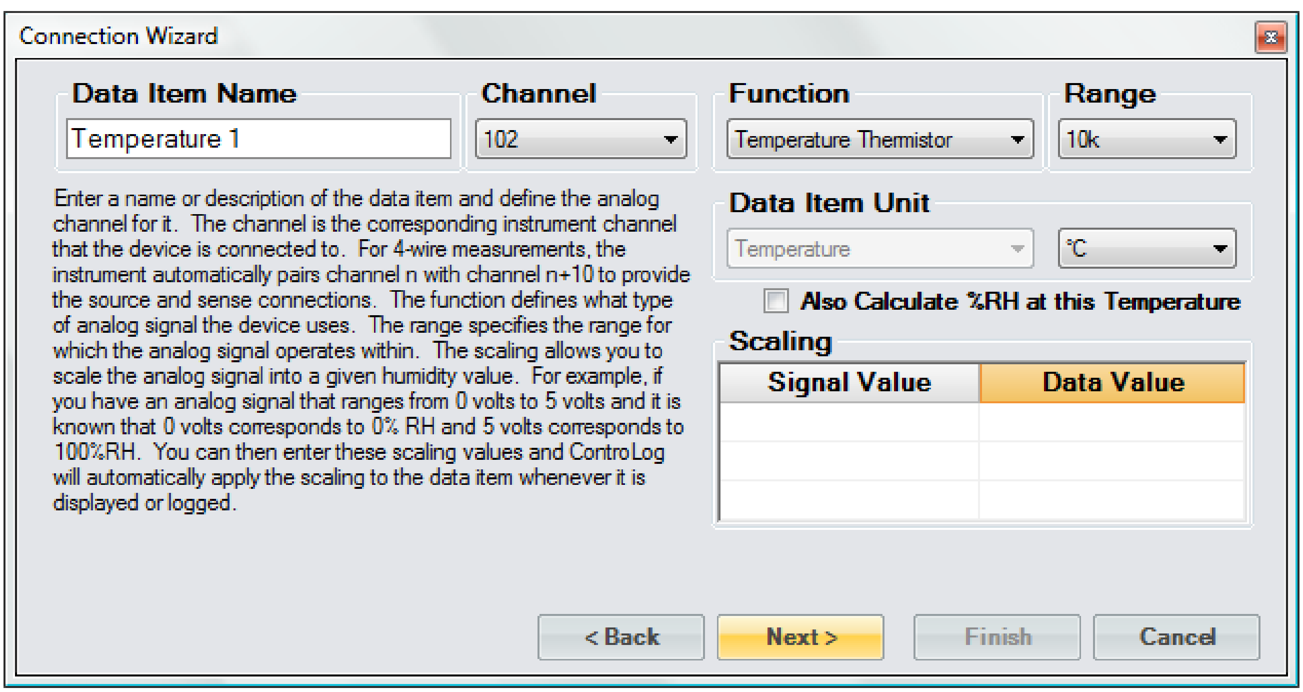
The first item is given the name "Dew/Frost Point." We select the Channel number that the signal is connected to, and since the signal is a voltage, we select "Volts DC" as the function. The range is set to "10V", and we know the signal corresponds to a temperature in degrees Celsius. We also scale the value since we know -10V corresponds to a Frost Point temperature of -100 °C, and +10V corresponds to a Dew Point temperature of +100 °C. By entering scaling, ControLog automatically scales the signal for display in the parameter tab and when recorded in the data tab.



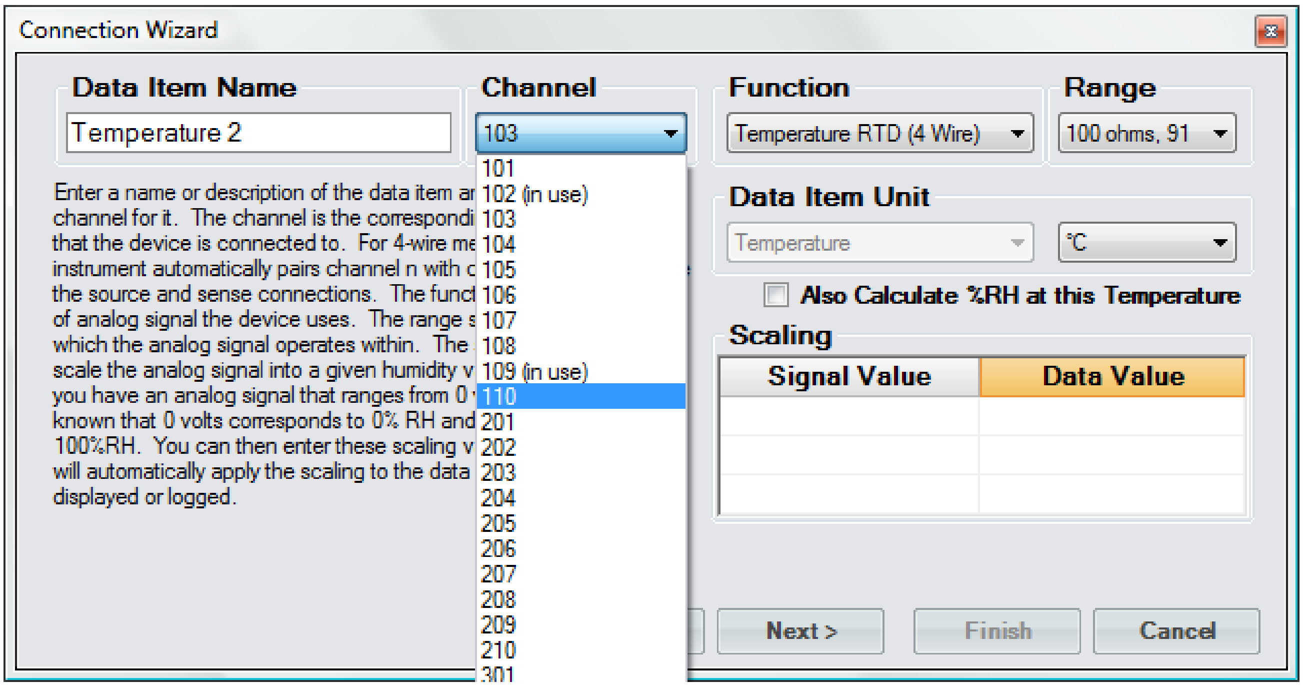
The second item is named “Temperature 1”. We select the Channel number to which the signal is connected. Notice ControLog indicates which channels have already been configured and are in use.



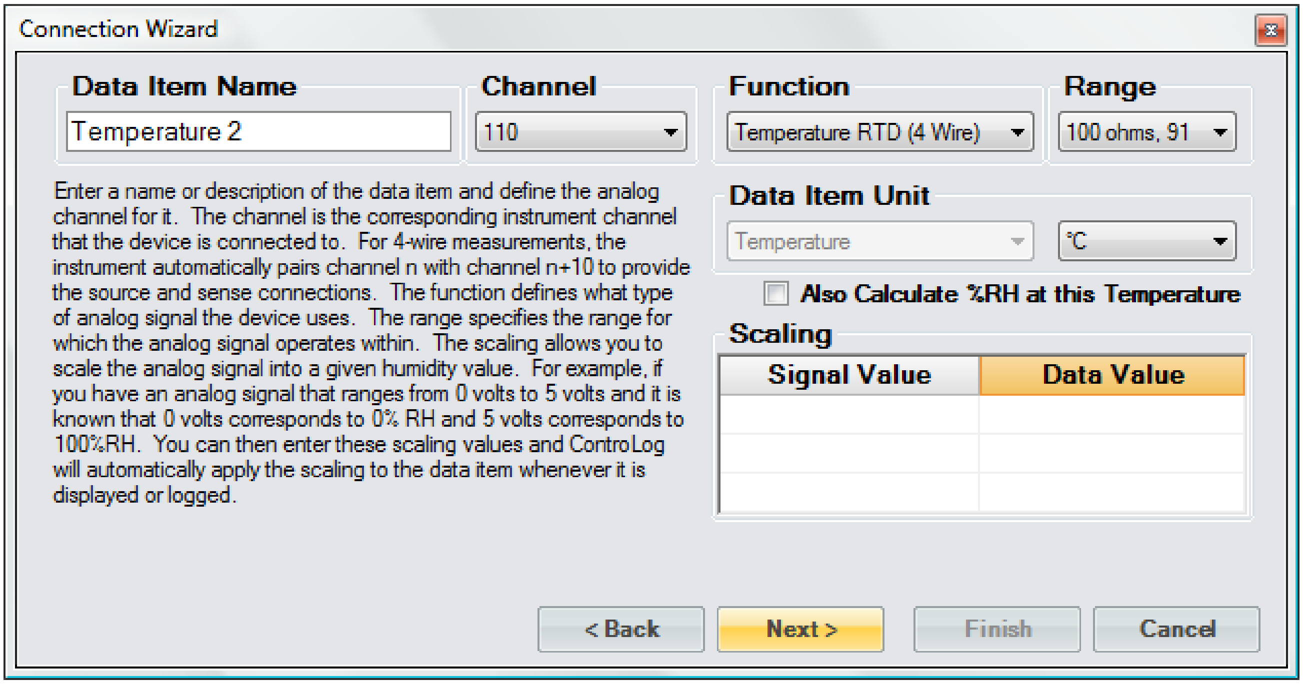
The function is set to “Temperature Thermistor,” and we set the Range to “10k” based on the type of Thermistor we are connecting. Notice that ControLog automatically selects temperature as the unit type but allows the user to select the desired temperature unit. No scaling is required for this data item since the signal value is the actual temperature value.



The third item is named "Temperature 2". The function is set to "Temperature RTD (4 Wire)," and we set the Range to "100 ohms, 85" based on the type of RTD we connected. Next, select the Channel number the RTD is connected to. Notice that the channel list is smaller because 4-wire signals are automatically paired with the selected channel plus 10 to provide the source and sense connections for an RTD. Given this, the RTD in this example occupies both channels 110 and 120 to complete its 4-wire connection.



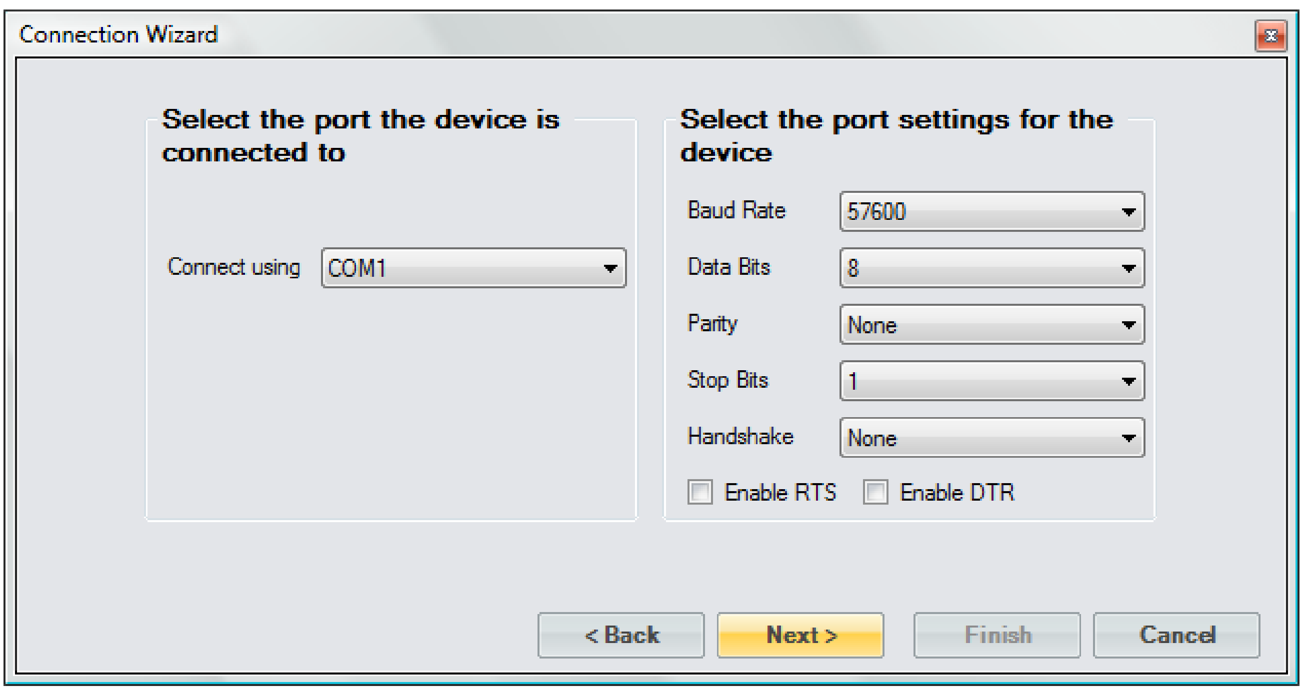
Again, notice that ControLog automatically selects temperature as the unit type but allows the user to select the desired temperature unit. No scaling is required for this data item since the signal value is the actual temperature value.



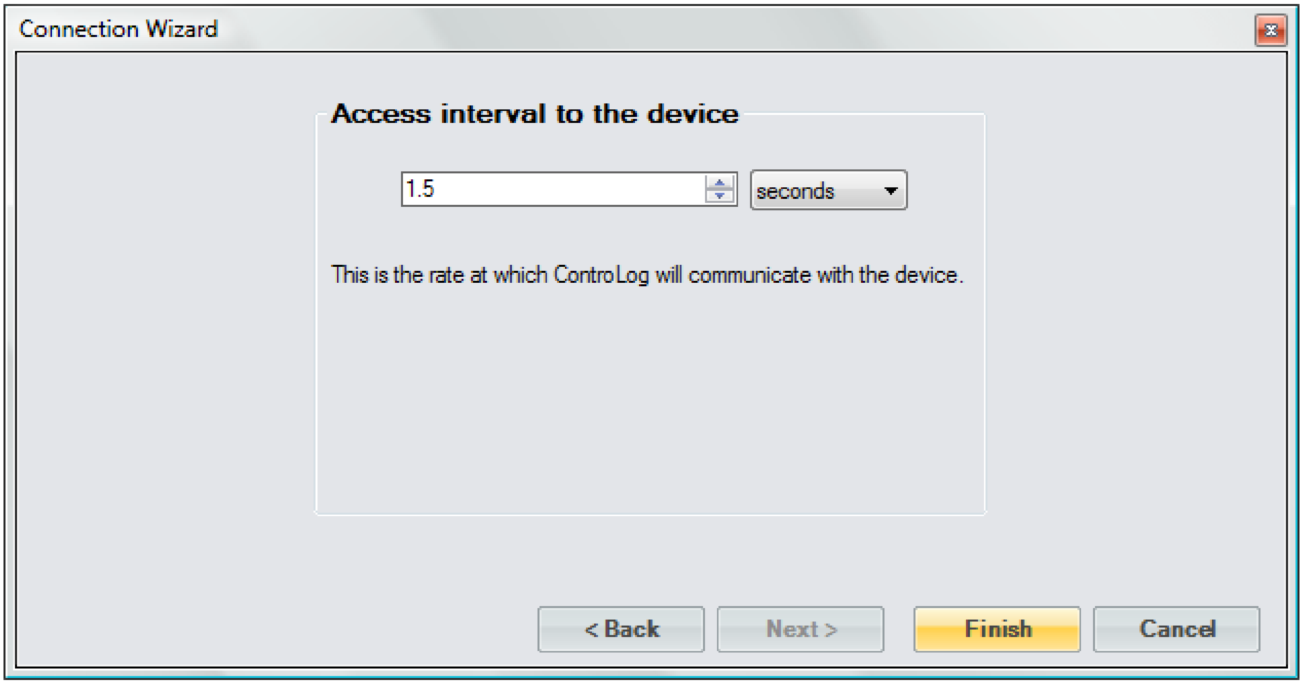
Save the newly created device to a file so it can be recalled later.

Select to connect to the device now.

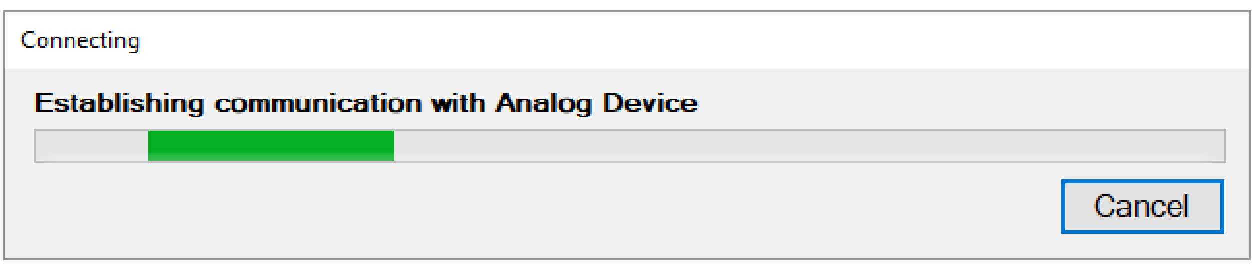
Select the communication port that the Keysight Technologies® 34970A Data Acquisition/Switch Unit is connected to and select the port settings for the 34970A.



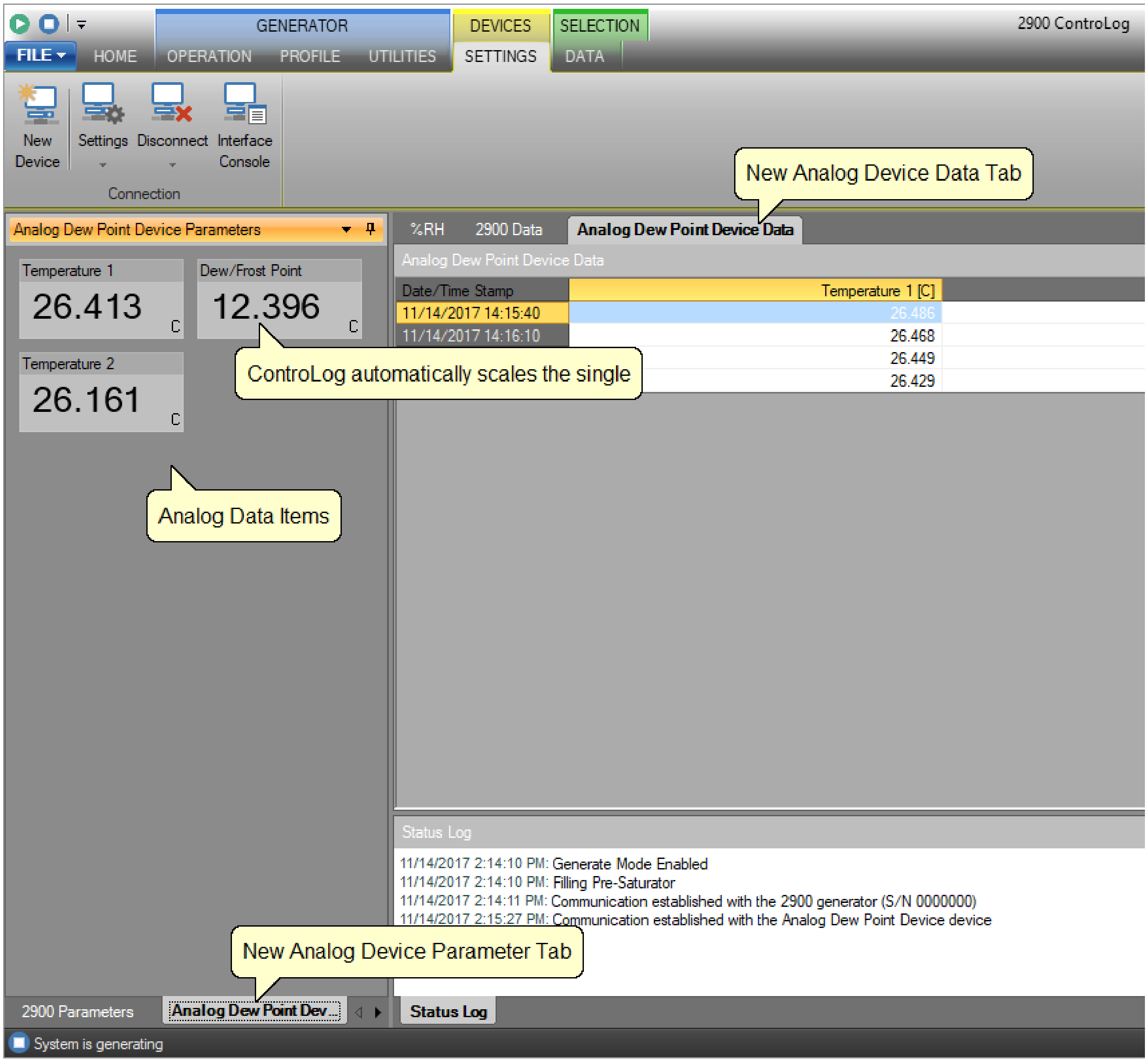
Enter a sufficient access interval for the number of signals being monitored. In this example, we have less than 10 signals, so that we can start with the minimum access interval of 1.5 seconds.



Once completed, ControLog attempts to establish communication with the Keysight Technologies® 34970A Data Acquisition/Switch Unit.



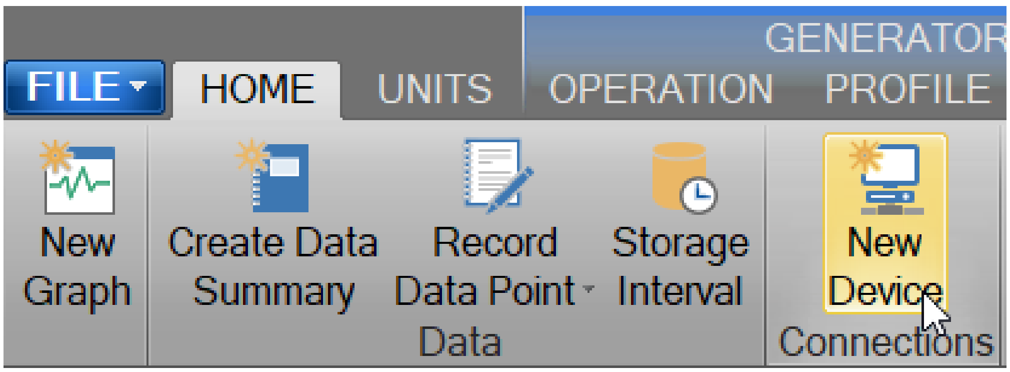
Once communication is successfully established with the 34970A, a new parameter tab and data tab are created. Notice that ControLog automatically scales the voltage signal based on the definitions described when defining the data item.



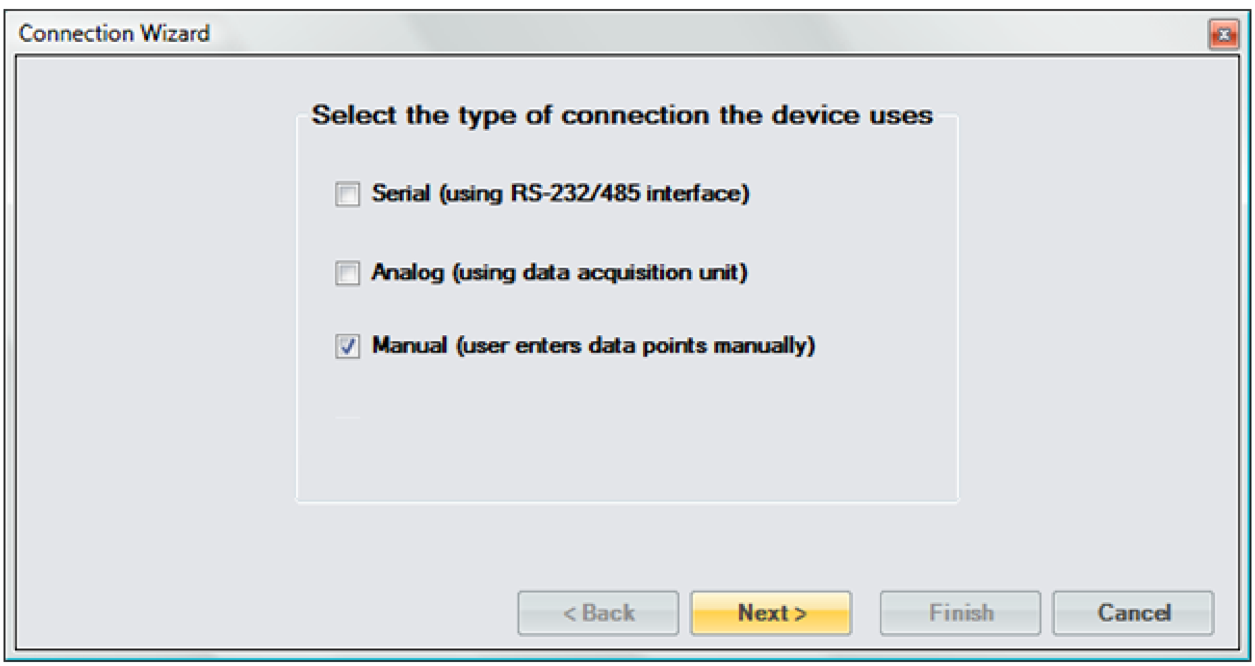
10.3 Manual Connection

A Manual Connection allows the user to manually record data items for a device that either has no interface or has an interface that ControLog does not support. Manual devices still have their parameter and data tab, but the user manually enters the data values. When users want to record values, they click on the value tile for the data item in the parameter tab and enter it. Once all data items for the device have been entered, ControLog records the values into the data tab for the device.

Select "New" from the Connections menu to create a manual connection. This opens a "Connection Wizard" dialog that steps the user through the connection definition process.

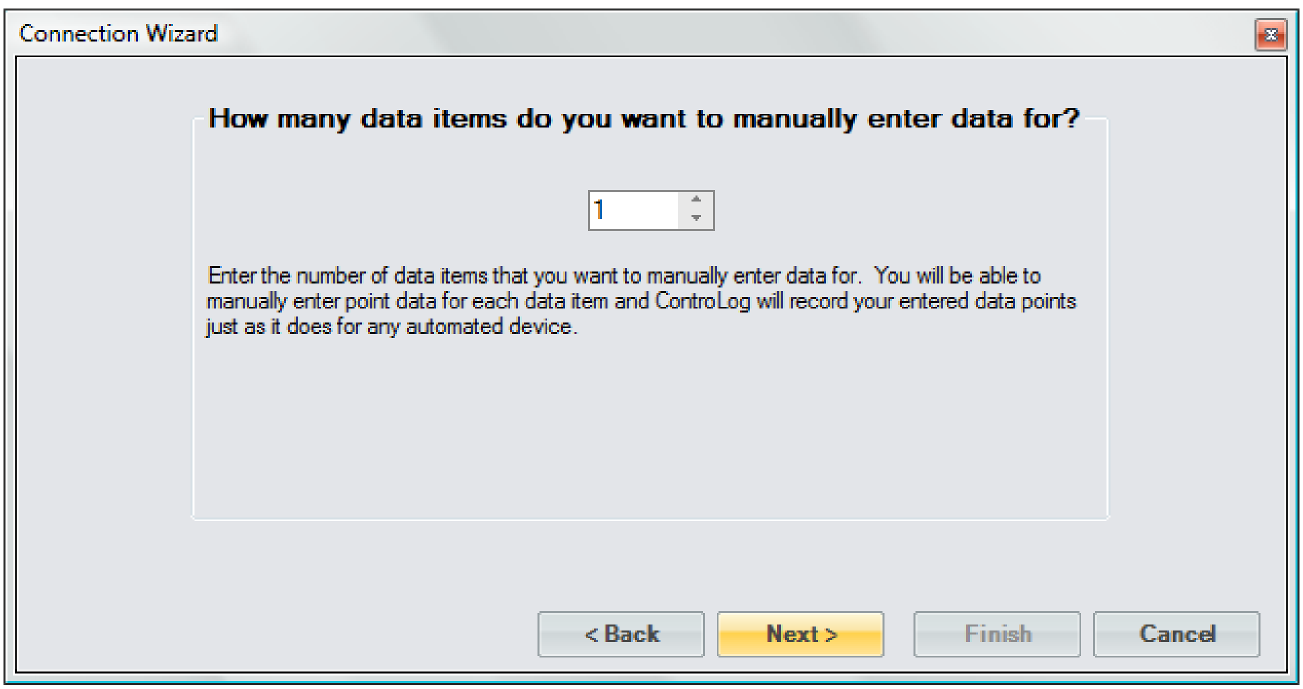


Select "Manual" as the type of connection the device uses.

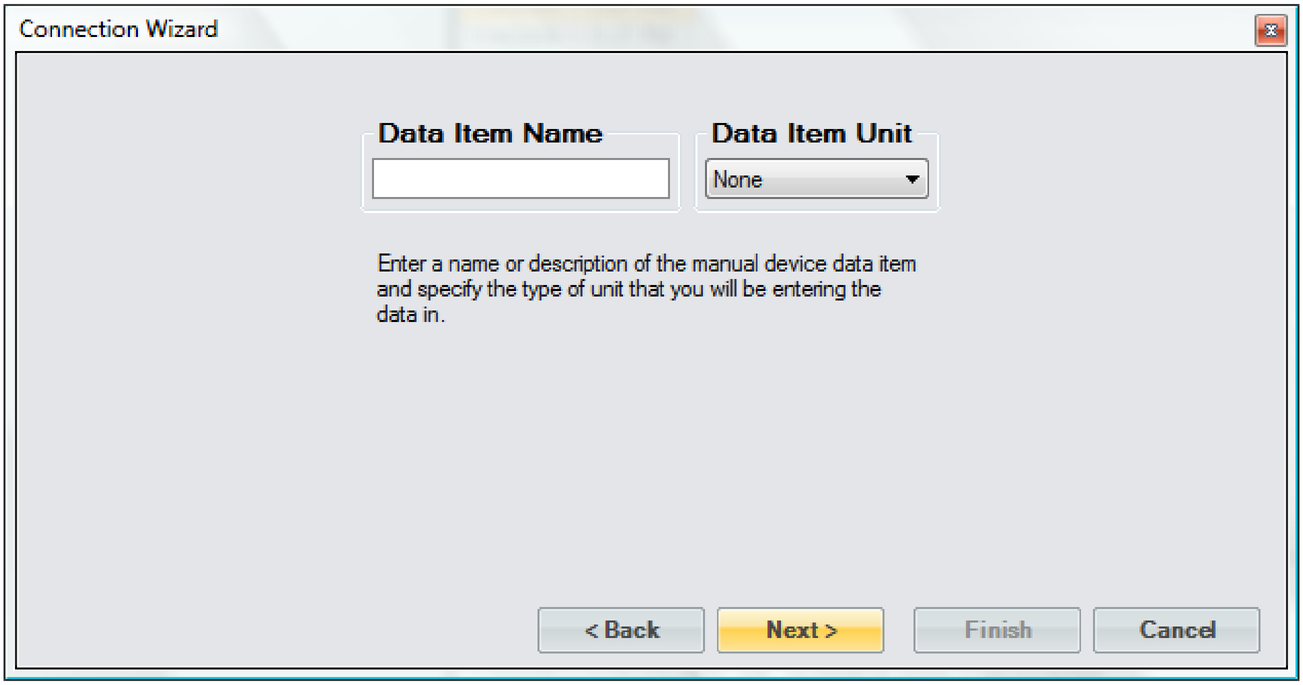


Enter a unique name for the device.

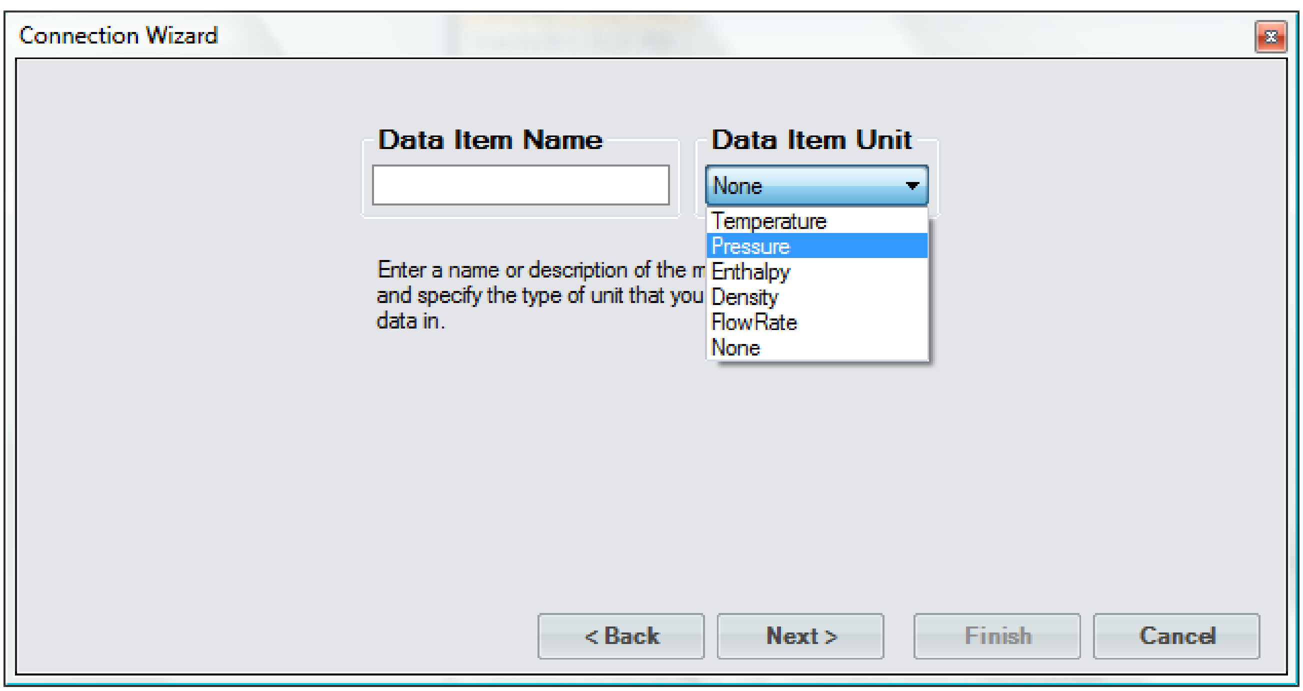
Select the number of manual data entries.



Enter a name or description of the manual device data item and specify its unit type.



The user only selects the unit type because all manual entries are entered in the currently selected system unit. For example, if the user creates a manual data item that is a temperature and has the system units set to degrees Celsius, then the user enters manual values in degrees Celsius. If the system units are set to degrees Fahrenheit, the user must enter manual values in degrees Fahrenheit.



Select the name and location to save the new manual connection. Clicking the "Browse" button opens a save file dialog that allows the user to specify the name and browse to the desired location to save the file. All device connection files are saved in XML format with a (*.device) extension.

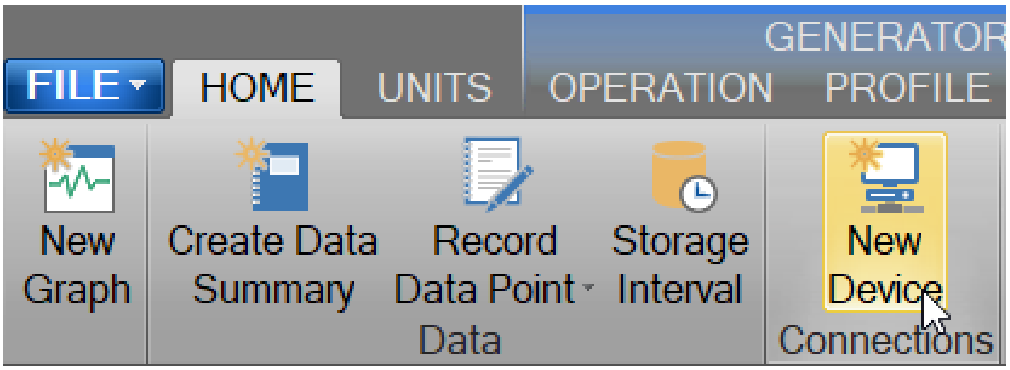
Last, the user selects whether to connect to the device or exit without connecting.

Note – *The user can connect anytime by loading the device from the Connections menu.*

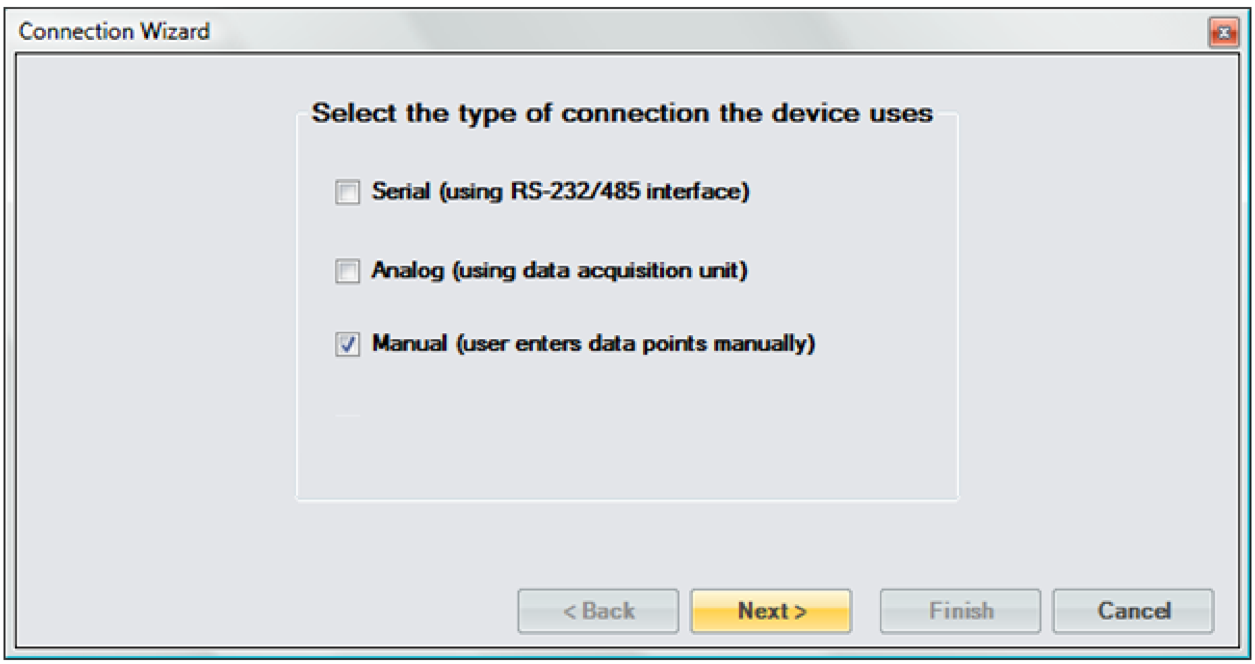
10.3.1 Manual Connection Example

This example demonstrates the creation of a Manual connection that consists of three data items: Frost Point, Test Pressure, and Test Temperature.

Start by selecting “New” from the Connections menu.

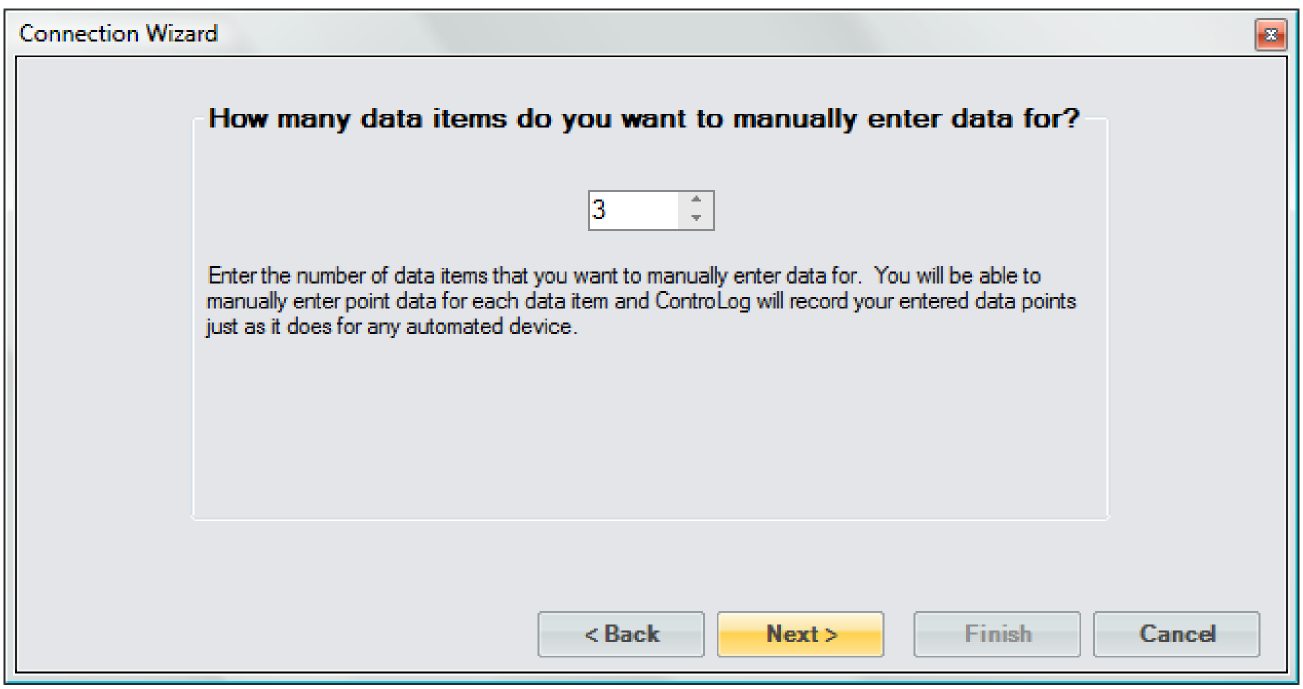


Select “Manual” as the type of connection the device uses.

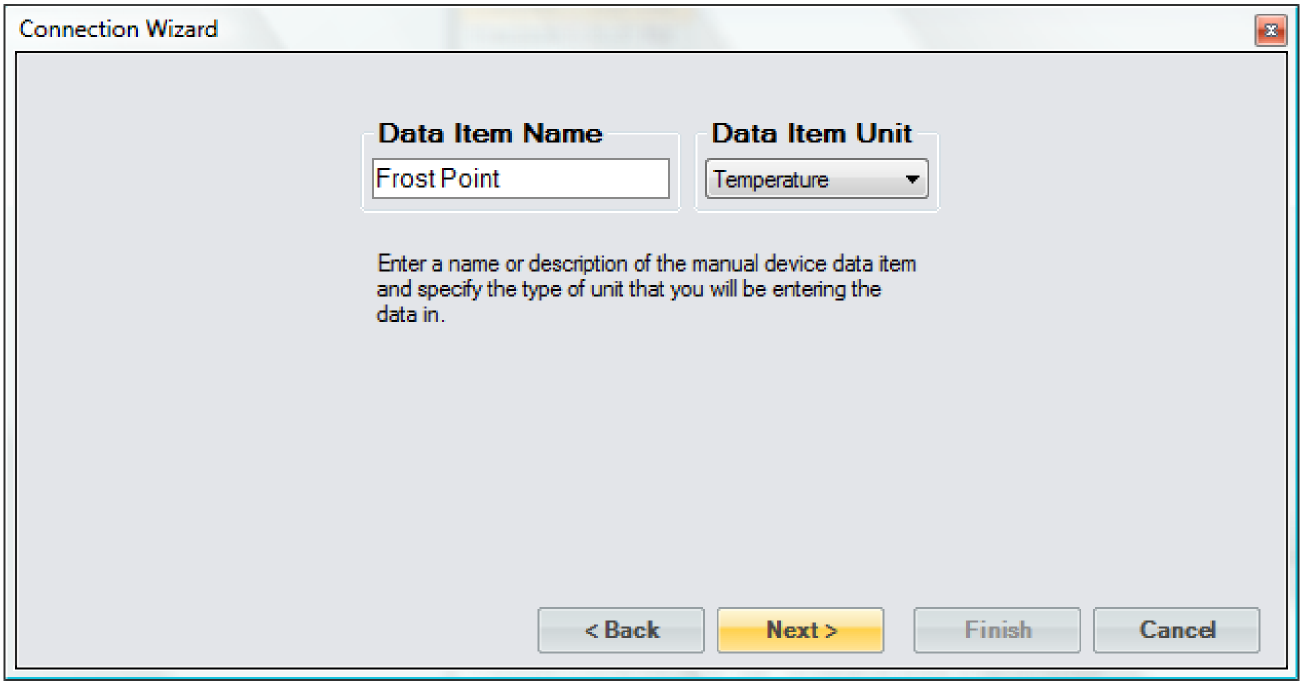


Enter “Manual Device” as the name for the device.

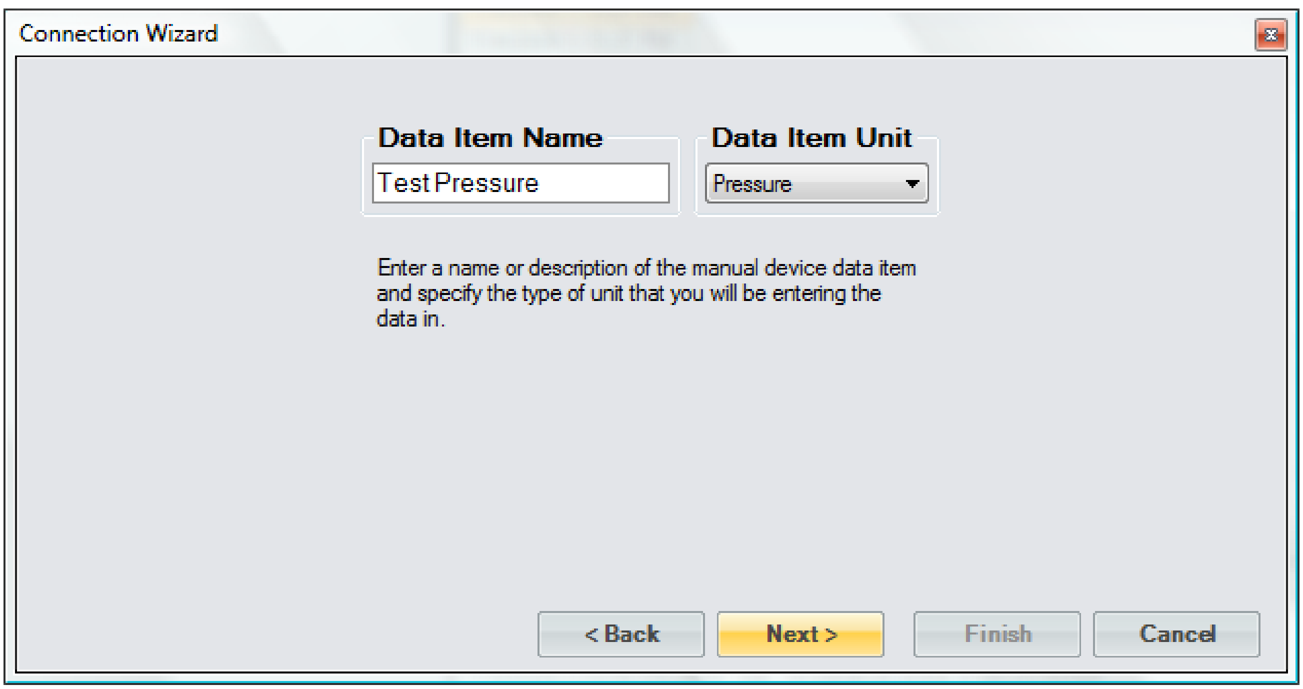
We have three data items that we want to enter for this device manually.



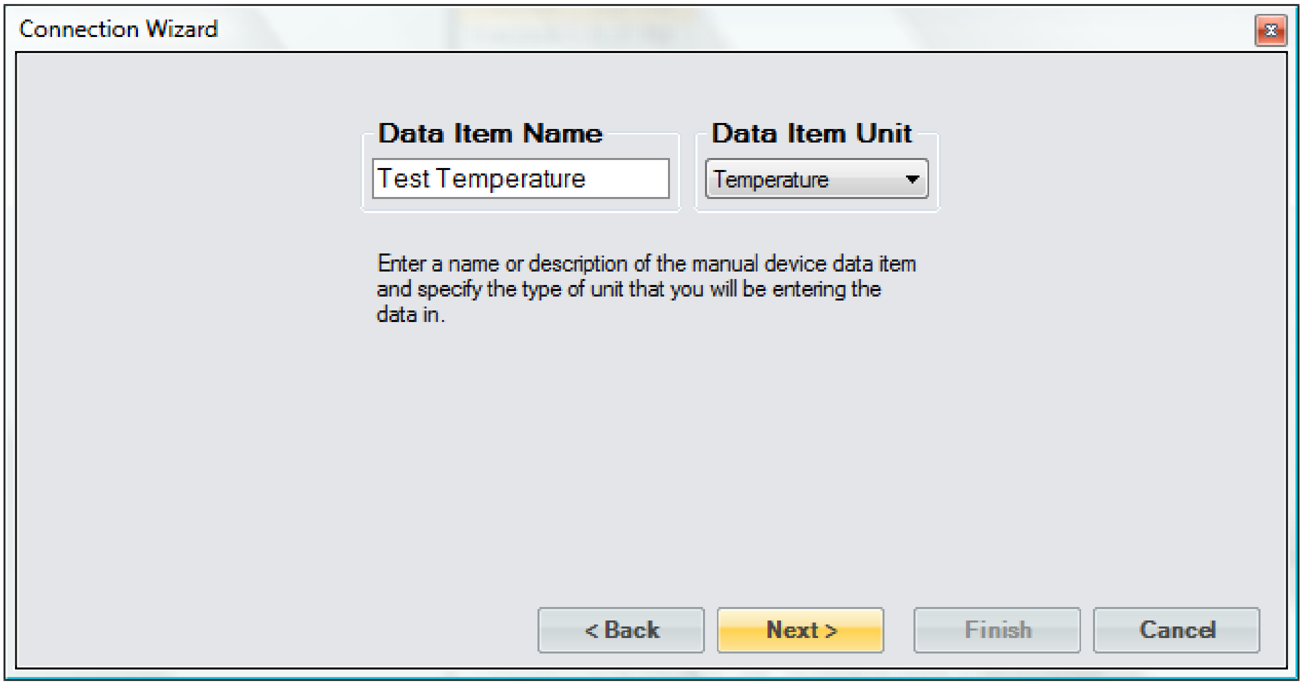
The first point is Frost Point, which is a temperature unit type.



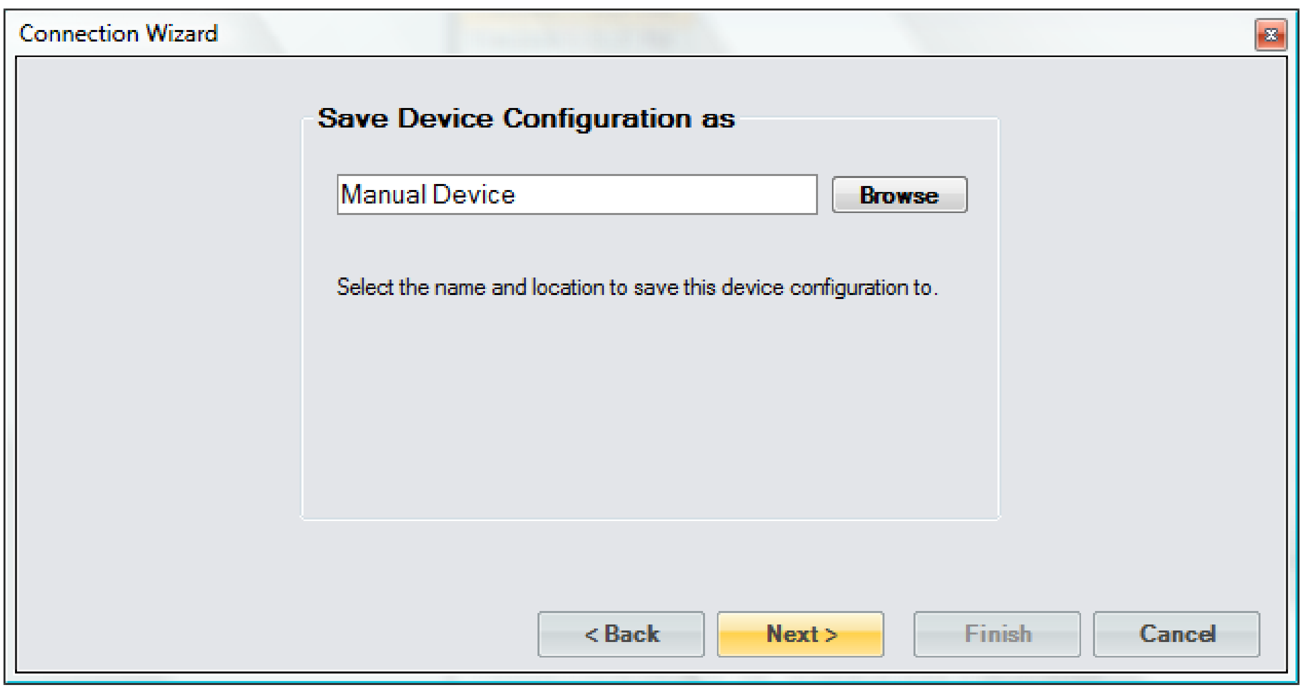
The second point is Test Pressure, which is a pressure unit type.



The third point is Test Temperature, a temperature unit type.

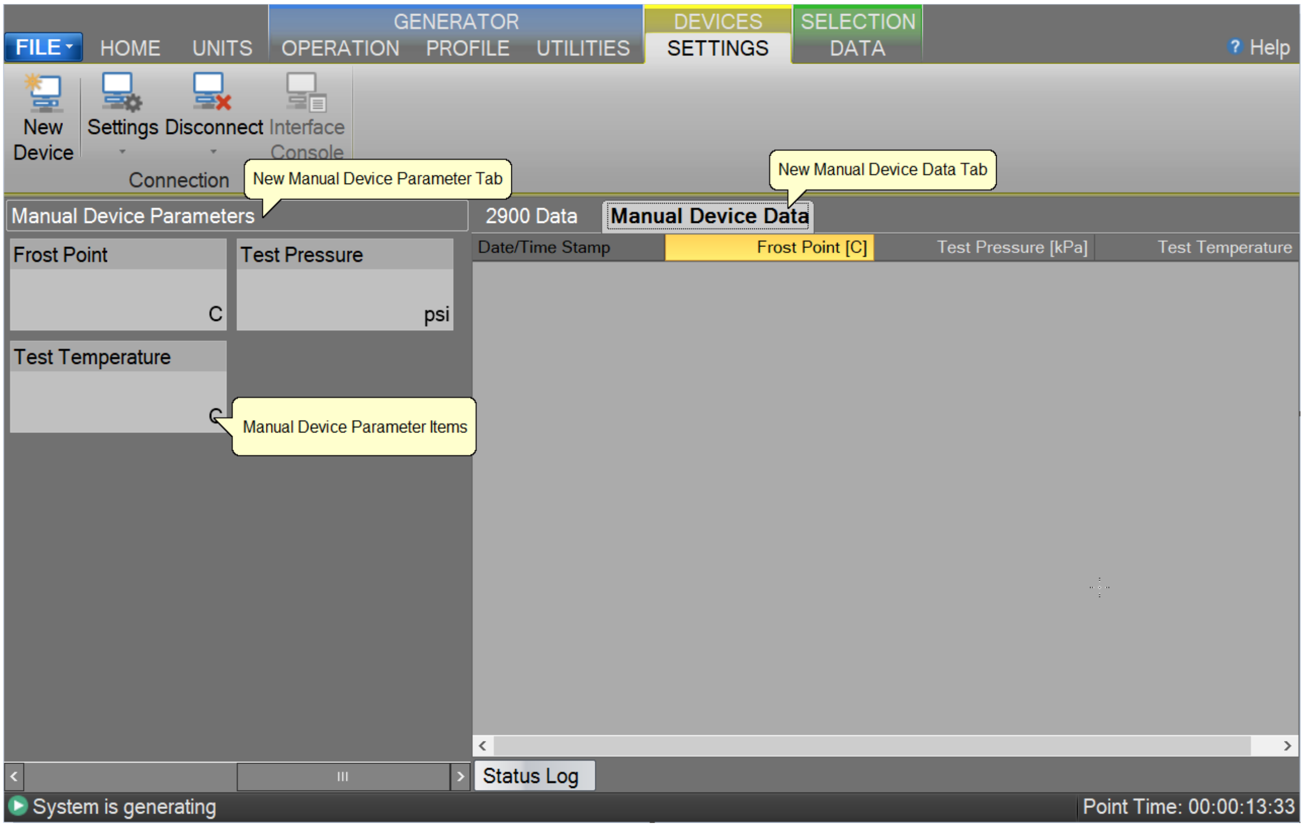


Save the newly created device to a file so that it can be recalled at a later time.



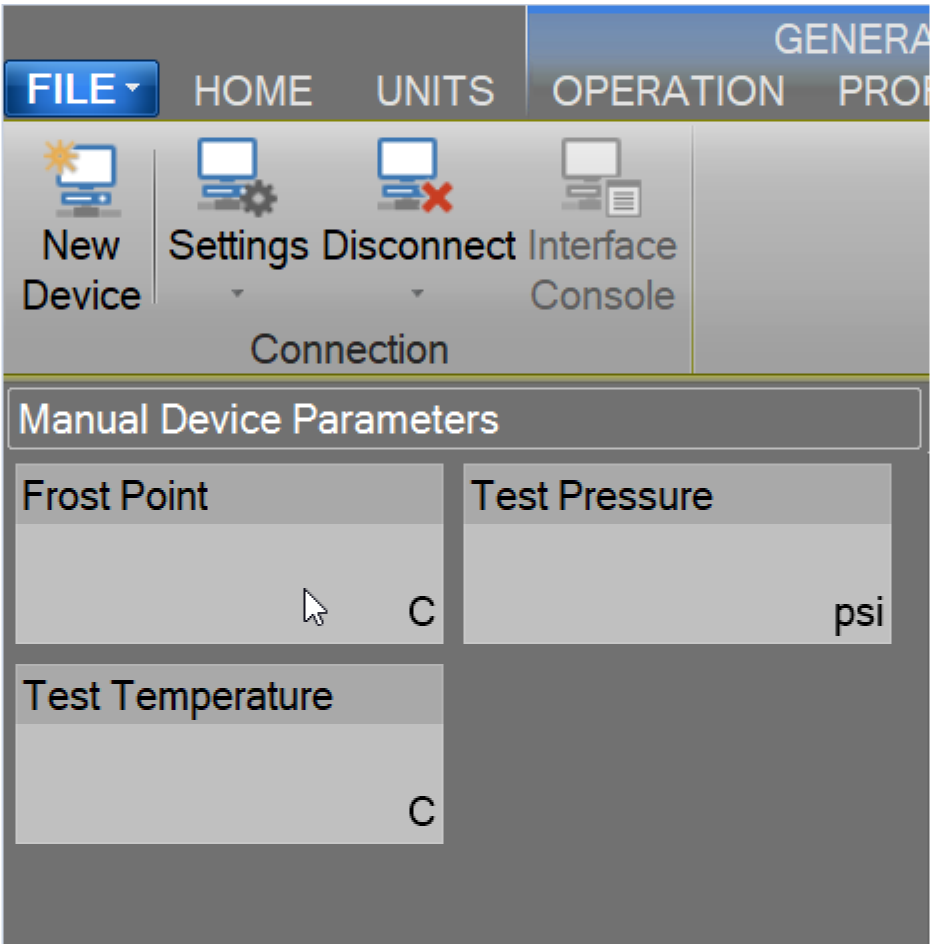
Select to connect to the device now.

Once completed, a new parameter tab and data tab are created.

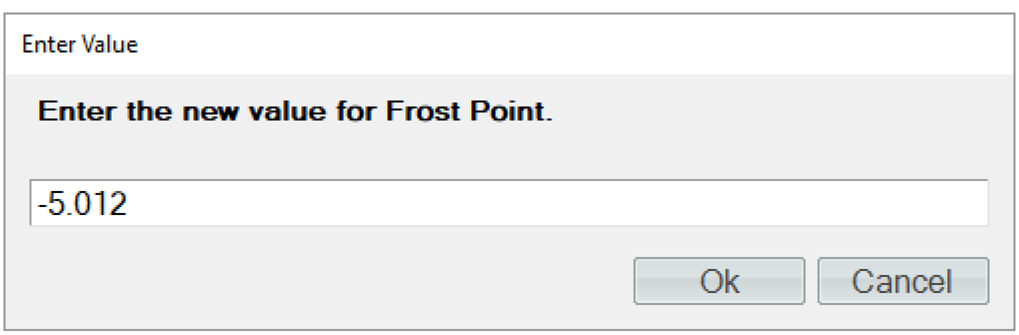


To manually enter a value, click on the value tile you want to enter. A Manual Entry box appears, and the title of the manual item being entered is underlined. For example, click the Frost Point value tile to enter a manual value for the Frost Point item.

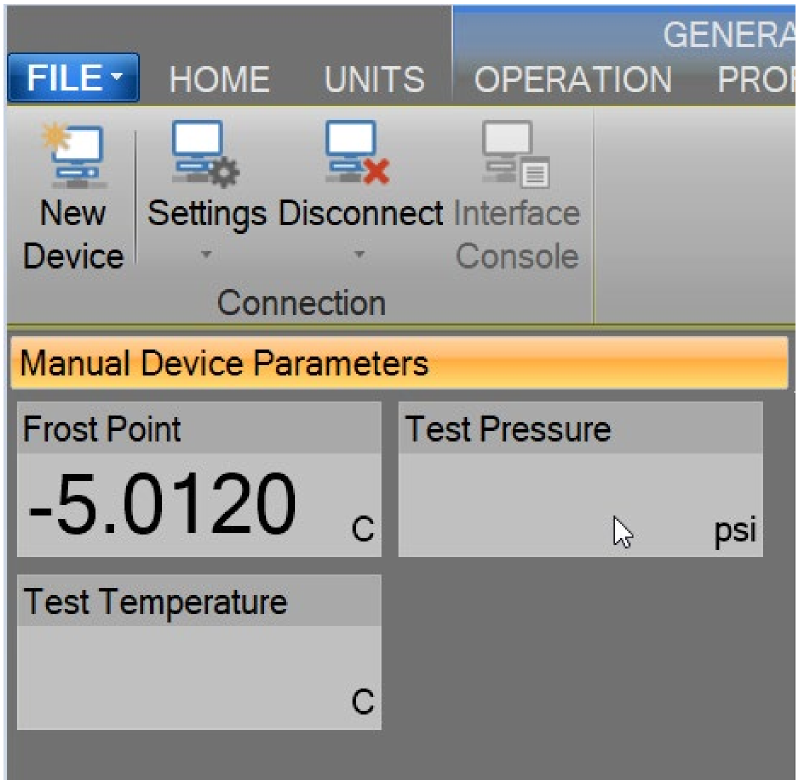
Note – *The manual entries are not recorded in the data tab until all data item values have been manually entered.*



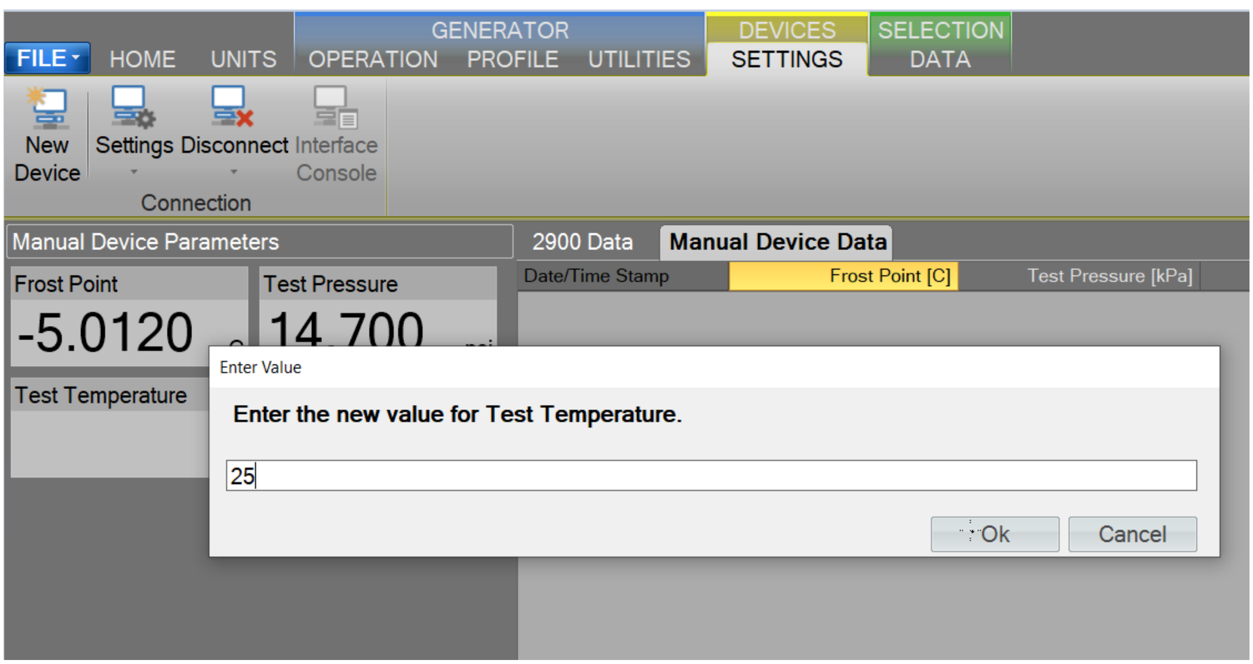
Enter the manual value into the Manual Entry box and select Ok.



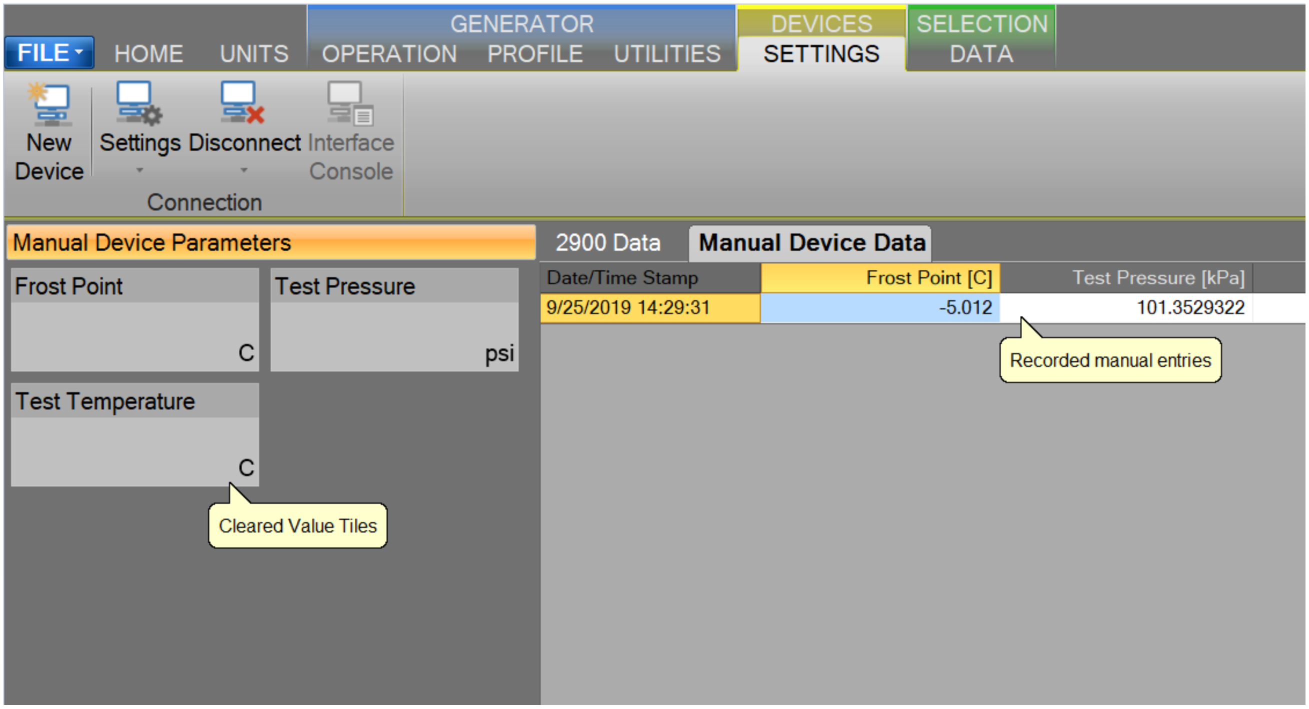
The manual entry is displayed in the value tile of the parameter tab.



Repeat the process for the remaining data items.



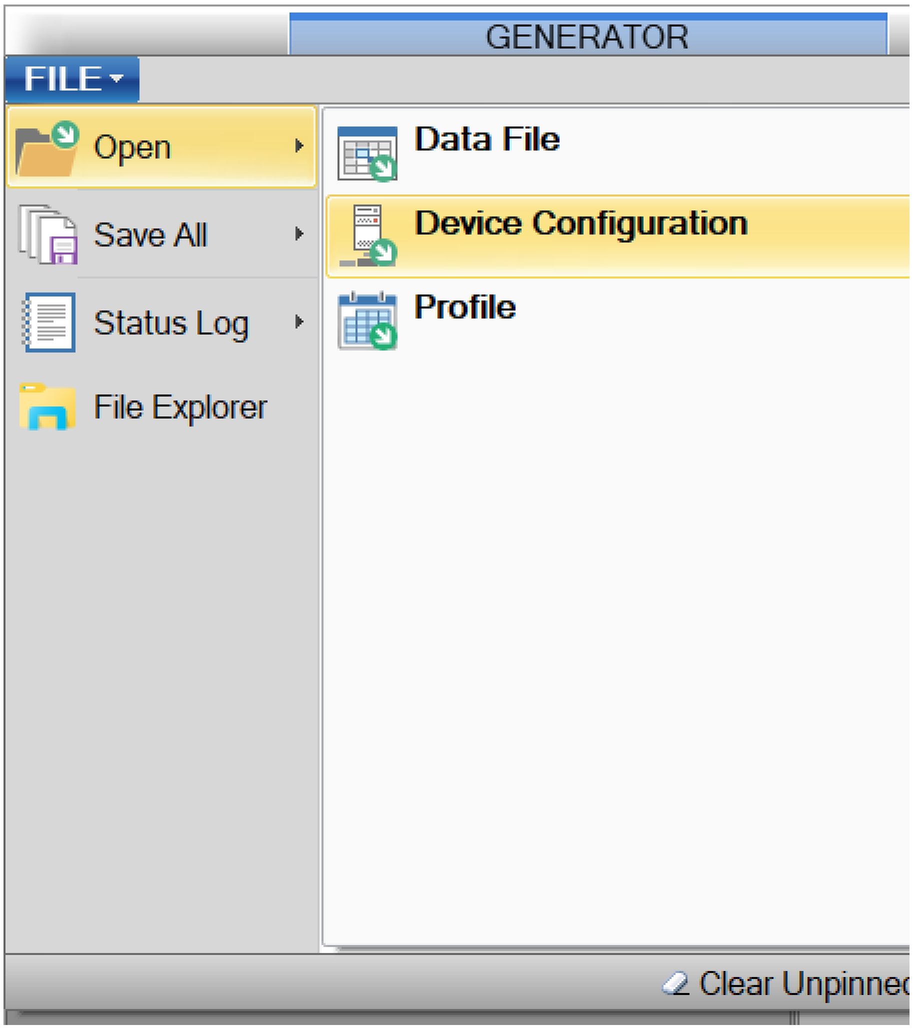
Once all data items have been manually entered, ControLog records the values and clears out the value tiles in preparation for the next set of manual entries.



10.4 Opening a Device Connection

Saved device connections can be loaded from previously saved device configuration files.

To perform the open, select "Open" from the file menu and select Device Configuration.



11 DATA BACKUP

ControLog does not require any direct backup of its operating files. It is recommended to perform a periodic backup on user-generated files such as uncertainty solutions for the generator, profiles, device setups data files, and/or calibration reports or coefficients.

The default location for user data is under the following directory:

…Documents\Thunder Scientific

> **Note** – *The user has complete control of where to save data, and the above directory may not be their chosen location.*

12 SYSTEM

The System comprises several sub-systems, each with individual yet cooperative functions that operate the Model 9500 Humidity Generation System.

12.1 CONTROL SYSTEM

The Control System performs all control functions required for humidity generation. The control system comprises several main components, each with individual yet cooperative functions. The control computer controls the parameters needed to generate humidity, such as pulsing heaters and operating valves. The Human Machine Interface (HMI) Computer is the primary interface for the user and communicates setpoints and data to and from the control computer.

12.1.1 Control Computer

The Control computer is an NI cDAQ-9136 controller built around an Intel Atom quad-core processor and 32 GB of nonvolatile storage for advanced data-logging and embedded monitoring applications. The NI cDAQ-9136 has four 32-bit general-purpose counter/timers used with the hardware-timed digital modules.

12.1.1.1 NI 9216 24-Bit, 100 Ohm RTD Analog Input Module

The NI 9216 resistance temperature detector (RTD) analog input module features eight channels and 24 bits of resolution for PT100 Ω RTD measurements with built-in 50/60 Hz noise rejection. The NI 9216, compatible with 3-wire and 4-wire RTD measurements, automatically detects the type of RTD (3-wire or 4-wire) connected to the channel and configures each channel for the appropriate mode. The module provides 1 mA of current excitation per channel.

12.1.1.2 NI 9209 ±10 V, 24-Bit Analog Input Module

The NI 9209 voltage input module has 16 differential channels of ±10 V that can be configured as 32 single-ended channels of ±10 V input with built-in 50/60 Hz noise rejection.

12.1.1.3 NI 9403 TTL Digital Input/Output Module

The NI 9403 is a 32-channel, 7 µs bidirectional digital I/O module. Each channel is compatible with 5 V/TTL signals and features 1,000 Vrms transient isolation between the I/O channels and the backplane. The NI 9403 also features ±30 V overvoltage protection and can source up to 2 mA output current per channel.

12.1.1.4 NI 9401 TTL Digital Input/Output Module

The NI 9401 is an 8-channel, 100 ns bidirectional digital I/O module. The NI 9401 generates 4 separate hardware-timed pulse width modulation (PWM) signals. Each channel is compatible with 5 V/TTL signals and features 1,000 Vrms transient isolation between the I/O channels and the backplane.

12.1.2 HMI Computer

The Human Machine Interface (HMI) is an embedded PC with a Multi-Point Touch display. It provides the main two user interface components: visual and touch. The visual component provides the operator with a rich data experience, including real-time data values, graphs, uncertainty, and status.

The touch component provides the operator with an intuitive interface to control the system's operation. The HMI computer runs the ControLog and HumiCalc with Uncertainty software applications.

12.1.3 ControLog® Software

ControLog is an embedded software application that fully automates the operation of the Model 9500 Humidity Generation System and allows various device connections through several different interfaces. Data from the generator and attached devices are automatically retrieved and stored for viewing in either numerical or graphical format in real-time or post-process. Data can be transferred off the system via a USB drive for further viewing and post-processing. The ControLog software also provides the primary interface to the operator via the multi-point touch display and keyboard. Key features of the ControLog software are:

- ControLog stores data into individual data sheets. Each data sheet contains a spreadsheet-type view consisting of a date/time stamp and the measured data items corresponding to that date/time stamp. Datasheets consist of three similar but different types: Device Data, File Data, and Data Summary. Each type has the same spreadsheet view and operation, but all three have different data sources.

- Graphing is a powerful tool to view recorded data or monitor current data in real-time. The graph works hand in hand with the data sheets. While the generator is operating, data sheets store the most recent data points from the generator and connected devices at the desired interval. A graph can be used to create a visual picture of this stored data.

- The Auto Profiling feature is very similar to the Generate mode, with the main exception that profiling relies on a predefined list of setpoints referred to as a profile. The user-configurable profile is used as ControLog's road map during Auto Profile operation. It defines which setpoint values to go to, at what rate to go from one setpoint to another, and how long to stay at a specific setpoint before moving to the next setpoint.

- ControLog supports a customizable interface that works with most devices. ControLog allows the user to create a new device connection using the "Connection Wizard" or open previously saved connections. The wizard opens a separate dialog window containing various steps that guide the user in defining the communication required to receive the desired data items from the device. The user can create as many (up to 60) or as few data items as they see fit for any device. Each data item can be uniquely named and, once connected, is recorded in its own data sheet. ControLog also allows the user to save these interfaces for future use. The "Connection Wizard" allows the user to step through the connection configuration. The user can progress through the connection configuration steps using the "Next" and "Back" buttons. At any time, the user may cancel the new connection or opening of a connection by selecting the "Cancel" button. Once the last step has been completed, the "Finish" button is available to complete the new connection.

12.1.4 HumiCalc with Uncertainty® Software

HumiCalc with Uncertainty is an embedded software application that operates in conjunction with ControLog. All humidity calculations, based on the temperature and pressure measurements from the generator, are calculated in real-time using HumiCalc with Uncertainty. This does not stop at calculations, as HumiCalc with Uncertainty can easily calculate complex humidity uncertainties. This allows the software to calculate real-time uncertainty for the 9500 Humidity Generation System. Key features of the HumiCalc with Uncertainty software are:

Highly accurate formulas that replace charts and tables:

- Automatically applies enhancement factors and temperature and pressure corrections.
- Ability to calculate uncertainty and as found error.
- Each known item now contains an uncertainty field that you can expand to enter individual uncertainty components.

Once the calculation is performed, the newly calculated values are displayed along with the expanded uncertainty values at the desired confidence level. Each calculated result can also be expanded to see the individual components that made up the final expanded uncertainty value.

12.2 Electrical System

The 3-phase, 4-wire power source is input at TB-MAIN. From TB-MAIN, power is applied through circuit protectors CB1-CB4 to relays MR1-MR4. These 3 pole relays are activated by +24 VDC control signals discussed later.

TB-MAIN provides single phase 240 VAC power to the AC/DC power supplies (DC1/+24 VDC, DC2/+15 VDC, DC3/+5, and +12 VDC), along with the human-machine interface computer (HMI) power supply brick and condensate pump (PV2).

The +5 and +12 VDC power supply (DC3) provides power to the console fan (CF1). The +24 VDC power supply (DC1) provides power for the small cooling fans (CF2 & CF3) located in the electrical and computer enclosures and for all control signals that activate relays, stepper motors, and solenoid valves. Except for analog inputs from RTDs, liquid level circuits, and transducers, all other system control (input & output) is performed digitally at a logic level of +5 VDC. All limit sensing switches operate at a +24 VDC digital level. The +15 VDC power supply (DC2) is the voltage source providing power to the flow and pressure transducers and the liquid-level circuits.

Refer to drawing: 9500D901-1, 9500D901-12, 9500D901-13, 9500D901-14, and 9500S914

12.2.1 Solid State Relays

Six quad solid-state relays (SSR) on a single relay board are located in the controller enclosure. Each SSR controls the operation of specific solenoids and heaters used for pneumatic, fluid, and temperature control. Two 3-phase solid-state relays (SSR1 & SSR2) are located on the main power panel inside the electrical enclosure. These control the 3-phase fluid heaters for the pre-saturator and bath circulation fluid.

12.2.1.1 Bath Cool Solenoid Valve

The Bath Cool Solenoid Valve (SOL1), when activated, allows the refrigerant to be injected into the refrigeration evaporator (EX2).

12.2.1.2 Pre-Saturator Cool Solenoid Valve

The Pre-Saturator Cool Solenoid Valve (SOL2), when activated, allows bath fluid to flow through a coil within the pre-saturator (PSAT).

12.2.1.3 Air Supply Solenoid Valve

The Air/Gas Supply ON/OFF Solenoid Valves (SOL3 & SOL14), when activated, allow supply pressure into the system. The 9500 supports two supply pressure inputs for when a pressure booster is needed to achieve high pressure. The Low-Pressure Supply Solenoid Valve (SOL3), when activated, allows the low range supply pressure (<325 psiG) directly from the air supply source into the system. The High-Pressure Supply Solenoid Valve (SOL14), when activated, allows the high supply pressure from a single source or an air booster (325 pisG) into the system. The system controls which supply solenoid valve to open based on the required pressure to generate the given humidity setpoint. When requiring pressures below the low range max, the system activates SOL3 and deactivates SOL14 to use the low range supply. When requiring pressures above the low range max, the system deactivates SOL3 and activates SOL14 to use the high range supply from the air booster. When shutdown, both SOL3 and SOL14 are deactivated.

12.2.1.4 Reservoir Fill Solenoid Valves

The reservoir fill solenoid valves (SOL4&5) are electrically parallel and are in series pneumatically (outlet to outlet) for bi-directional pressure handling capability. When activated, water is allowed to flow from the user-supplied distilled water supply to the system reservoir (RES).

CAUTION!

DO NOT ATTEMPT TO ACTIVATE THE RESERVOIR FILL SOLENOID VALVES WHEN THE SYSTEM IS PRESSURIZED. THIS MAY CAUSE AIR TO BLOW OUT OR PRESSURIZE THE RESERVOIR WATER SUPPLY LINE.

12.2.1.5 Pressure Vent Solenoid Valve

When deactivated (normally open), the Pressure Vent Solenoid Valve (SOL6) vents system pressure. It vents during all SHUTDOWN procedures, when power is removed from the system, and when the saturator pressure exceeds 110% of its rated value due to system misalignment or malfunction.

12.2.1.6 Low-Pressure Select Solenoid Valve

The Low-Pressure Select Solenoid Valve (SOL7) is activated at saturator pressures below 45 psi, allowing saturator pressure to be measured by transducer T3. When deactivated, it prevents pressures above 45 psi from entering transducer T3.

CAUTION!

IF SATURATOR PRESSURE IS ABOVE 45 PSIA (OR SUSPECTED OF BEING ABOVE 45 PSIA), DO NOT ATTEMPT TO ACTIVATE THE LOW-PRESSURE SOLENOID. DOING SO MAY DAMAGE THE 0-45 PSIA PRESSURE TRANSDUCER.

Note – *If pressures greater than 45 psi get beyond the low-pressure solenoid valve (due to a leaking valve seat, valve malfunction, or inadvertent actuation), the mechanical relief valve (RV2) activates. Any activation of this relief valve during normal operation indicates a malfunction of the low-pressure solenoid valve.*

12.2.1.7 Pre-Saturator Fill Solenoid Valve

The Pre-Saturator Fill Solenoid Valve (SOL8), when activated, allows distilled water to flow by gravity from the reservoir to the pre-saturator (PSAT).

12.2.1.8 Bath Holding Tank Fill Solenoid Valve

The Bath Holding Tank Fill Solenoid Valve (SOL11), when activated, allows distilled water to flow from the fill port near the countertop's middle back to the bath holding tank.

12.2.1.9 Bath Level Control Solenoid Valves
The bath water level control mechanism comprises two solenoid valves (SOL12 & 13), allowing bi-directional pumping of bath fluid to or from the bath holding tank utilizing the bath fluid circulation pump. Activation of SOL12 allows bath fluid to be pumped from the temperature bath to the bath holding tank (to lower the bath). Activation of SOL13 allows bath fluid to be pumped from the holding tank to the temperature bath (to raise the bath).

12.2.1.10 Pre-Saturator Heater
The Pre-Saturator Heater (H1) is a three-phase AC resistive heating element activated by a three-stage control process. The heat limit switch (HL1) must be in the normally closed position, indicating that pre-saturator heat is within allowable limits (i.e., below 100 °C).

12.2.1.11 Bath Fluid Heater
The Bath Fluid Heater (H2) is a three-phase AC resistive heating element activated by a three-stage control process. The heat limit switch (HL2) must be in the normally closed position, indicating that bath heat is within allowable limits (i.e., below 85 °C).

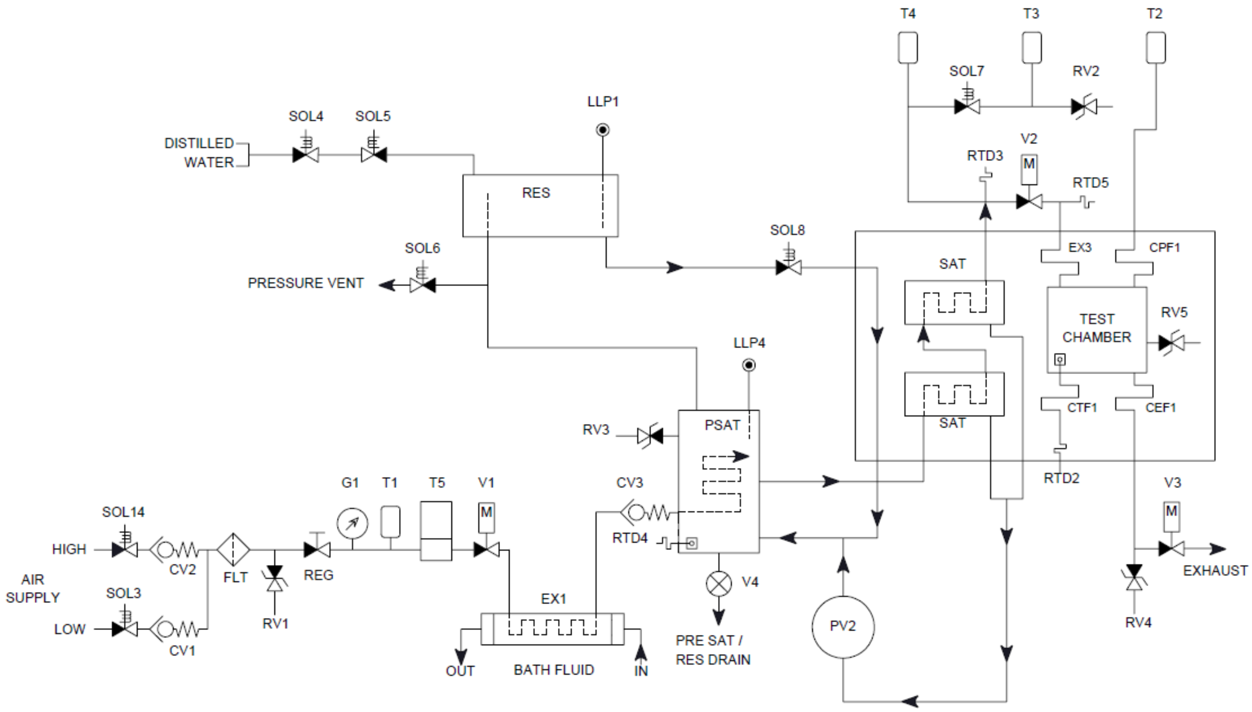
12.2.1.12 Expansion Valve Heater
The Expansion Valve Heater (H3), when activated, is used to warm the gas in the section of the pipe just before the expansion valve body, offsetting the cooling effects due to gas expansion.

12.2.1.13 Fluid Circulation Pump
The Bath Fluid Circulation Pump (PV1) is connected to the three-phase AC power through relay MR3.

12.2.1.14 Refrigeration Compressor
The Refrigeration Compressor (COMP) is connected to the three-phase AC power through relay MR4.

12.3 PNEUMATIC SYSTEM
The pneumatic system of the Model 9500 is designed as an open-loop two-pressure system. Clean instrument quality air enters the generating system at the pressure inlet and is admitted through the air supply ON/OFF solenoid valve (SOL3 & SOL14) and air supply filter (FLT) to the pressure regulator (REG). Regulated supply pressure is indicated on the air supply pressure gauge (G1) and computer monitored with a pressure transducer (T1). After regulation, the airstream passes through the mass flow meter (T5) to the flow control valve (V1). From the flow control valve, the airstream passes through a tube in shell type heat exchanger (EX1), which conditions the air stream to bath fluid temperature, then to the pre-saturator (PSAT). The pre-saturator warms the airstream and brings it to near saturation at the elevated temperature. The pre-saturated airstream exits the pre-saturator and enters the saturators (SAT). As the nearly saturated air flows through the saturators, it is cooled to bath fluid temperature forcing water vapor to condense as the air temperature establishes equilibrium with the bath fluid. The pressure, P_S (T3 or T4), and temperature, T_S (RTD3), of the saturated gas are measured at the final saturation point. Upon exiting the second saturator, the saturated airstream encounters the expansion valve (V2). After reducing the saturated airstream from saturator pressure to chamber pressure, the air passes through a small heat exchanger (EX3) within the temperature bath, conditioning the air to bath fluid temperature. The airstream enters the test chamber through the fitting on the lower right side at

the desired humidity, chamber pressure (T2), and chamber temperature (RTD2) conditions. The airstream exits the test chamber through the exhaust port (if access ports are capped), located at the upper left side of the test chamber, through the chamber pressure control valve (V3), allowing pressure control of the test chamber, and then out through the exhaust fitting of the console.



Refer to drawing: 9500D901-1, 9500D901-5, 9500D901-6, 9500D901-8, 9500D901-9, 9500D901-10, 9500S911, 9500S912, 9500S914 and 9500S915

12.3.1 Pressure Measurement

There are six pressure transducers in the system. Transducer T1 is used for measurement of the supply pressure. Transducer T2 is used for the control and measurement of the test chamber. Transducers T3 and T4 are used for control and measurement of the saturator. Transducers T7 and T8 are used for control of the refrigeration system.

T1 = AIR/GAS SUPPLY

T2 = TEST CHAMBER

T3 = LOW-RANGE SATURATOR

T4 = HIGH-RANGE SATURATOR

T7 = REFRIGERATION LOW-SIDE

T8 = REFRIGERATION HIGH-SIDE

12.3.1.1 Air / Gas Supply Pressure Transducer

The Air/Gas Supply Transducer (T1) is powered by +15 VDC from the ±15 VDC power supply (DC2) and provides a 0.5-5.5 VDC output for the 0-500 psiG range.

12.3.1.2 Test Chamber Pressure Transducer

The Test Chamber Pressure Transducer (T2) is powered by +15 VDC from the ±15 VDC power supply (DC2) and provides a digital output for the measurement range of 0 to 23 psiA. For overpressure protection, the chamber is equipped with 2 mechanical pressure relief valves (RV4 and RV5).

12.3.1.3 Saturation Low-Pressure Transducer

The Saturation Low Range Pressure Transducer (T3) is powered by +15 VDC from the ±15 VDC power supply (DC2) and provides a digital output for the measurement range of 0 to 45 psiA. This pressure transducer is pneumatically connected to the saturator via the Low-Pressure Select Solenoid Valve (SOL7) that only opens below 45 psiA and a mechanical pressure relief valve (RV2) for overpressure protection.

12.3.1.4 Saturation High-Pressure Transducer

The Saturator High Range Transducer (T4) is powered by +15 VDC from the ±15 VDC power supply (DC2) and provides a digital output for the measurement range of 0 to 325 psiA. Although this transducer has an operating range of 0 to 325 psiA, it is only used between 45 and 325 psiA. At pressures below 45 psiA, the low-range transducer is used. Overpressure protection is provided by a mechanical pressure relief valve (RV3).

12.3.1.5 Refrigeration Low-side Transducer

The refrigeration low-side Transducer (T7) is powered by +5 VDC from the +5 and +12 VDC power supply (DC3) and provides a 0.5-4.5 VDC output for the 0-500 psiG range.

12.3.1.6 Refrigeration High-side Transducer

The refrigeration high-side Transducer (T8) is powered by +5 VDC from the +5 and +12 VDC power supply (DC3) and provides a 0.5-4.5 VDC output for the 0-500 psiG range.

12.3.2 Mass Flow Rate Measurement

There is one mass air flow meter in the system. The mass air flow meter controls the flow rate through the system and into the chamber.

T5 = MASS FLOW METER

12.3.2.1 Mass Flow Transducer

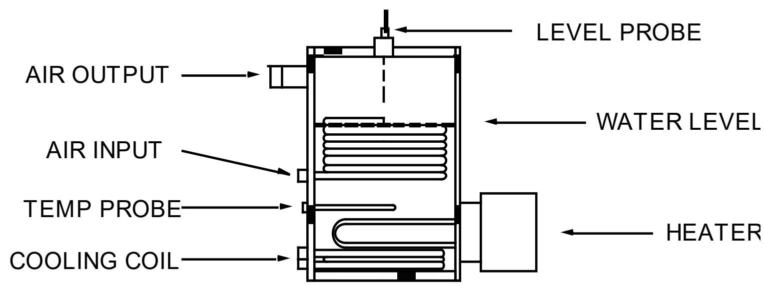
The mass flow transducer (T5) is powered by ±15 VDC from the power supply (DC2). The output of the transducer is 0 to 5 VDC.

12.3.3 Pre-Saturator

The airstream of a two-pressure generator must be saturated with water vapor at test temperature on the high-pressure (saturator) side of the expansion valve. This is accomplished by first passing the airstream through a pre-saturator (PSAT). The pre-saturator is a vertical pressure vessel presenting a water surface to the incoming airstream and is maintained at a constant temperature, approximately 26 °C warmer than the desired final saturation temperature. Air enters the pre-saturator and flows through a coil of tubing, warming the air to pre-saturator water temperature. The air exits the tubing coil and is directed onto the water surface, causing a circular flow pattern within the pre-saturator which supersaturates the airstream. After pre-saturation, the air exits near the top of the pre-saturator and is directed to the saturator.

Pre-Saturator water temperature, sensed by a 100Ω RTD (RTD4), is automatically adjusted and controlled between ambient and 100 °C by the control system. The heating of the pre-saturator is provided by a 4500-watt stainless steel immersion type heater, controlled through solid-state switching. Cooling is achieved by controlling the solenoid valve (SOL2) that allows bath fluid cooler than the pre-saturator to flow through the pre-saturator cooling coil, thereby cooling the pre-saturator to the setpoint temperature.

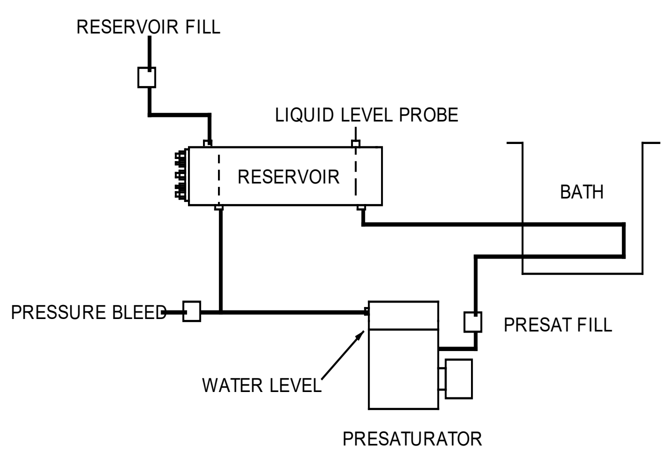
The pre-saturator water level is computer-controlled via a liquid level transducer (LL4) and a solenoid valve (SOL8). This allows distilled water to flow from the supply reservoir (RES), maintaining the level constant to within approximately 1/16 inch (2 oz.).



PRESATURATOR ASSEMBLY

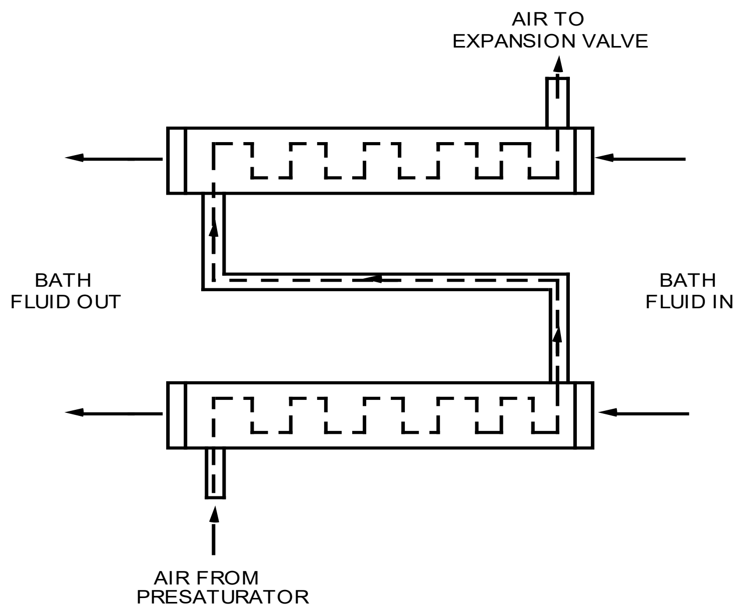
12.3.4 Reservoir

The reservoir is a pressure vessel constructed of 300 series stainless steel and holds an approximate working volume of 3.25 gallons of distilled water for the pre-saturator. This vessel is maintained at pre-saturation pressure and, upon demand, allows reserve distilled water to flow freely to the pre-saturator. The reservoir water level is sensed and indicated on the computer monitor. The operator can perform reservoir filling before each start-up sequence. The operator is notified with a low reservoir warning if a low-level water condition is sensed during the humidity generator's operation.



12.3.5 Saturators

Saturation of the airstream upstream of the expansion valve is accomplished in two single-pass tube-in-shell type heat exchangers. These assemblies are called saturators and are located within the fluid bath beneath the test chamber. The airstream from the pre-saturator (PSAT), humidified to an absolute moisture content greater than saturation at bath fluid temperature, is made to flow through these saturators on the shell side of the heat exchanger while temperature-controlled fluid flows through the tube side of the saturators in a direction opposite that of the airstream. As the pre-saturated air flows through the saturator, excess water vapor is condensed as the airstream establishes thermal equilibrium with the fluid, ensuring that the airstream is fully saturated at bath fluid temperature. The Saturation Pressure (T3&T4) and Saturation Temperature (RTD3) are monitored as the airstream exits the second saturator. These measurements are used to calculate and control the desired humidity parameter.



12.3.6 Flow Control Valve

The Flow Control Valve (V1) is a 1/4 turn ball valve actuated by a gear-reduced intelligent hybrid stepper motor and is used to control mass flow rates through the generating system. The computer-controlled flow control valve allows the mass flow rate to be controlled by varying the orifice of the flow control valve from nearly closed to fully open, depending upon the required mass flow rate.

12.3.7 Expansion Valve

After exiting the saturator, the saturated high-pressure airstream is reduced to chamber pressure through the expansion valve. The Expansion Valve (V2) is a 1/4 turn ball valve actuated by a right-angled gear reduced intelligent hybrid stepper motor that allows the saturated high-pressure airstream to be reduced to chamber pressure by varying the orifice of the expansion valve from a nearly closed to fully open depending upon the required saturator pressure and mass flow rate. Since the expansion process causes cooling, this valve is heated and thermally insulated to maintain the valve body above the dew point of the air stream while providing for a more isothermal expansion.

12.3.8 Chamber Pressure Control Valve

Test chamber pressures of ambient to 20 psi are controlled using a pressure control valve on the exhaust of the test chamber. The Chamber Pressure Control Valve (V3) is a 1/4 turn ball valve actuated by a gear-reduced intelligent hybrid stepper motor and is used to control chamber pressure. Chamber pressure is controlled by varying the orifice of the pressure control valve from fully open to nearly closed depending upon the required chamber pressure and mass flow rate.

12.3.9 Test Chamber

The Model 9500 Humidity generator incorporates a test chamber completely immersed in a water bath. The bath provides temperature conditioning and thermal stability to the test space and associated humidity-generating components. Pressure relief devices (RV4, RV5) protect the chamber from overpressure. Pressure relief valve RV4 relieves at approximately 10 psi (gauge) and is located outside the bath before the chamber pressure control valve. RV5 is also a 10 psi (gauge) pressure relief valve mounted on the right side of the test chamber but relieves at a slightly higher pressure because it is under several inches of water.

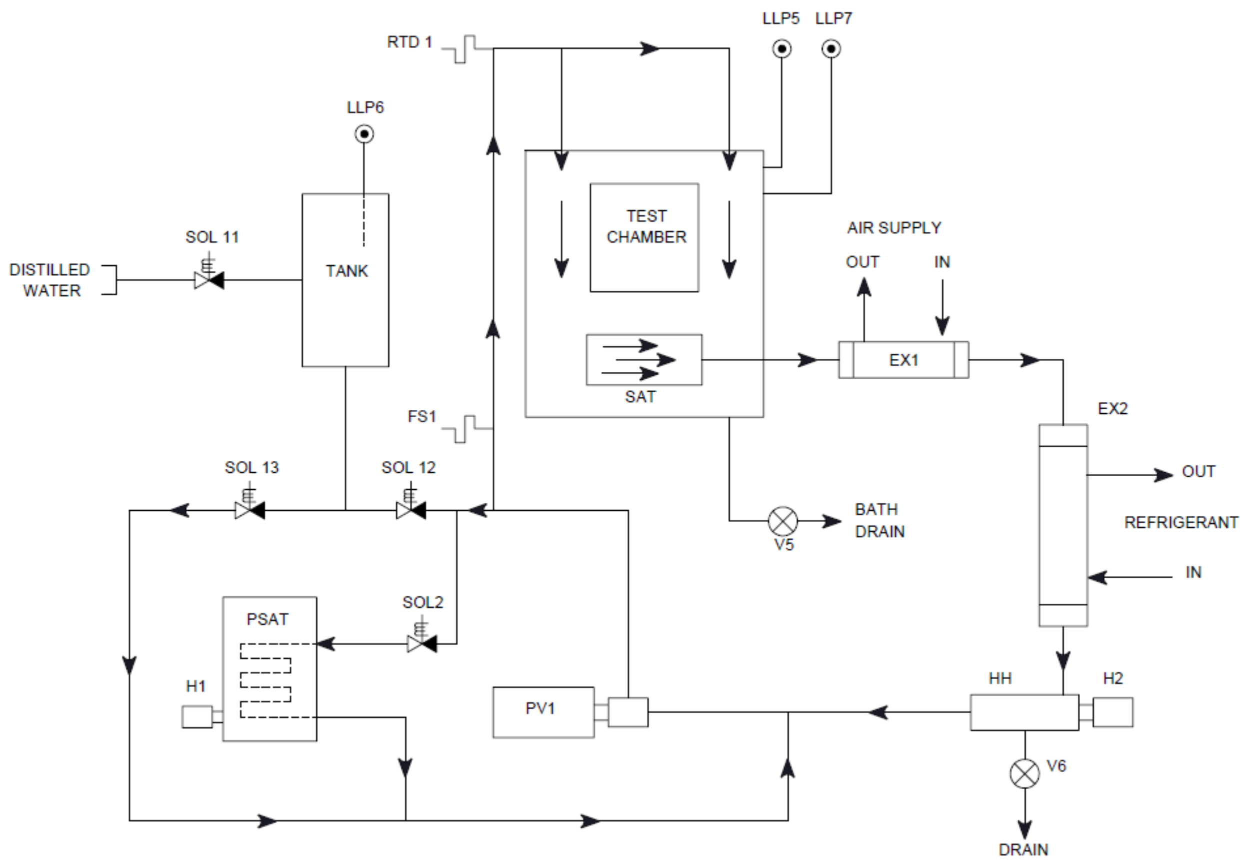
Removal of the chamber cover allows for full access to the test space. Access is also available through circular ports in the chamber cover or circular port cover adapters. The air inlet is located at the lower right side of the chamber and is a 3/4-16 straight thread fitting. The air outlet is located at the upper left side of the chamber and is also a 3/4-16 straight thread fitting. The chamber pressure measurement port is located at the upper left side near the front corner and is a 5/16-24 straight thread fitting. The chamber temperature RTD can be positioned where needed within the chamber. Excess chamber RTD cable may be pulled into or out of the chamber by loosening the cable compression fitting located outside the bath enclosure and then carefully feeding the cable through the fitting.

12.3.10 Condensate Pump

The condensate pump (PV2) recycles the water condensed in the saturators back into the Pre-Saturator (PSAT). This feature allows longer run times since excess water vapor used for super-saturation of the air stream is not lost as condensed waste but instead sent back to the pre-saturator. The condensate pump is a solenoid-actuated diaphragm metering pump. The condensate pump is configured to use an external pulse through the input signal port on the pump (far right plug) using OP22. The pump configuration (set by the up/down arrow keys and indicated on the LCD) is PULSE SIGNAL>MULTIPLY PULSES=1 (Refer to Series MP Electronic Metering Pump – Installation Operation Maintenance Manual). This means the pump strokes once for each pulse sent by the 9500. The pump stroke length setting is 100% (indicated by the center dial setting). Stroke length adjustments must only be made while the pump is running and the solenoid is activated. By applying moderate pressure to the dial, it will turn each time the stroke solenoid energizes.

12.4 Fluid System

In this closed-loop non-pressurized system, temperature-conditioned distilled water, circulated by a magnetically coupled circulation pump (PV1), flows from the pump outlet over the temperature control sensor (RTD1), splits into two bath inlets, and flows into the temperature bath. After circulating around the test chamber, the fluid is drawn through the saturators (SAT), through the air supply heat exchanger (EX1), and into the refrigeration evaporator (EX2). After cooling, bath fluid enters the immersion heater housing (HH), flows over the immersion heater (H2), and exits to the circulation pump intake, completing the bath fluid circulation circuit. The bath fluid level, measured by LLP5 and LLP7, is controlled by pumping bath fluid to or from the bath water holding tank (TANK) by energizing one of two solenoid valves (bath drain SOL12 & bath fill SOL13). Bath holding tank water level is measured by LLP6 and filled through computer activation of SOL11. Pre-Saturator (PSAT) cooling is performed by computer activation of solenoid valve SOL2, allowing bath fluid to flow from the circulation pump outlet, through the pre-saturator cooling coil, to the pump intake.



Refer to drawing: 9500D901-1, 9500D901-6, 9500D901-10, 9500D901-7, 9500D901-11, 9500S911, 9500S912, 9500S913 and 9500S915

12.4.1 Liquid Level Measurement

The system has two analog liquid levels and three single-point liquid level indicators. One of the analog liquid levels is used to measure the Water Reservoir. The other analog liquid level is used to measure the Holding Tank. The three liquid level indicators are used to determine the indication of water for the pre-saturator full, upper bath level, and lower bath level.

LL1 = WATER RESERVOIR LEVEL

LL2 = NOT USED

LL3 = NOT USED

LL4 = PRE-SATURATOR FULL INDICATOR

LL5 = UPPER BATH LEVEL INDICATOR

LL6 = HOLDING TANK LEVEL

LL7 = LOWER BATH LEVEL INDICATOR

12.4.2 Fluid Flow Measurement

A pressure switch indicates that the circulation pump is running, and water is circulating within the system.

FS1 = FLUID FLOW

12.4.3 Temperature Controlled Bath

The Model 9500 humidity generating system incorporates a computer-controlled temperature bath, utilizing distilled water as the heat transfer medium. The test chamber, saturators, heat exchanger, and connecting tubing are immersed in approximately 20 gallons of distilled water circulated at 50 gallons per minute by a magnetically coupled centrifugal pump (PV1). This provides temperature conditioning of these components, resulting in inherent temperature stability and stable humidity. Bath water levels are automatically controlled and maintained by the computer. Access to the test chamber cover is provided by pumping water from the bath into the holding tank until the water level is lower than the chamber cover flange.

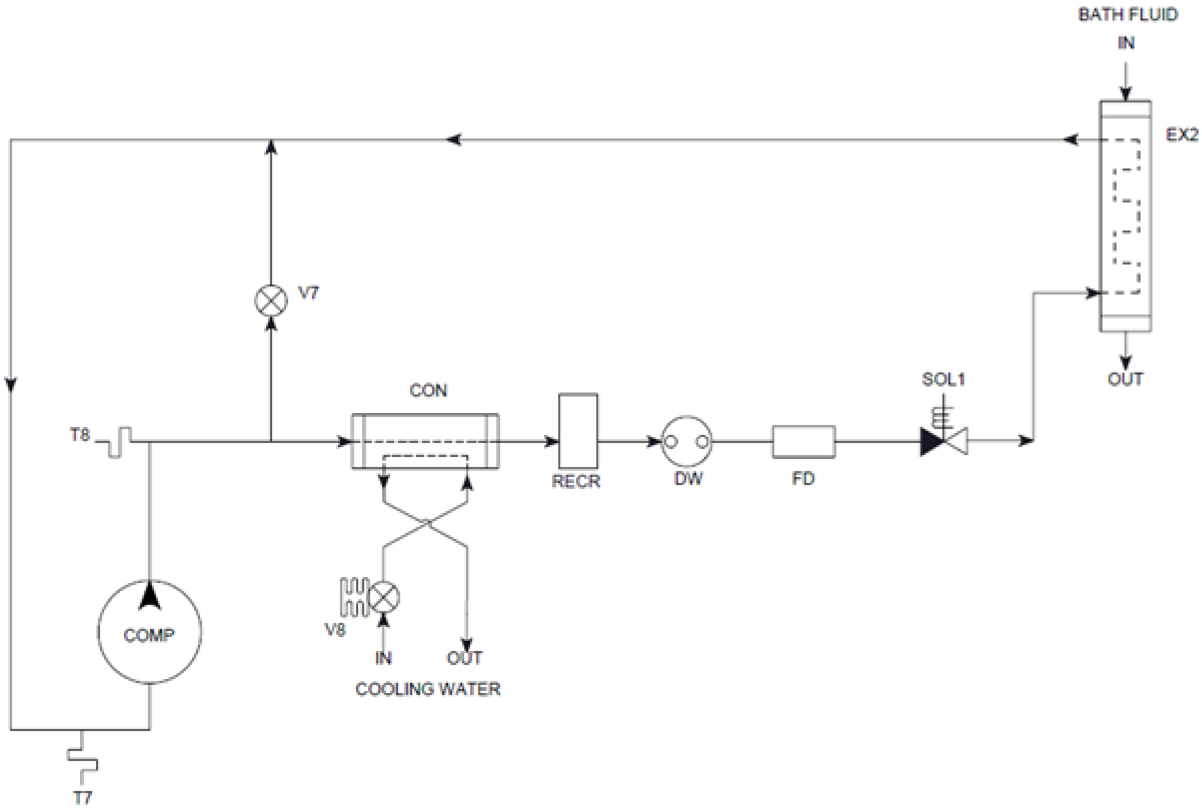
Note – *An appropriate amount of propylene glycol must be added to the temperature bath fluid if the system is to be operated below 5 °C.*

12.4.4 Bath Heating

The temperature bath's distilled water is heated by a 4500-watt, 3-phase, copper-clad immersion heater (H2). This heater, installed into a copper heater housing (HH), is located in the main fluid path, between the refrigeration evaporator (EX2) and circulation pump (PV1) inlet. Primary power to the immersion heater is switched by a 3-pole relay (MR2). A liquid-filled temperature sensing element (HL2) that disconnects the primary power immersion heater relay provides a high-temperature disconnect of the immersion heater.

12.4.5 Bath Refrigeration

The temperature bath's distilled water is cooled by an R134a, hermetic type, refrigeration system. "Refrigerant 134a" is compressed from a low-pressure vapor into a heat-laden high-pressure vapor by the refrigeration compressor (COMP). High-pressure vapor flows to the water-cooled condenser (CON), which is cooled to a high-pressure liquid as heat is removed. The condensed refrigerant flows through the sight-glass dry/wet indicator (DW) and into the filter-drier (FD). It then passes to the chamber cool solenoid (SOL1), where the refrigerant is metered into the refrigerant evaporator (EX2). The refrigerant expands and changes to a low-pressure vapor as it absorbs heat. Heat-laden vapor is then piped to the suction side of the compressor, and the cycle is repeated. During high heat demand, such as a temperature setpoint change (i.e., 25 °C to 50 °C), the refrigeration compressor is automatically shut down by the controller until cooling is again demanded. Once started, the compressor remains on as cooling is continuously required to hold the bath fluid at the set temperature.



Note – *System requires 6 lbs. (~2.7 kg) of refrigerant R134A*

Refer to drawings: 9500D901-1 and 9500D901-7

12.4.6 Temperature Measurement

The system has six 100Ω Platinum Resistance Thermometer (RTD) probes. Three probes control and measure the pre-saturator, bath fluid, and expansion valve temperature. The other three probes measure the test chamber, saturator, and cabinet temperatures.

RTD1 = BATH FLUID

RTD2 = TEST CHAMBER

RTD3 = SATURATOR

RTD4 = PRE-SATURATOR

RTD5 = EXPANSION VALVE

RTD6 = CABINET

13 MAINTENANCE

The Model 9500 Humidity generator requires little periodic maintenance. Following the proper operating procedures as given in this manual will help assure trouble-free operation of this system.

CAUTION!

ALWAYS PROPERLY SHUTDOWN THE TOUCH PANEL PC VIA WINDOWS BEFORE SWITCHING OFF THE GENERATORS POWER.

13.1 BATH FLUID

Interval: **Monthly**

Change monthly if the bath contains distilled water only. Change at user-defined intervals if the bath water is mixed with propylene glycol or alcohol. For more details, refer to section 2.12.5 *Temperature Bath Filling Procedure*.

13.2 AIR INPUT FILTER

Interval: **Yearly**

1) For safety purposes, close ControLog, power down the touch panel PC, switch the main power switch (S1) OFF, and disconnect AC power.
2) Disconnect facility air supply.
3) Remove left and rear console panels.
4) Locate the air input filter (FLT) and open the drain valve on the bottom of the filter bowl, ensuring system pressure is vented.
5) Remove the filter bowl by turning counterclockwise (facing the bottom of the filter) and unthreading from the filter head.
6) Remove the end cap on the bottom of the filter element.
7) Pull off (pull-down) used element and discard.
8) Push the new element (AU10-050) onto the center mounting stud, so it seals securely.
9) Replace end cap on element bottom.
10) Check that the O-ring seal is clean and seated correctly in the groove.
11) Screw filter bowl back onto filter head (hand tighten only).
12) Close the drain valve on the bottom of the filter bowl.
13) Replace console panels.
14) Reconnect facility air supply and reconnect AC power.

Refer to drawing: 9500D901-1, 9500D901-5 and 9500D901-8

13.3 Pressure Regulator

Interval: **Yearly**

1) Apply a light grease to the adjusting screw threads. This facilitates easy turning of the adjusting knob, especially at high pressures.
2) Cleaning – See manufacturer's service instructions.

Refer to drawing: 9500D901-1, 9500D901-5 and 9500D901-8

13.4 Pre-Saturator Liquid Level Checkout

Interval**: As needed**

The pre-saturator liquid level is fixed by the physical length of the pre-saturator liquid level probe (LLP4) mounted in the lid of the pre-saturator (PSAT) assembly.

The following procedure is designed to test the integrity of the liquid level circuit (LL4) and need only be performed if it is suspected that the liquid level circuitry is malfunctioning:

1) Remove the front console access panel. Locate the LL4 housing and remove the housing cover.
2) Toggle the main system "POWER" switch to ON.
3) Allow the touch panel PC to boot and ControLog to connect to the generator.
4) Locate the LL4 liquid level probe (LLP4) and disconnect the cable. The red LED should be illuminated.
5) Short the center pin of the cable to the chassis ground. The green LED should illuminate.
6) Repeat steps (3) and (4) as necessary to verify the correct operation. If step (3) or (4) fails, the board or cable requires repair. This board is not adjustable.
7) Turn off the system from the File menu, and switch the main system "POWER" to OFF.
8) Reconnect the cable to the probe and replace the housing cover on LL4.
9) Replace the front console access panel.

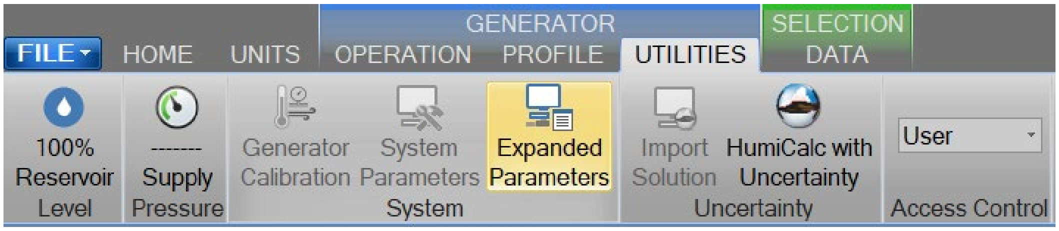
13.5 Reservoir Liquid Level Alignment

Interval: **As needed**

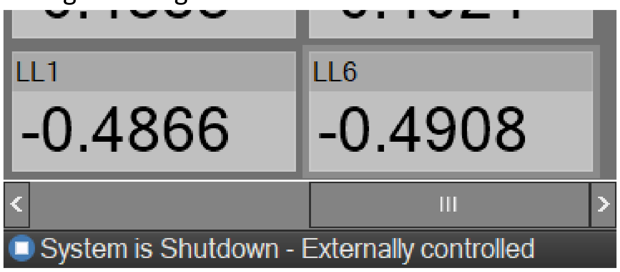
This procedure need not be performed unless it is suspected that the reservoir liquid level indicator is malfunctioning.

1) Remove the front console access panel.
2) Locate the LL1 housing and remove the black housing cover.
3) Press the main system "POWER" switch to ON.
4) Allow the touch panel PC to boot and ControLog to connect to the generator.

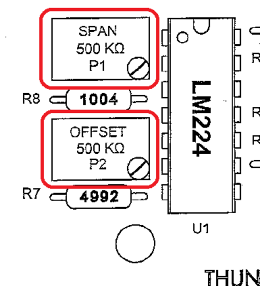
5) Open the Expanded Parameters by selecting it from the Utilities menu tab.



6) Scroll down to the end of the newly opened expanded parameter tab to locate the raw LL1 voltage reading

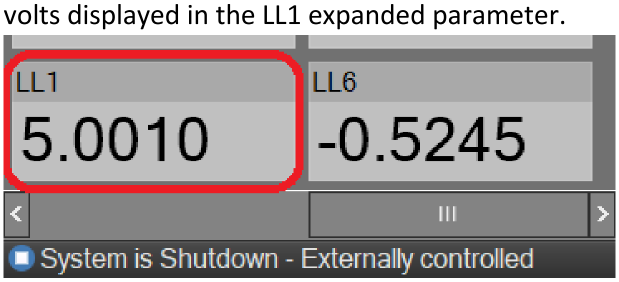


7) Locate the P1 and P2 adjustable potentiometers in the upper left of the LL1 circuit board.



8) Check that P2 is adjusted full counterclockwise (CCW). It clicks when at full CCW. If you do not hear the click, turn at least 20 to 30 times to ensure P2 is adjusted CCW fully.

9) Remove the level probe cable at the probe and attach a .001µF ceramic capacitor between it and the chassis ground. Adjust the P1 adjustable potentiometer for an output of 5.00 (±0.01) volts displayed in the LL1 expanded parameter.



10) Replace the level probe cable at the probe and check for an LL1 reading between 1 VDC and 5.8 VDC.

> **Note** – *If the output at terminal 1 is above 6.0 VDC, drain a small amount of water from the reservoir. This indicates that the water level in the reservoir is too high.*

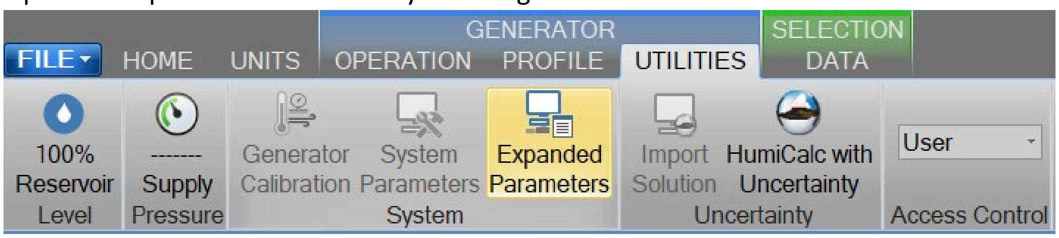
11) Turn off the system from the File menu, and switch the main system "POWER" to OFF.
12) Replace LL1 housing cover.
13) Replace the front console access panel.

13.6 Holding Tank Liquid Level Adjustment

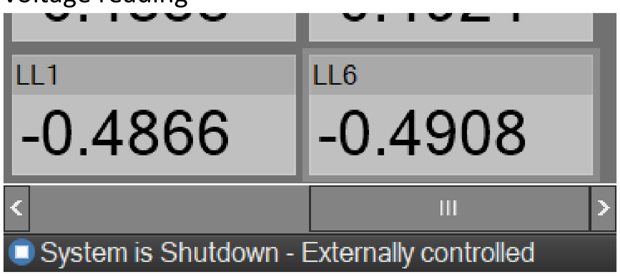
Interval: **As needed**

This procedure need not be performed unless it is suspected that the bath holding tank liquid level indicator is malfunctioning or misaligned.

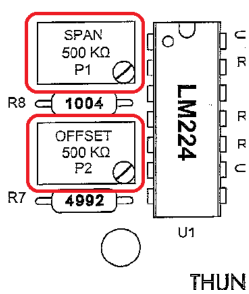
1) Remove the front console access panel.
2) Locate the LL6 housing and remove the black housing cover.
3) Press the main system “POWER” switch to ON.
4) Allow the touch panel PC to boot and ControLog to connect to the generator.
5) Open the Expanded Parameters by selecting it from the Utilities menu tab.



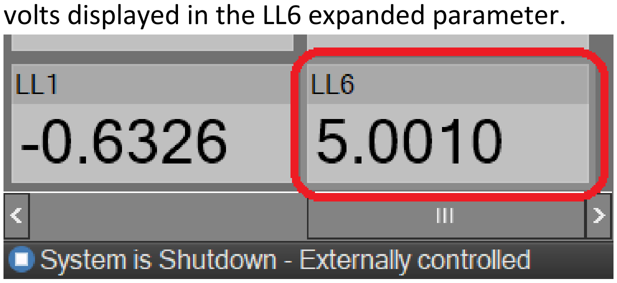
6) Scroll down to the end of the newly opened expanded parameter tab to locate the raw LL6 voltage reading



7) Locate the P1 and P2 adjustable potentiometers in the upper left of the LL6 circuit board.



8) Check that P2 is adjusted full counterclockwise (CCW). It clicks when at full CCW. If you do not hear the click, turn at least 20 to 30 times to ensure P2 is adjusted CCW fully.
9) Remove the level probe cable at the probe and attach a .001µF ceramic capacitor between it and the chassis ground. Adjust the P1 adjustable potentiometer for an output of 5.00 (±0.01) volts displayed in the LL6 expanded parameter.



10) Replace the level probe cable at the probe and check for an LL6 reading between 1 VDC and 5.8 VDC.

> **Note** – *If the output at terminal 1 is above 6.0 VDC, drain a small amount of water from the tank. This indicates that the water level in the tank is too high.*

11) Turn off the system from the File menu, and switch the main system "POWER" to OFF.
12) Replace LL6 housing cover.
13) Replace the front console access panel.

13.7 Bath Liquid Level Checkout

Interval: **As needed**

This procedure need not be performed unless it is suspected that the bath level control circuits are malfunctioning.

> **Note** – *The following procedures may require that the bath is partially drained to bring the level below the lower bath level sensor.*

1) Remove the right-side console access panel. Locate the LL5 and LL7 housings.
2) Press the main system "POWER" switch to ON.
3) Allow the touch panel PC to boot and ControLog to connect to the generator.
4) With the bath level approximately 1/4 inch or more below the lower bath level sensor, the red LEDs of LL5 and LL7 should be illuminated.
5) With a moistened finger, touch the lower probe to the bath wall. The green LED should illuminate. Repeat this procedure for the upper probe. Its associated green LED should illuminate.
6) Repeat step 3 as necessary to verify the correct operation. If step 3 fails, the associated board or cable requires repair. These boards are not adjustable.
7) Wipe the lower and upper probes free of oils and other contaminants using a clean cloth. Clean on and around the probes.
8) Turn off the system from the File menu, and switch the main system "POWER" to OFF.
9) Replace the console access panel.

13.8 Warning and Error Messages

Before system start-up and during humidity generation, the system monitors itself for warnings, errors, and sources of possible malfunction. All warning and error messages are automatically logged in the status log and displayed in the 9500 Reported Warnings & Errors tab. Catastrophic errors will result in an automatic shutdown. While it is not necessary to understand the error message, it is vital to write down the error message exactly as it appears when contacting Thunder Scientific for technical support.

13.8.1 Bath Temperature at Minimum Limit

This error indicates that the bath fluid temperature probe is reading below its minimum value for a specific amount of time. A failed probe or incorrect calibration are the most common causes of this error.

13.8.2 Bath Temperature Over Range or at Maximum Limit

This error indicates that the bath fluid temperature probe is reading above its maximum limit value for a specific time or has reached its over-range point. A failed probe or incorrect calibration are the most common causes of this error, but other causes are also possible such as the probe being inserted in the incorrect location after a calibration.

13.8.3 Chamber Temperature at Minimum Limit

This error indicates that the chamber temperature probe is reading below its minimum value for a specific amount of time. A failed probe or incorrect calibration are the most common causes of this error.

13.8.4 Chamber Temperature Over Range or at Maximum Limit

This error indicates that the chamber temperature probe is reading above its maximum limit value for a specific time or has reached its over-range point. A failed probe or incorrect calibration are the most common causes of this error, but other causes are also possible such as the probe being inserted in the incorrect location after a calibration.

13.8.5 Saturation Temperature at Minimum Limit

This error indicates that the saturation temperature probe is reading below its minimum value for a specific time. A failed probe or incorrect calibration are the most common causes of this error.

13.8.6 Saturation Temperature Over Range or at Maximum Limit

This error indicates that the saturation temperature probe reads above its maximum limit value for a specific time or has reached its over-range point. A failed probe or incorrect calibration are the most common causes of this error, but other causes, such as the probe being inserted in the incorrect location after a calibration or a faulty heater control component, are also possible.

13.8.7 Pre-Saturation Temperature at Minimum Limit

This error indicates that the pre-saturation temperature probe is reading below its minimum value for a specific time. A failed probe or incorrect calibration are the most common causes of this error.

13.8.8 Pre-Saturation Temperature Over Range or at Maximum Limit

This error indicates that the pre-saturation temperature probe is reading above its maximum limit value for a specific time or has reached its over-range point. A failed probe or incorrect calibration are the most common causes of this error, but other causes, such as the probe being inserted in the incorrect location after a calibration or a faulty heater control component, are also possible.

13.8.9 Expansion Valve Temperature at Minimum Limit

This error indicates that the expansion valve temperature probe is reading below its minimum value for a specific time. A failed probe or incorrect calibration are the most common causes of this error.

13.8.10 Expansion Valve Temperature Over Range or at Maximum Limit

This error indicates that the expansion valve temperature probe is reading above its maximum limit value for a specific time or has reached its over-range point. A failed probe or incorrect calibration are the most common causes of this error, but other causes, such as the probe being inserted in the incorrect location after a calibration or a faulty heater control component, are also possible.

13.8.11 Insufficient Supply Pressure to Generate

This error indicates insufficient supply pressure to start generating or to continue generating. Ensure the air supply is on, the system is configured for the correct supply input, and the inputs meet the supply pressure requirements for the generator.

For more information, refer to section 2.11 Facility Requirements

13.8.12 Supply Pressure Over Range or at Maximum Limit

This error indicates that the pressure transducer T1 is over range or has been at its maximum limit value for a specific time. Check the supply pressure regulators to ensure the incoming supply pressure is regulated to the supply pressure requirements for the generator.

For more information, refer to section 2.11 Facility Requirements

13.8.13 High-Range Pressure at Minimum Limit

This error indicates that the pressure transducer T4 is reading below its minimum value for a specific time. A failed transducer or incorrect calibration are the most common causes of this error.

13.8.14 High-Range Pressure Over Range or at Maximum Limit

This error indicates that the pressure transducer T4 is over range or has been at its maximum limit value for a specific time. A failed transducer or incorrect calibration are the most common causes of this error. Also, if using fittings or tubing connected to the chamber inlet, ensure it can flow at the desired flow rate and is not causing any back pressure or blockage.

13.8.15 Low-Range Pressure at Minimum Limit

This error indicates that the pressure transducer T3 is reading below its minimum value for a specific time. A failed transducer or incorrect calibration are the most common causes of this error.

13.8.16 Low-Range Pressure Over Range or at Maximum Limit

This error indicates that the pressure transducer T3 is over range or has been at its maximum limit value for a specific time. A failed or leaking Low-Pressure Select Solenoid Valve (SOL7), failed transducer, or incorrect calibration are the most common causes of this error.

13.8.17 Chamber Pressure at Minimum Limit

This error indicates that the pressure transducer T2 is reading below its minimum value for a specific time. A failed transducer or incorrect calibration are the most common causes of this error.

13.8.18 Chamber Pressure Over Range or at Maximum Limit

This error indicates the pressure transducer T2 is over range or has been at its maximum limit value for a specific time. A failed transducer or incorrect calibration are the most common causes of this error.

13.8.19 Mass Flow Rate at Minimum Limit

This error indicates that the flow meter T5 is reading below its minimum value for a specific time. A wet flow meter is the most common cause of this error. Other causes include a failed flow meter or incorrect calibration.

13.8.20 Mass Flow Rate Over Range or at Maximum Limit

This error indicates that the flow meter T5 is over range or has been at its maximum limit value for a specific time. A wet flow meter is the most common cause of this error. Other causes include a failed flow meter or incorrect calibration.

13.8.21 Flow Valve Reported Error:

This error indicates that the stepper motor for valve V1 is reporting an internal error. A failed stepper motor or a jammed flow valve are the most common causes of this error. It is important to relay the number displayed after this error when contacting Thunder Scientific for technical support.

13.8.22 Flow Valve Failed to Find Home Position

This error indicates that valve V1's stepper motor cannot find its home position. A failed stepper motor or a jammed flow valve are the most common causes of this error.

13.8.23 Flow Valve at Minimum Limit

This error indicates that valve V1 has been at its minimum position for a specific time. This indicates that the system cannot reduce the flow rate to reach the setpoint. A wet flow meter is the most common cause of this error.

13.8.24 Flow Valve at Maximum Limit

This error indicates that valve V1 has been at its maximum position for a specific time. This indicates that the system cannot increase the flow rate to reach the setpoint. Insufficient supply pressure source for the given setpoint or a blocked or restricted chamber inlet is the most common cause of this error.

13.8.25 Expansion Valve Reported Error:

This error indicates that the stepper motor for valve V2 is reporting an internal error. A failed stepper motor or a jammed expansion valve are the most common causes of this error.

13.8.26 Expansion Valve Failed to Find Home Position

This error indicates that valve V2's stepper motor cannot find its home position. A failed stepper motor or a jammed expansion valve are the most common causes of this error.

13.8.27 Expansion Valve at Minimum Limit – Check for air leaks

This warning indicates that valve V2 has been at its minimum position for a specific time. This is an indication that the system is unable to pressurize the saturator. An air leak is the most common cause of this error.

13.8.28 Expansion Valve at Maximum Limit – Reduce Mass Flow Rate

This warning indicates that valve V2 has been at its maximum position for a specific time. Operating the generator at high humidity with high mass flow rates is the most common cause of this warning. Try reducing the mass flow rate setpoint when generating above 98% Relative Humidity or equivalent.

13.8.29 Chamber Valve Reported Error:

This error indicates that the stepper motor for valve V3 is reporting an internal error. A failed stepper motor or a jammed chamber valve are the most common causes of this error.

13.8.30 Chamber Valve Failed to Find Home Position

This error indicates that the valve V3's stepper motor cannot find its home position. A failed stepper motor or a jammed chamber valve are the most common causes of this error.

13.8.31 Chamber Valve at Maximum Limit – Check chamber for air leaks

This error indicates that valve V3 has been at its maximum position for a specific time. This indicates that the chamber cannot pressurize to the setpoint. A chamber leak caused by a loose chamber lid or missing chamber access cover is the most common cause of this error.

13.8.32 Low-Range Pressure Transducer Not Responding

This error indicates that the low-range pressure transducer (T3) is not responding to commands from the computer. A failed transducer is the most common cause of this error, but a disconnected or damaged serial cable could also be the cause.

13.8.33 High-Range Pressure Transducer Not Responding

This error indicates that the high-range pressure transducer (T4) is not responding to commands from the computer. A failed transducer is the most common cause of this error, but a disconnected or damaged serial cable could also be the cause.

13.8.34 Chamber Pressure Transducer Not Responding

This error indicates that the chamber pressure transducer (T2) is not responding to commands from the computer. A failed transducer is the most common cause of this error, but a disconnected or damaged serial cable could also be the cause.

13.8.35 Check and Clean Bath Level Probes

This warning indicates that the system cannot maintain the bath level during operations. A fouled bath level probe is the most common cause of this error. Try wiping the metal wire of the upper bath probe (LL5) and lower bath level probe (LL7) to clear any build-up.

13.8.36 No Fluid Flow – Check Fluid Circulation System

This error indicates that no bath flow was detected within the fluid circulation system. Make sure the fluid circulation system is full of water. Other causes include a failed or incorrectly wired generator causing the pump to rotate in reverse or a fluid pump failure or tripped breaker.

For more information, refer to section 2.12.5 Temperature Bath Filling Procedure

13.8.37 No Bath Fluid Heat

This warning indicates that the heater H2 for the fluid circulation system has been running at full power without any increase in temperature for a given amount of time. Possible causes include a failed heater (H2), tripped heat limit switch (HL2), or the bath fluid temperature probe (RTD1) is not installed or being installed in the wrong location.

13.8.38 No Pre-Saturator Heat

This warning indicates that the heater H1 for the pre-saturator (PSAT) has been running at full power without any increase in temperature for a given amount of time. Possible causes include a failed heater (H1), tripped heat limit switch (HL1), or the pre-saturation temperature probe (RTD4) is not installed or is installed in the wrong location.

13.8.39 No Expansion Valve Heat

This warning indicates that the heater H3 for the expansion valve has been running at full power without any increase in temperature for a given amount of time. Possible causes include a failed heater (H3), the expansion valve temperature probe (RTD5) not being installed, or being in the wrong location.

13.8.40 Cabinet Temperature Over Range or at Minimum/Maximum Limit – Check Cabinet Fans

This warning indicates the cabinet temperature probe is reading below its minimum value or above its maximum value for a specific amount of time. Insufficient floor space around the generator, running with panels removed, or cabinet fans not operating is the most common cause of this warning. It is also possible to receive this error if the generator is being operated in an environment outside the generator's operating temperature range.

For more information, refer to section 2.11 Facility Requirements

13.8.41 Unable to Fill Pre-Saturator

This error indicates that the pre-saturator (PSAT) was unable to fill. An empty distilled water reservoir is the most common cause of this error. Assure the reservoir is full and try to fill the pre-sat manually.

For more information, refer to section 5.6.1 Pre-saturator Level

13.8.42 Unable to Fill Bath Fluid Holding Tank

This warning indicates that the bath fluid holding tank was unable to fill. The user taking too long to add water during the filling process is the most common cause of this error. Try repeating the filling process. Other causes are a failed or clogged Bath Holding Tank Fill Solenoid Valve (SOL11).

For more information on adding water, refer to section 5.3.1 Fill Holding Tank

13.8.43 Unable to Fill distilled Water Reservoir

This warning indicates the water reservoir was unable to fill. The user taking too long to add water during the filling process is the most common cause of this error. Try repeating the filling process. Other causes are failed or clogged reservoir fill solenoid valves (SOL4&5).

For more information on adding water, refer to section 5.1.1 Fill Water Reservoir

13.8.44 Distilled Water Reservoir is Empty

This warning indicates that the water reservoir is empty and that it should be filled now.

For more information on adding water, refer to section 5.1.1 Fill Water Reservoir

13.8.45 Distilled Water Reservoir is Low

This warning indicates the water reservoir is low and should be filled soon.

For more information on adding water, refer to section 5.1.1 Fill Water Reservoir

13.8.46 Bath Fluid Holding Tank is Empty

This warning indicates that the bath fluid holding tank is empty and needs to be filled.

For more information on adding water, refer to section 5.3.1 Fill Holding Tank

13.8.47 Refrigeration Compressor Low Side Pressure at Minimum Limit

This error indicates that the refrigeration low-side pressure transducer (T7) is reading below its minimum value for a specific time. An inoperative Bath Cool Solenoid Valve (SOL1) or failed +5 VDC power supply (DC3) is the most common cause of this error. Other causes include refrigeration system failure/leak or a failed transducer T7.

13.8.48 Refrigeration Compressor Low Side Pressure Over Range or at Maximum Limit

This error indicates that the refrigeration low-side pressure transducer (T7) is over range or has been at its maximum limit for a specific time. A refrigeration system failure or failed transducer T7 is the most common cause of this error. It is also possible to receive this error if the generator is being operated in an environment outside the generator's operating temperature range.

For more information, refer to section 2.11 Facility Requirements

13.8.49 Refrigeration Compressor High Side Pressure at Minimum Limit

This error indicates that the refrigeration high-side pressure transducer (T8) is reading below its minimum value for a specific time. A refrigeration leak or failure is the most common cause of this error. Other causes include a failed timer relay (TR5), failed +5 VDC power supply (DC3), or a failed transducer T8.

13.8.50 Refrigeration Compressor High Side Pressure Over Range or at Maximum Limit

This error indicates that the refrigeration high-side pressure transducer (T8) is over range or has been at its maximum limit for a specific time. The most common cause of this error is the cooling water supply not being on or flowing.

For more information, refer to section 2.11.5 Cooling Water Supply

Other causes include a refrigeration system failure or a failed transducer T8.

13.8.51 System Failed to Vent Pressure on Shutdown

This warning indicates the system failed to vent off the pressure after a shutdown within a given amount of time. A clogged or overly restrictive muffler on the pressure vent outlet is the most common cause of this error. This error can also be received if solenoid SOL6 is bad or clogged.

13.8.52 Pressure Alignment Error - Check Low and High-Range Pressure Transducers.

This warning indicates the low range and high range pressure transducers are not reading within the Alignment Delta (psi) at startup. Check the calibration on both transducers and ensure both transducers are operational and reading correctly.

13.8.53 Mass Flow Rate is being limited to achieve Humidity setpoint.

This warning occurs when the system limits the mass flow rate to 75 L/min when the Humidity setpoint is greater than 98 %RH. This can occur if the user changes temperature and humidity simultaneously or if the user is changing temperature when generating a humidity that is sensitive to temperature deltas between the chamber and saturation temperature. The system limits the flow to ensure a proper pressure delta is maintained at low saturation pressures. If this warning does not clear once the system has stabilized at its humidity and temperature setpoints, then a mass flow rate setpoint reduction is recommended to remove the warning.

13.8.54 Insufficient Supply Pressure to reach setpoint.

This warning occurs when the system is set to generate a humidity value that requires more pressure than the supply has available. This can occur if the user changes temperature and humidity simultaneously or if the user is changing temperature when generating a humidity that is sensitive to temperature deltas between the chamber and saturation temperature. If this warning does not clear once the system has stabilized at its temperature setpoint, then check the supply pressure as it might be insufficient for the desired humidity setpoint.

13.8.55 Switching Supply Pressure Inputs - Mass Flow Rate reduced.

This warning occurs when the system is switching between either the low supply pressure input or the high supply pressure input. Because of the mass flow meter design, the system must stop the flow control before switching to the higher supply pressure. Expect the system to have a considerable mass flow rate reduction when switching from the low supply input to the high supply input and a minor flow rate reduction when switching from the high supply input to the low supply input.

Refer to section 2.11.4 Air Supply for more information.

14 RS-232 COMMANDS

The Thunder Scientific Model 9500 Humidity Generator can connect via a serial connection to an external computer or laptop. Connect the external computer or laptop to the “External Control” cable from the cable access hole on the countertop.

14.1 SERIAL SETTINGS

The Model 9500 only supports the following serial communication rate and configuration.

Baud Rate = 57600
Data Bits = 8
Parity = None
Stop Bits = One
Handshake = None
RTS Enable = True
DTR Enable = False

14.2 GET AND SET COMMANDS

Commands to Get and Set values to the Model 9500. Please note that the values are not specific and vary based on the actual reading of the 9500.

14.2.1 %RH

To get the current value you send:

get %rh<CR><LF>

You receive:

Setpoint: 50<LF>

Actual: 50<CR><LF>

To set a new value, you send:
set %rh 20<CR><LF>

where:
<CR> is a carriage return character.
<LF> is a linefeed character.

14.2.2 Frost Point

To get the current value you send:
get frost point<CR><LF>

You receive:
Setpoint: 0<LF>
Actual: 0<CR><LF>

To set a new value, you send:
set frost point -5<CR><LF>

14.2.3 Dew Point

To get the current value you send:
get dew point<CR><LF>
You receive:
Setpoint: 20<LF>
Actual: 12.03227011<CR><LF>

To set a new value, you send:
set frost point 20<CR><LF>

14.2.4 PPMv

To get the current value you send:
get ppmv<CR><LF>

You receive:
Setpoint: 14120<LF>
Actual: 14120.3867<CR><LF>

To set a new value, you send:
set ppmv 14120<CR><LF>

14.2.5 PPMw

To get the current value you send:
get ppmw<CR><LF>

You receive:
Setpoint: 8785<LF>
Actual: 8784.870045<CR><LF>

To set a new value, you send:
set ppmw 8785<CR><LF>

14.2.6 Saturation Pressure

To get the current value you send:
get saturation pressure<CR><LF>

You receive:
Setpoint: 30<LF>
Actual: 29.48623339<CR><LF>

To set a new value, you send:
set saturation pressure 30<CR><LF>

14.2.7 Chamber Pressure

To get the current value you send:
get chamber pressure<CR><LF>

You receive:
Setpoint: 10<LF>
Actual: 14.7<CR><LF>

To set a new value, you send:
set chamber pressure 15<CR><LF>

14.2.8 Saturation Temperature

To get the current value you send:
get saturation temperature<CR><LF>

You receive:
Actual: 23<CR><LF>

To set a new value, you send:
set saturation temperature 23<CR><LF>

14.2.9 Chamber Temperature

To get the current value you send:

get chamber temperature<CR><LF>

You receive:

Actual: 23.1<CR><LF>

14.2.10 Bath Temperature

To get the current value you send:

get bath temperature<CR><LF>

You receive:

Setpoint: 23<LF>
Actual: 23<CR><LF>

14.2.11 Mass Flow Rate

To get the current value you send:

get mass flow rate<CR><LF>

You receive:

Setpoint: 50<LF>
Actual: 40<CR><LF>

To set a new value, you send:

set mass flow rate 50<CR><LF>

14.2.12 Cabinet Temperature

To get the current value you send:

get cabinet temperature<CR><LF>

You receive:

Actual: 30.1<CR><LF>

14.2.13 Expansion Valve Temperature

To get the current value you send:

get expansion valve temperature<CR><LF>

You receive:

Actual: 23.5<CR><LF>

14.2.14 Pre-Saturator Temperature

To get the current value you send:
get pre-saturator temperature<CR><LF>

You receive:
Actual: 35.0<CR><LF>

14.2.15 Supply Pressure

To get the current value you send:
get supply pressure<CR><LF>

You receive:
Actual: 150.0<CR><LF>

14.2.16 Water Reservoir Level

To get the current value you send:
get water reservoir level<CR><LF>

You receive:
Actual: 95.5<CR><LF>

14.2.17 Bath Reserve Level

To get the current value you send:
get bath reserve level<CR><LF>

You receive:
Actual: 95.5<CR><LF>

14.2.18 Bath Level

To get the current value you send:
get bath level<CR><LF>

You receive:
Actual: 100<CR><LF>

14.3 Run Commands.

Commands to operate the generator.

14.3.1 Generate

You send:
generate<CR><LF>

14.3.2 Shutdown

You send:
shutdown<CR><LF>

14.4 Run State Commands

Commands to return the run state of the generator.

14.4.1 Run State

You send:

get run state<CR><LF>

You receive:

Expanded: X.X<CR><LF>

Where X.X can be the following:

Request to Generate = 0.1
Generate = 1
Request to Shutdown = 1.1
Shutdown = 0

14.5 Group Commands

Commands to get groups or lists of data at once. Please note that the values are not specific and vary based on the actual reading of the 9500.

14.5.1 Setpoints

To get the current list of setpoint values, you send:
get setpoints<CR><LF>

You receive 9 setpoint values:
"%rh setpoint"<LF>
"frost point setpoint"<LF>
"dew point setpoint"<LF>
"PPMv setpoint"<LF>
"PPMw setpoint"<LF>
"saturation pressure setpoint"<LF>
"saturation temperature setpoint"<LF>
"mass flow rate setpoint"<LF>
"chamber pressure setpoint"<CR><LF>

Example:

You send:
get setpoints<CR><LF>

You receive 9 setpoint values:
50*<LF>*
19.3685927763809*<LF>*
19.3685927763809*<LF>*
28099.8010136974*<LF>*
17482.0353973598*<LF>*
11.9769275*<LF>*
23*<LF>*
50*<LF>*
10<CR>*<LF>*

14.5.2 Actuals

To get the current list of actual values you send:
get actuals<CR><LF>

You receive 21 actual values:
"%rh"<LF>
"frost point"<LF>
"dew point"<LF>
"PPMv"<LF>
"PPMw"<LF>
"saturation pressure"<LF>

“chamber pressure”<LF>
“saturation temperature”<LF>
“chamber temperature”<LF>
“bath temperature”<LF>
“mass flow rate”<LF>
“high-range transducer”<LF>
“low-range transducer”<LF>
“cabinet temperature”<LF>
“expansion valve temperature”<LF>
“pre-saturator temperature”<LF>
“supply pressure”<LF>
“water reservoir level”<CR><LF>
“holding tank level”<CR><LF>
“bath reserve level”<CR><LF>
“bath level”<CR><LF>

Example:

You send:
get actuals<CR><LF>

You receive 21 actual values:
49.9848614617792*<LF>*
12.0307560817887*<LF>*
12.0307560817887*<LF>*
14119.0297431908*<LF>*
8784.02582376005*<LF>*
29.48623339*<LF>*
14.7*<LF>*
22.9983457854*<LF>*
23.0033463644*<LF>*
23.0010032846*<LF>*
50.7071233593023*<LF>*
29.48824255*<LF>*
29.48623339*<LF>*
28.3574358438*<LF>*
23.4548343478*<LF>*
49.2342457546*<LF>*
100.016*<LF>*
2.48492523665688*<LF>*
0*<LF>*
0*<LF>*
100*<CR><LF>*

15 DRAWINGS AND DIAGRAMS

This section contains drawings and diagrams of the Model 9500 Humidity generator to assist the user in better understanding the operation and location of components of the system.

> **Note** – *All drawings and diagrams contained within this manual are proprietary information protected by copyright. All rights are reserved. No part of these drawings and diagrams may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopying and recording, for any purpose without the prior written consent of Thunder Scientific Corporation.*

9500 Drawing List

Drawing #	Drawing Title
9500D901-1	Components
9500D901-2	Dimensional Drawing
9500D901-3	Component Locations
9500D901-4	Component Utilities
9500D901-5	Pneumatic Schematic
9500D901-6	Fluid Schematic
9500D901-7	Refrigeration Schematic
9500D901-8	Pneumatic Components Pre-Sat, Reservoir
9500D901-9	Pneumatic Components Chamber
9500D901-10	Fluid Components
9500D901-11	Refrigeration Components
9500D901-12	Electrical Main Panel Layout
9500D901-13	Electrical Sub Panel Layout
9500D901-14	Computer Panel Layout
9500D903	Countertop Mounting Locations
9500S911	Exp. Heat / Solenoid Valve Control Schematic
9500S912	Pre-Saturator Heater Schematic
9500S913	Bath Heater Schematic
9500S914	Solenoid Valve Control Schematic
9500S915	Transducer Schematic
9500S916	Pres Tran / Stepper Drive Schematic
9500S917	Temperature Probe Schematic
9500S918	Pump / Comp / Flow Schematic
9500S919	AC / DC Power Distribution
9500D905	4 Port Chamber Lid Assembly
9500D906	5 Port Chamber Lid Assembly
9500D907	2 Port Chamber Lid Assembly

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ITEM NO.	FIND #	TSC STOCKCODE	DESCRIPTION	QTY.
82	V8	V46AA-1C	REFRIG. WATER VALVE	1
81	V7	EV-104	CONSTANT PRESSURE EXP. VALVE	1
80	V6	G5X713	1/4" NPT FEMALE BALL VALVE (150 PSI)	1
79	V5	D9500A029	FLUID BATH DRAIN ASSY	1
78	V4	S1VS6-A	3/8" SHUT OFF VALVE	1
77	V3	D9500A033	CHAMBER VALVE ASSEMBLY	1
76	V2	9500A034	EXPANSION VALVE ASSEMBLY	1
75	V1	D9500A032	FLOW VALVE ASSEMBLY	1
74	TR5	TIMER5	TIMER RELAY	1
73	TANK	D9500A060	WATER SUPPLY TANK ASSEMBLY	1
72	T7,8	P528-500	0 - 500 PSI PRESSURE SENSOR	2
71	T5	FLM100M	FLOW METER	1
70	T4	CPT9000-325	0 - 325 PSIA PRECISION TRANSDUCER	1
69	T3	CPT9000-45	0 - 45 PSIA PRECISION TRANSDUCER	1
68	T2	CPT9000-23	0 - 23 PSIA PRECISION TRANSDUCER	1
67	T1	S209-500	0 - 500 PSIG TRANSDUCER	1
66	SSR1,2	D53TP25C	IP20 530 VAC 25A 3 PHASE RELAY	2
65	SOL7	A2012	2WNC 1/16 ORIFICE 24V SOLENOID VALVE	1
64	SOL6	71225SN2GF00	2 WAY N.O. 400 PSI SOLENOID	1
63	SOL4,5,11	71215SN2SN00	2 WAY N.C. 80 PSI SOLENOID	3
62	SOL3,14	SL712N	2 WAY SOLENOID VALVE	2
61	SOL2,8,12,13	71215SN2VN00	2 WAY N.C. 15 PSI SOLENOID	4
60	SOL1	E3S130	REFRIGERATION SOLENOID VALVE	1
59	SIL	MS002A	1/4" NPT SILENCER	1
58	S1	PWRSW-2P	220V 2-POLE CIRCUIT BREAKER SWITCH	1
57	RV5	S8C-3	1/2" ADJUSTABLE RELIEF VALVE	1
56	RV4	S8C-10	1/2" POPPET CHECK VALVE	1
55	RV3	S8C-150	1/2" ADJUSTABLE RELIEF VALVE	1
54	RV2	S4-CPA2-3	1/4" ADJUSTABLE CHECK VALVE	1
53	RV1	S4R3A	RELIEF VALVE	1
52	RTD6	S17624	CABINET TEMPERATURE PROBE	1
51	RTD3	4551348-6-15	6.50" - 100 Ω PROBE -200 TO 350°C	1
50	RTD1,2,4,5	4551348-4-15	4.00" - 100 Ω PROBE -200 TO 350°C	4
49	RES	D9500A024	RESERVOIR ASSEMBLY	1
48	REG	REG450	15 - 450 PSIG PRESSURE REGULATOR	1
47	RECR	RECR-5315	RECEIVER	1
46	PV2	METER PUMP	PULSATRON - LMK2TA-PTC2XXXX	1
45	PV1	TE-7R-MD	FLUID PUMP	1
44	PSAT	D9500A079	PRE-SAT WELD ASSEMBLY	1
43	PB24Q	PB24Q	RELAY BOARD	1
42	ODC5Q	ODC5Q	5 - 60 VDC RELAY	6
41	NI9403	N779787	TTL DIGITAL I/O MODULE (32 CH)	1
40	NI9401	N779351	TTL DIGITAL I/O MODULE (8 CH)	1
39	NI9216	N783664-01	24-BIT 100 Ω RTD ANALOG INPUT MODULE	1

REVISIONS

DWN	REV.	DESCRIPTION	DATE	APP. BY
DWF	A	REVISED WITH NEW COMPONENTS	11/18/2021	BB
CRB	B	REVISED COMPONENT RANGES	6/24/2022	BB

ITEM NO.	FIND #	TSC STOCKCODE	DESCRIPTION	QTY.
38	NI9209	N783729	±10V, 24-BIT ANALOG INPUT MODULE	1
37	NI9136	N784238	4 SLOT CONTROLLER	1
36	MR1,2,3,4	AFM315-310	15A 3 POLE MERCURY RELAY	4
35	MOXA	UPORT1650-8	USB - SERIAL HUB	1
34	MEM	SD1001	2GB FLASH MEMORY CARD	1
33	LLP6	D9500A062	SUPPLY TANK PROBE ASSY	1
32	LLP5,7	D00M90219	1/8" QUIKGRIP TUBE FITTING MOD.	2
31	LLP4	D9500A040	PRESAT LIQUID LEVEL PROBE	1
30	LLP1	D9500A097	RESERVOIR PROBE ASSEMBLY	1
29	LL4,5,7	D92A00043	LIQUID LEVEL ALARM PROBE BOARD ASSY	3
28	LL1,6	D96A00355	RESERVOIR LIQUID LEVEL BOARD ASSY	2
27	HL3	HLSW3	230° C THERMOSTAT SWITCH	1
26	HL1, 2	A19AAF-12	HEAT LIMIT SWITCH	2
25	HH	D9500A057	BATH HEATER HOUSING ASSEMBLY	1
24	H3	KHLVA-204/5-P	POLYIMIDE FLEXIBLE HEATER	1
23	H2	BLC710L3	3 ELEMENT 4500 W HEATER	1
22	H1	D94A00169	PRE-SATURATOR HEATER ASSY	1
21	G1	33HR98	0 - 400 PSI PRESSURE GAUGE	1
20	FS1	PS11	FLUID FLOW SWITCH	1
19	FLT	FLH15K	500 PSI AIR FILTER	1
18	FD	C-083	3/8" FLARE REFRIG FILTER / DRYER	1
17	EX3	D9500A089	3/4" X 24" SS FLEX TUBE ASSEMBLY	1
16	EX2	D9500A055	EVAPORATOR ASSEMBLY	1
15	EX1	D9500A053	AIR IN HEAT EXCHANGER	1
14	DW	SA-13S	REFRIG. WET / DRY INDICATOR	1
13	DC3	PS709-RD65A	5 & 12 VDC POWER SUPPLY	1
12	DC2	PS709-LRS-100-15	100W - 15 VDC POWER SUPPLY	1
11	DC1	PS709-HRPG-300-24	24VDC POWER SUPPLY	1
10	CV1,2,3	S6C-1/3	CHECK VALVE 1/3 PSI	3
9	CTF1	D9500A087	1/2" X 3" SS FLEX TUBE ASSEMBLY	1
8	CPF1,2	D9500A086	1/4" X 4" FLEX TUBE ASSEMBLY	2
7	CON	COCX7201J	DOUBLE WOUND CONDENSER COIL	1
6	COMP	AWA9512ZXT	3 PH REFRIGERATION COMPRESSOR	1
5	CF2,3	FN624N	24 VDC FAN	2
4	CF1	AI-CP2L	CONSOLE FANS	1
3	CEF1	D9500A088	3/4" X 6" SS FLEX TUBE ASSEMBLY	1
2	CB5	ABSPCD2G100	10A 2 POLE CIRCUIT BREAKER	1
1	CB1,2,3,4	ABSPCB3G100	10A 3 POLE CIRCUIT BREAKER	4

DO NOT SCALE FROM DRAWING

	9500
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APPLICATION

THIRD ANGLE PROJECTION

TOLERANCES

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.XX ±.015
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DRAWN	FURRY	4/7/2016
APPROVED	BB	4/7/2016
ISSUED	DWF	5/24/2016

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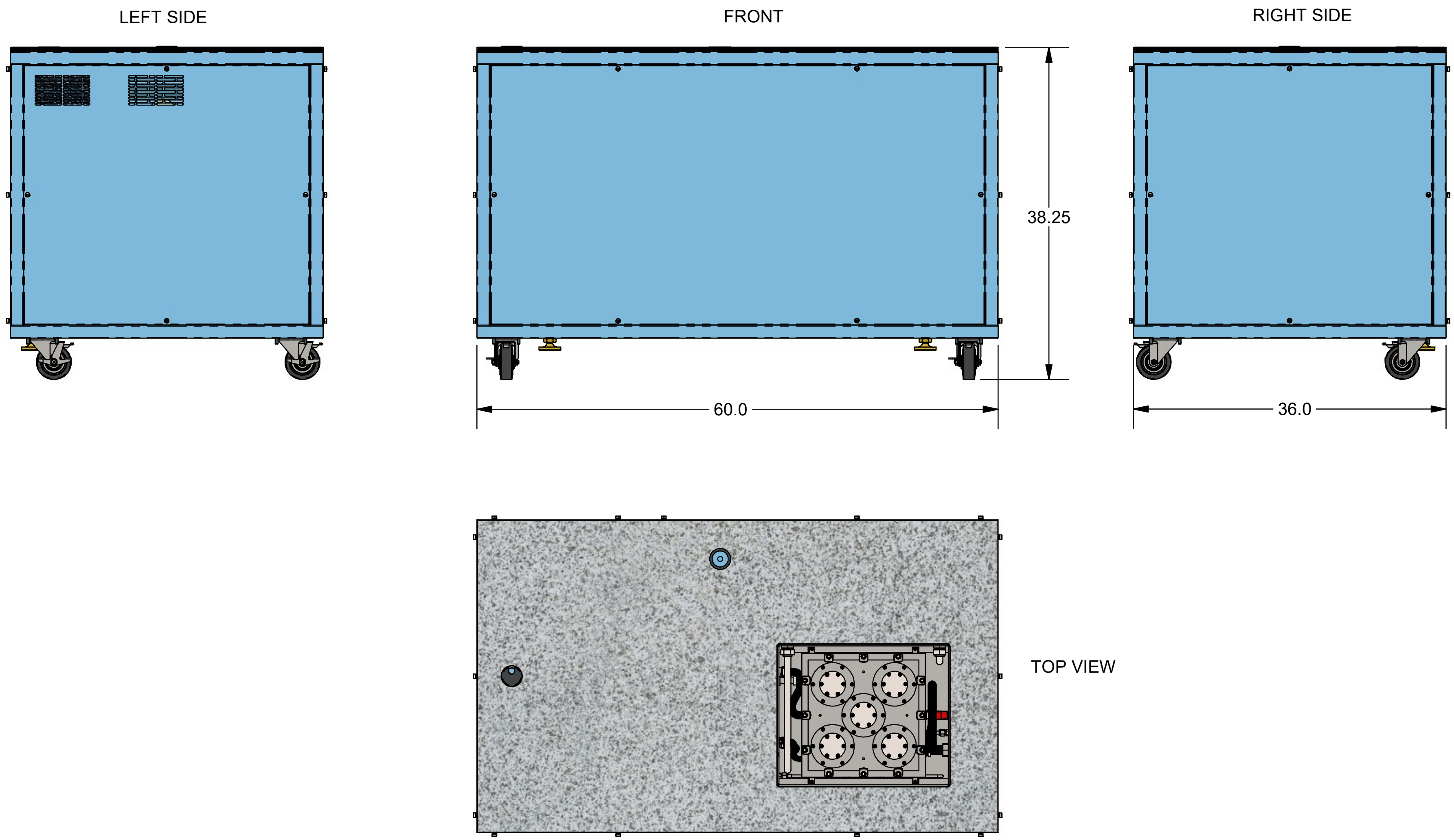
9500 Generator Components

SIZE	DWG. NO.	REV
A	9500D901	B
	WT. 1032.63	SHEET 1 OF 14



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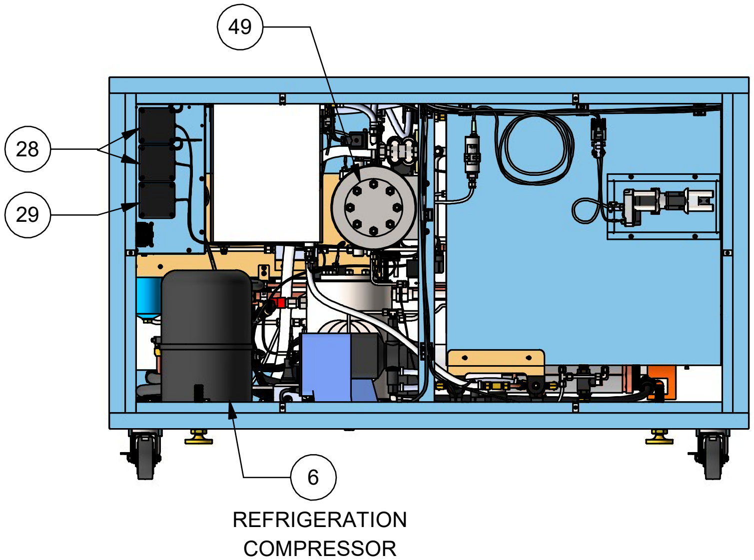
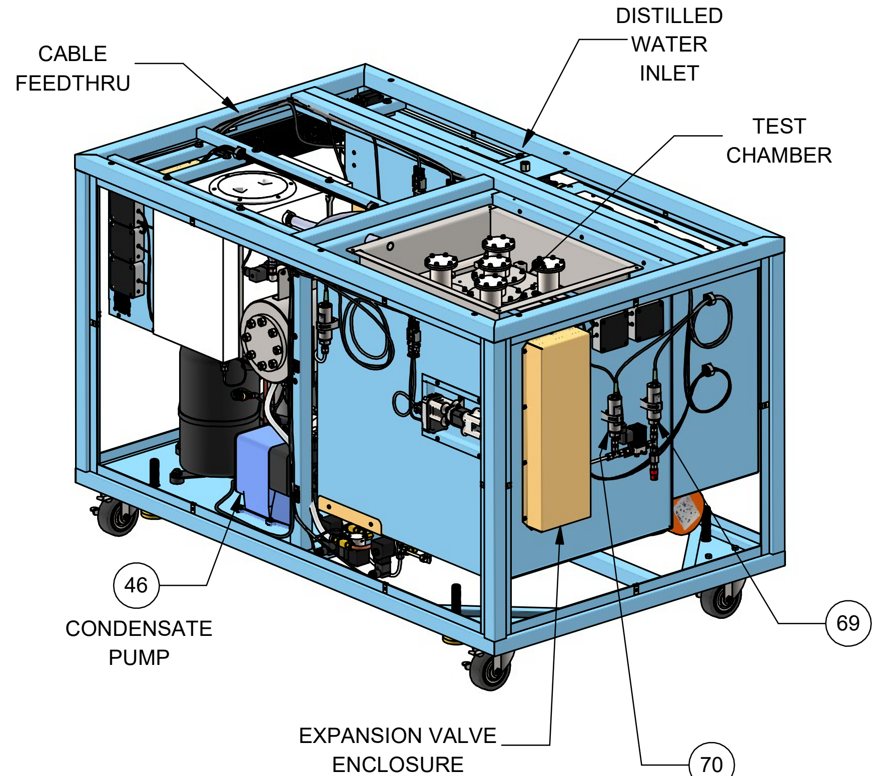
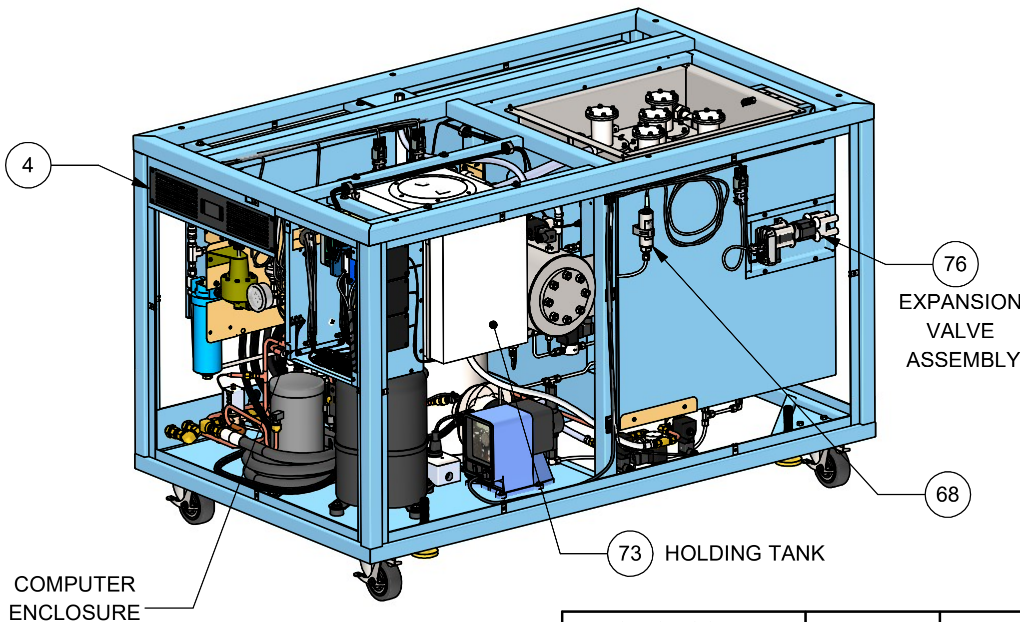
9500 Dimensional Drawing

SIZE	DWG. NO.	REV
A	9500D901	B
	WT. 983.78	SHEET 2 OF 14







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APPROVED	BB	4/7/2016
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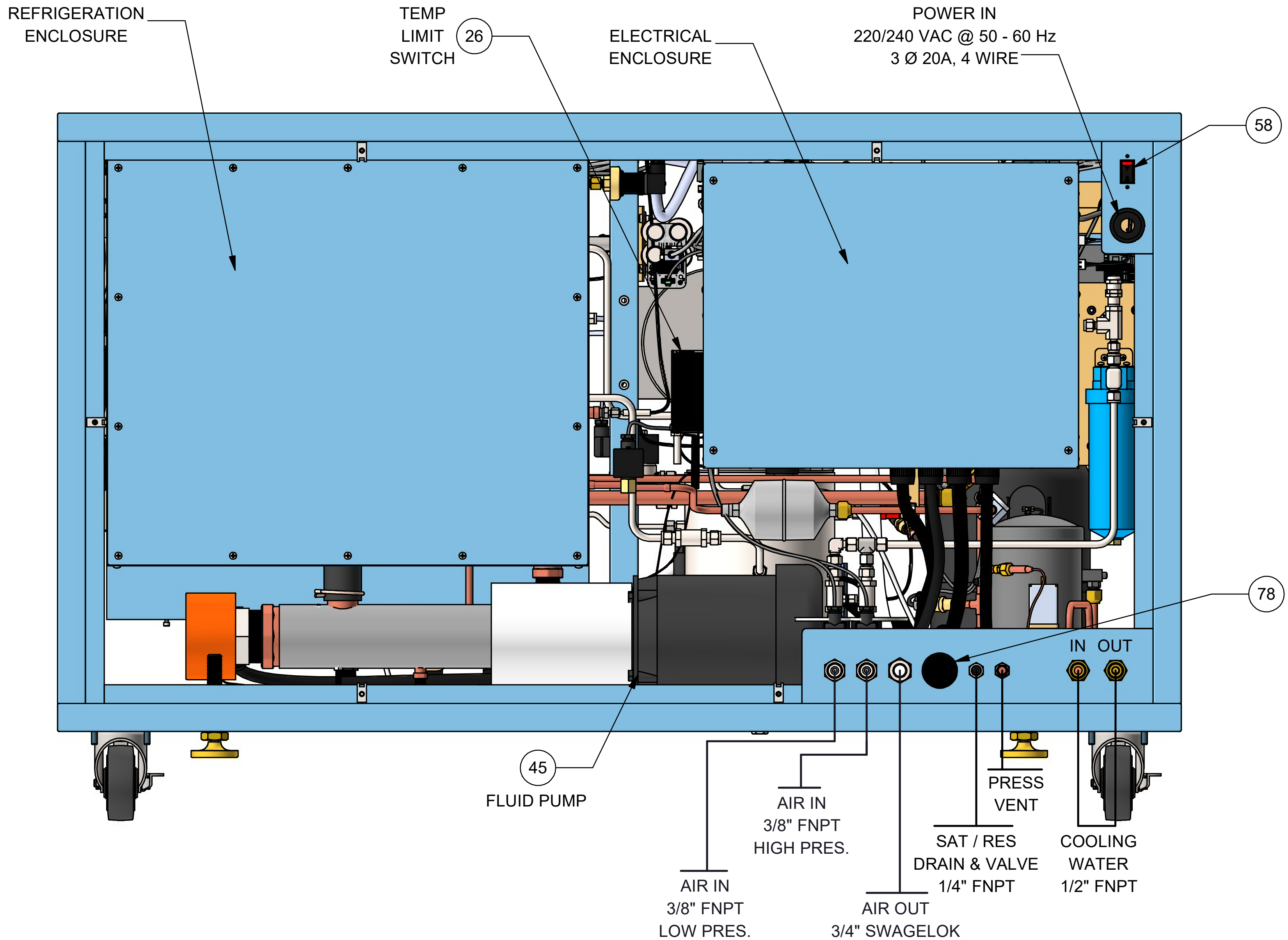
9500 Components

SIZE	DWG. NO.	REV
A	9500D901	B
	WT. 1036.67	SHEET 3 OF 14



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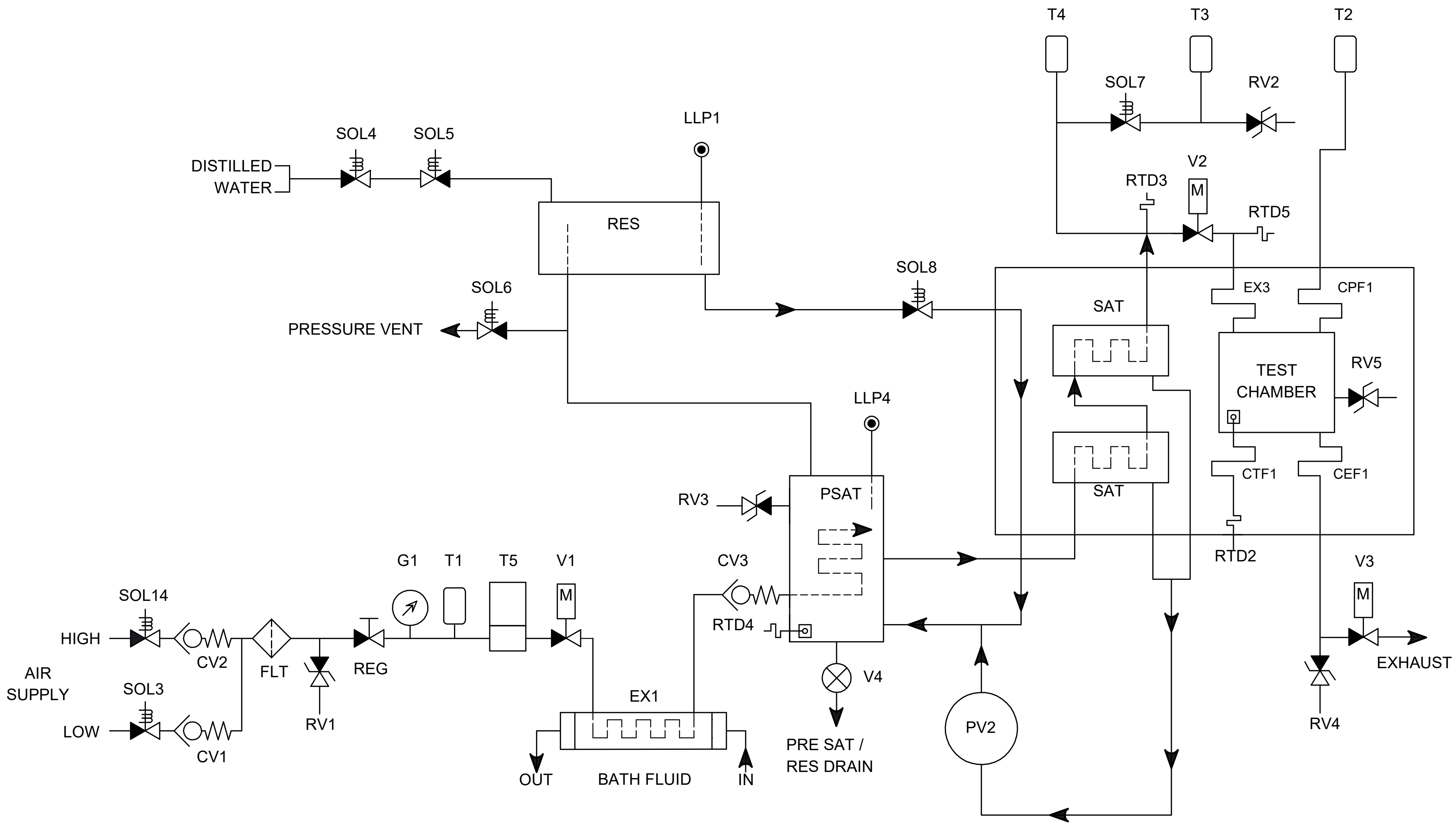
9500 Components

SIZE	DWG. NO.	REV
A	9500D901	B
	WT. 1036.67	SHEET 4 OF 14



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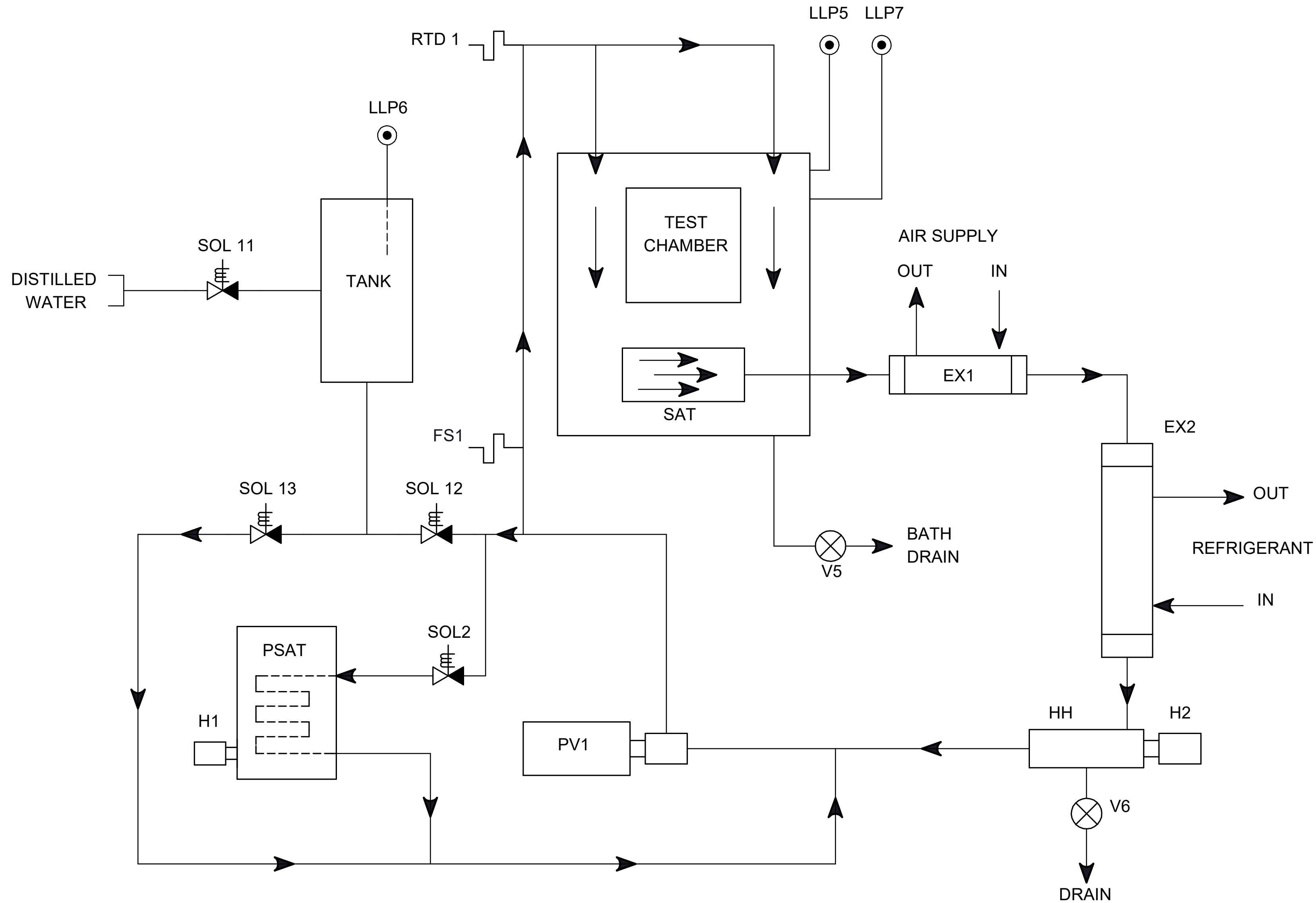
Pneumatic Schematic

SIZE	DWG. NO.	REV
A	9500D901	B
	WT. 1036.67	SHEET 5 OF 14



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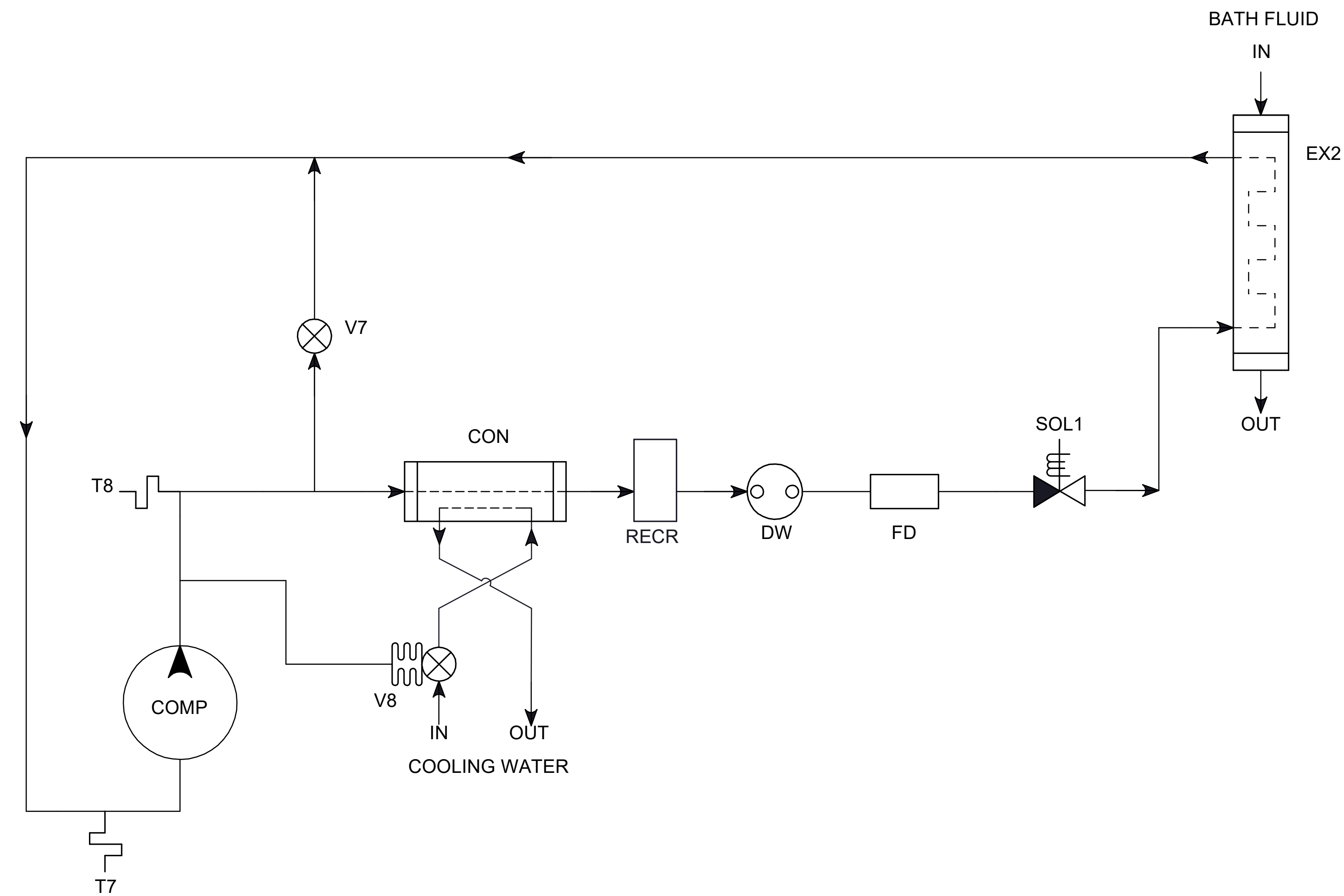
Fluid Schematic

SIZE	DWG. NO.	REV
A	9500D901	B
	WT. 1036.67	SHEET 6 OF 14



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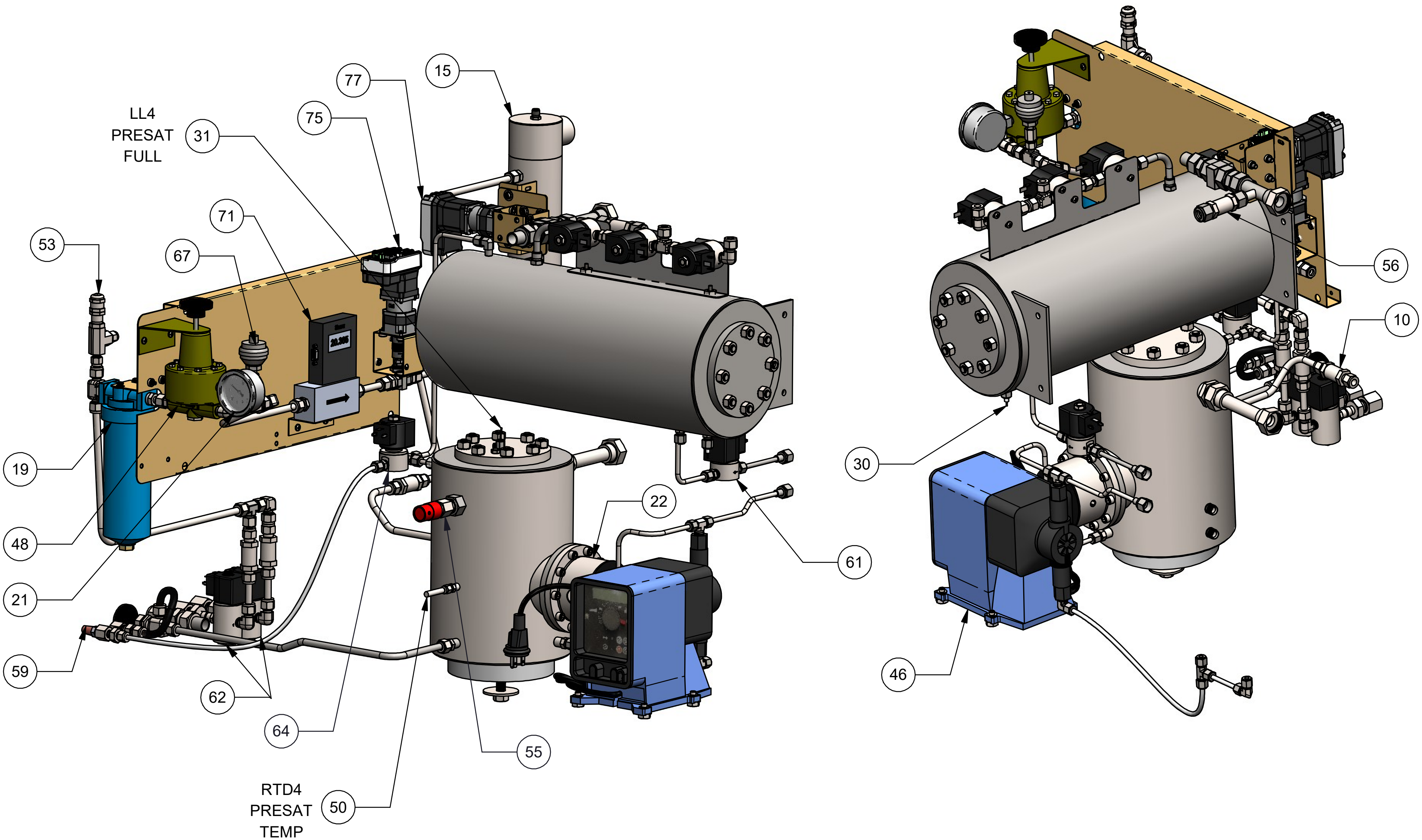
Refrigeration Schematic

SIZE	DWG. NO.	REV
A	9500D901	B
	WT. 1036.67	SHEET 7 OF 14



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	9500
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TOLERANCES
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ISSUED	DWF	5/24/2016

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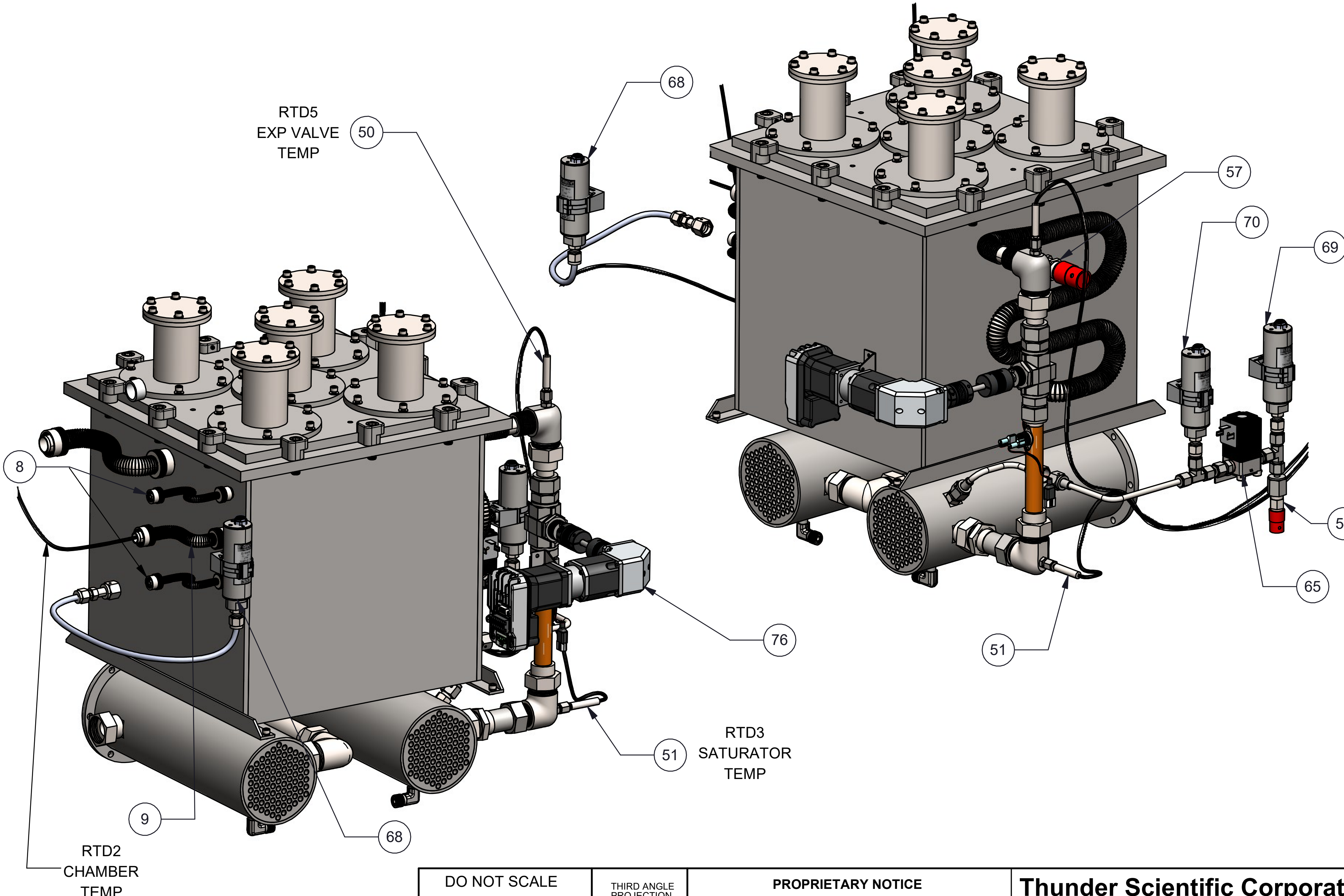
Pneumatic Components

SIZE	DWG. NO.	REV
A	9500D901	B
	WT. 1031.47	SHEET 8 OF 14



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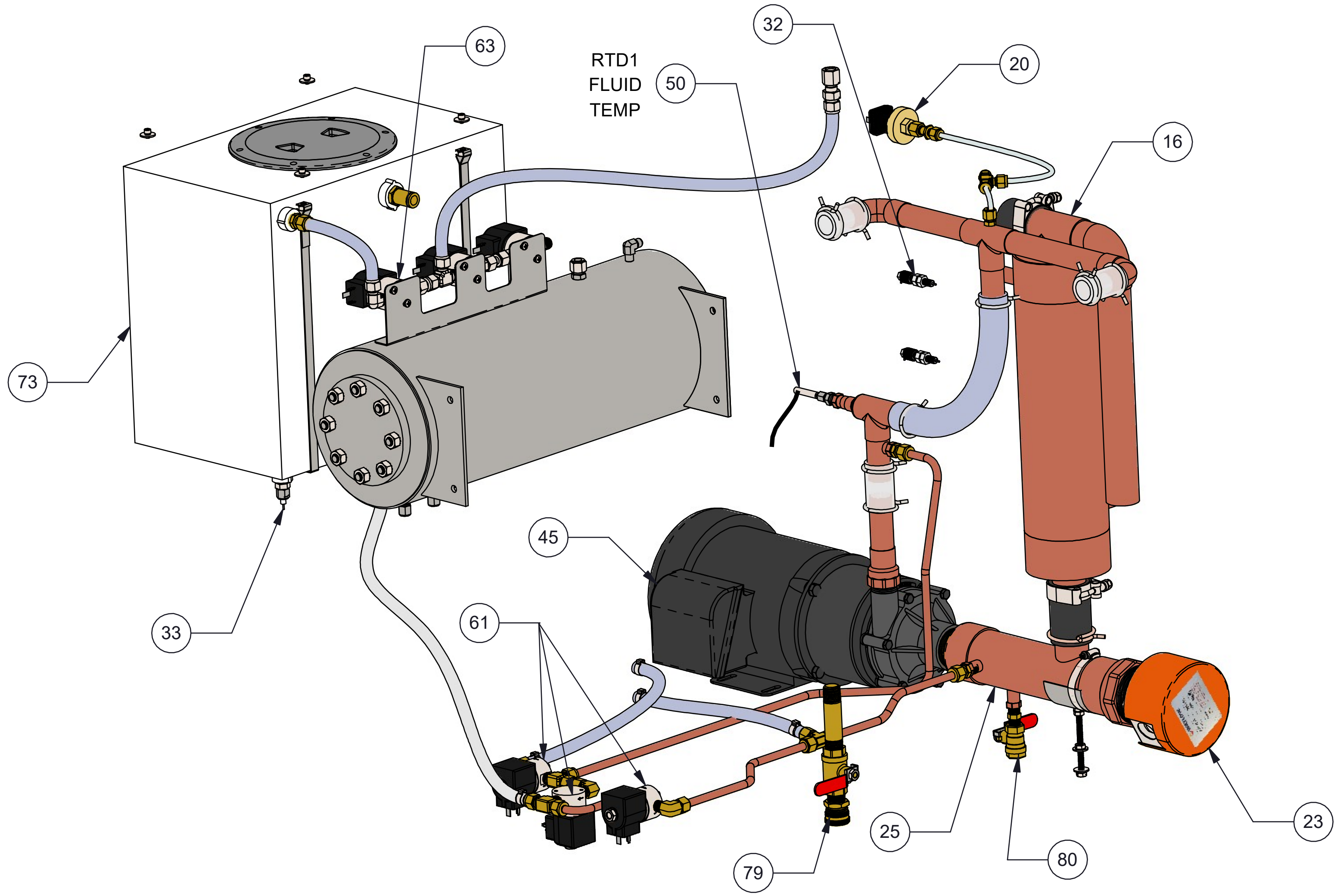
					Pneumatic Components
9500	TOLERANCES .XXX ±.010 .XX ±.015 ∠ ±.50° UNLESS NOTED OTHERWISE	DRAWN	FURRY	4/7/2016	SIZE A DWG. NO. 9500D901 REV B
NEXT ASSY / USED ON		APPROVED	BB	4/7/2016	
APPLICATION		ISSUED	DWF	5/24/2016	WT. 1031.47 SHEET 9 OF 14



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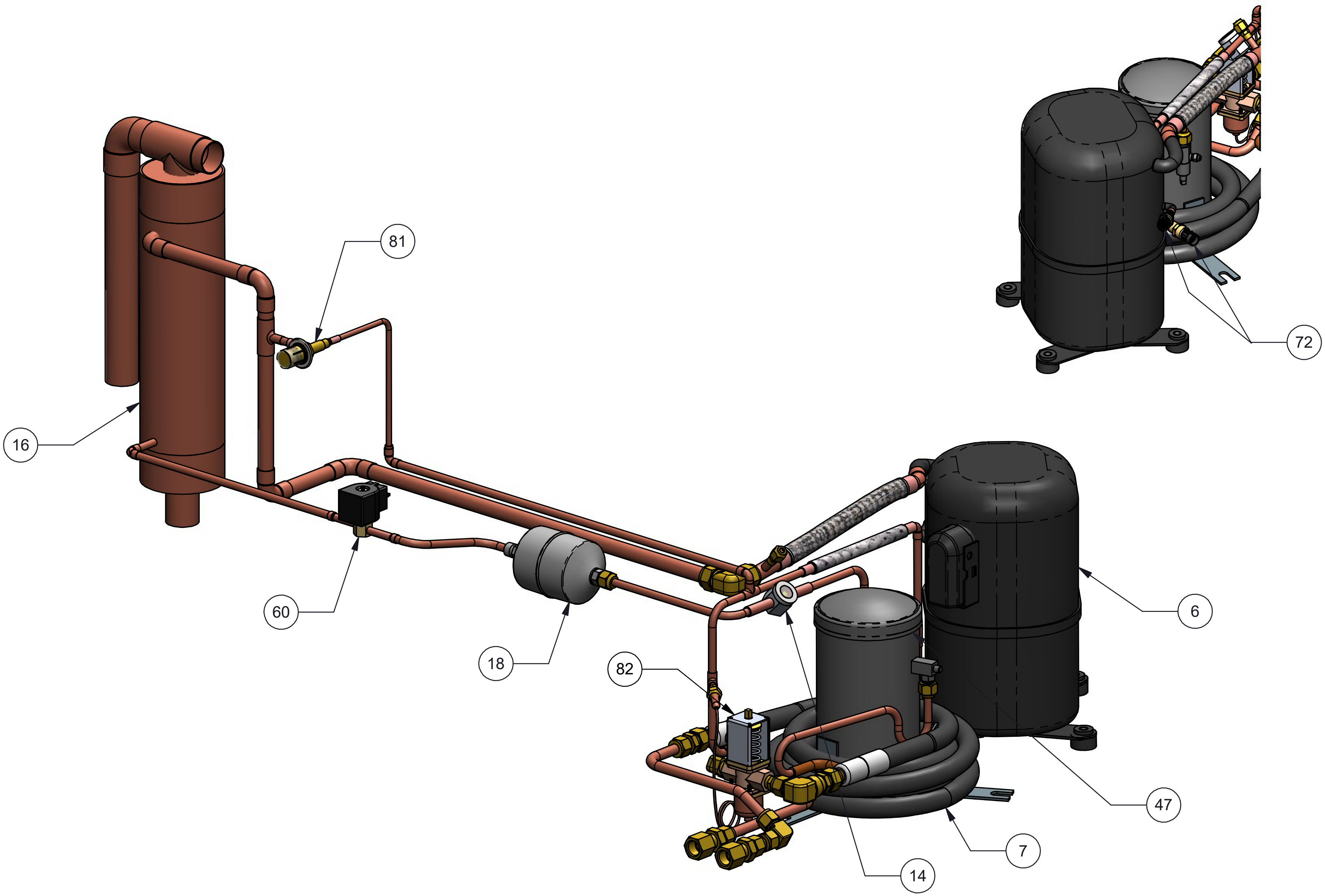
					Fluid Components
	9500	TOLERANCES .XXX ±.010 .XX ±.015 ∠ ±.50° UNLESS NOTED OTHERWISE	DRAWN FURRY	4/7/2016	SIZE A
NEXT ASSY	USED ON		APPROVED BB	4/7/2016	DWG. NO. 9500D901 REV B
APPLICATION			ISSUED DWF	5/24/2016	WT. 1031.47 SHEET 10 OF 14



DO NOT SCALE FROM DRAWING	
	9500
NEXT ASSY	USED ON
APPLICATION	

THIRD ANGLE PROJECTION

PROPRIETARY NOTICE

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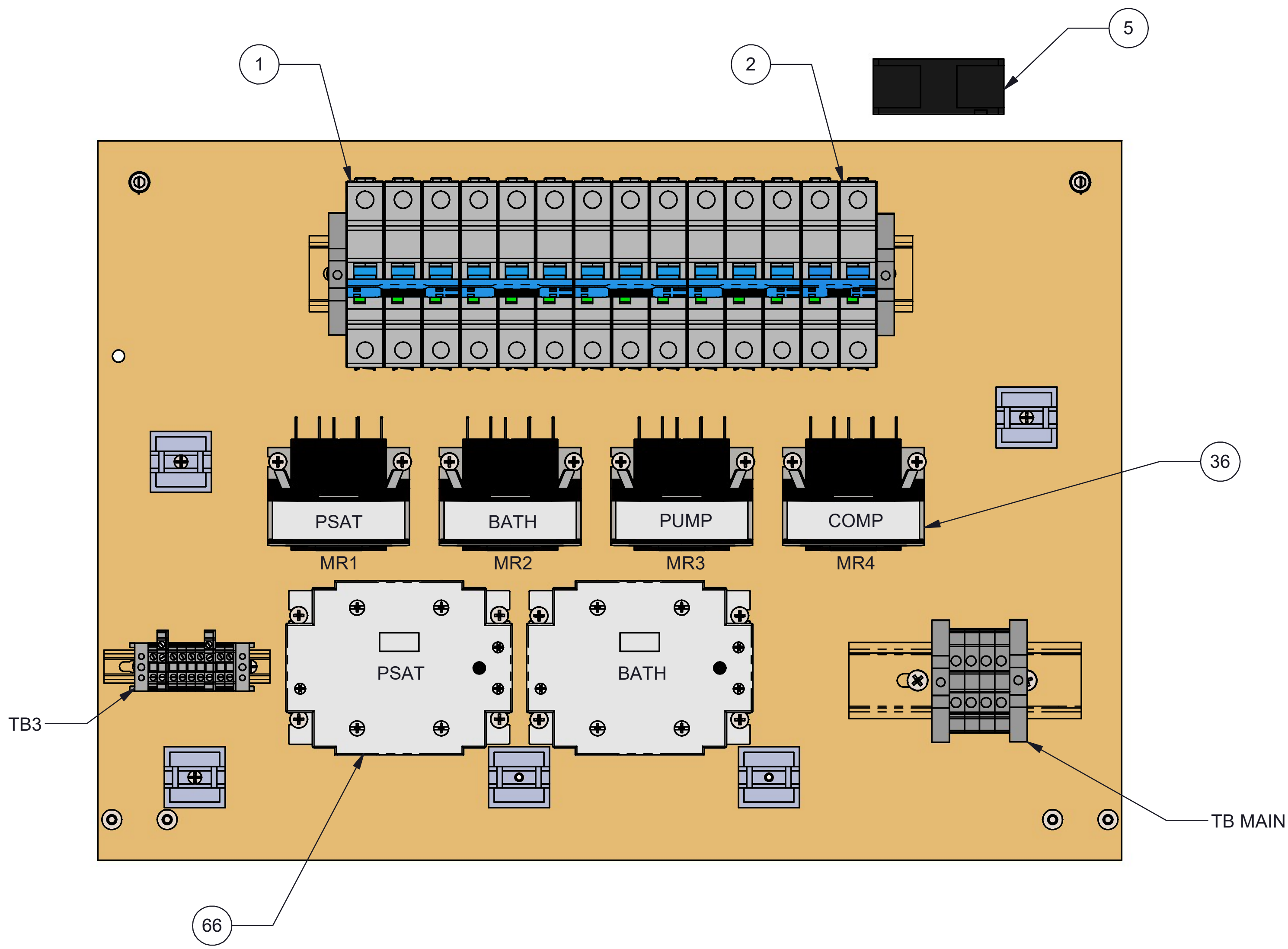
TOLERANCES
.XXX ±.010
.XX ±.015
∠ ±.50°
UNLESS NOTED OTHERWISE

DRAWN	FURRY	4/7/2016
APPROVED	BB	4/7/2016
ISSUED	DWF	5/24/2016

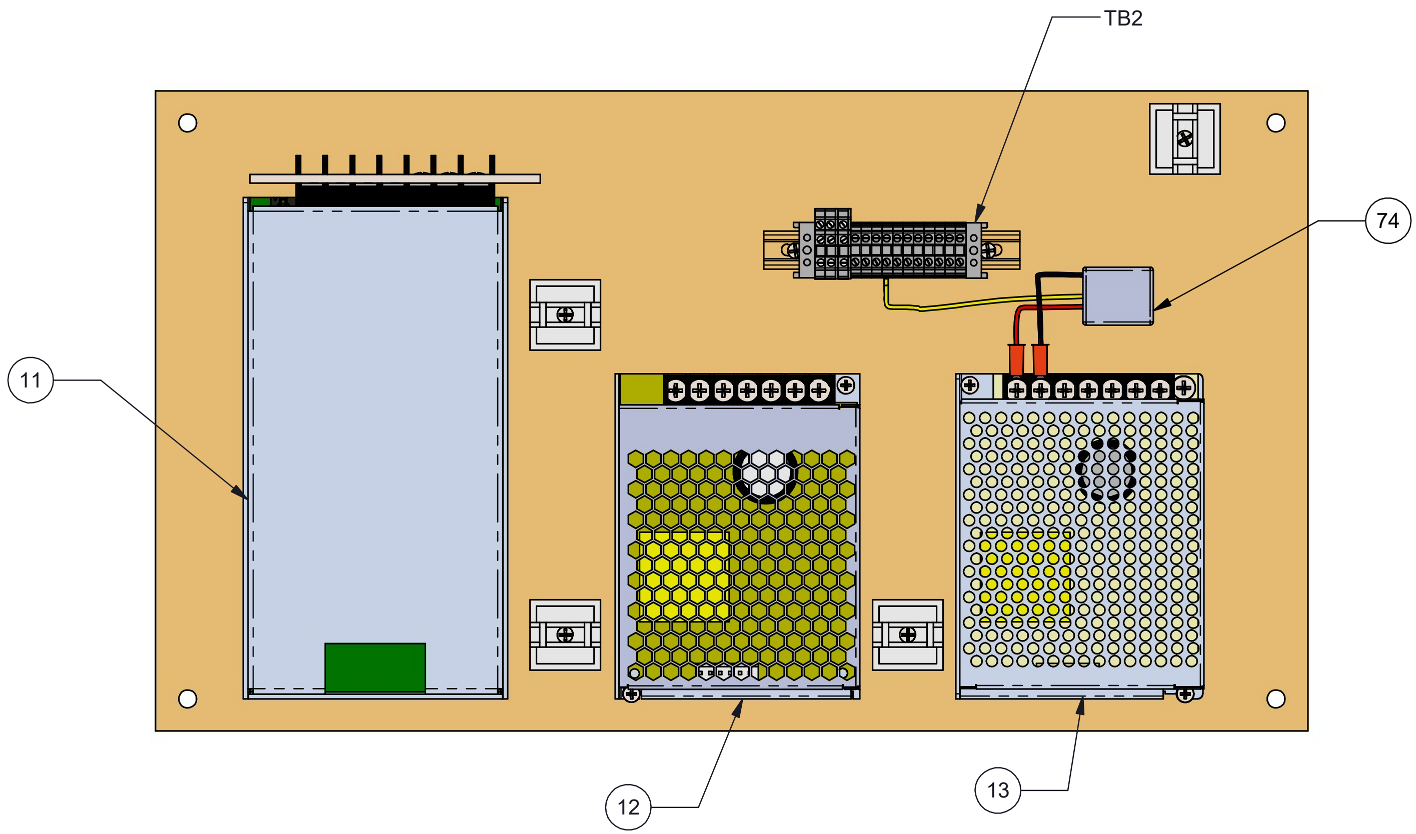
Thunder Scientific Corporation
623 Wyoming S.E. Albuquerque, NM 87123

Refrigeration Components

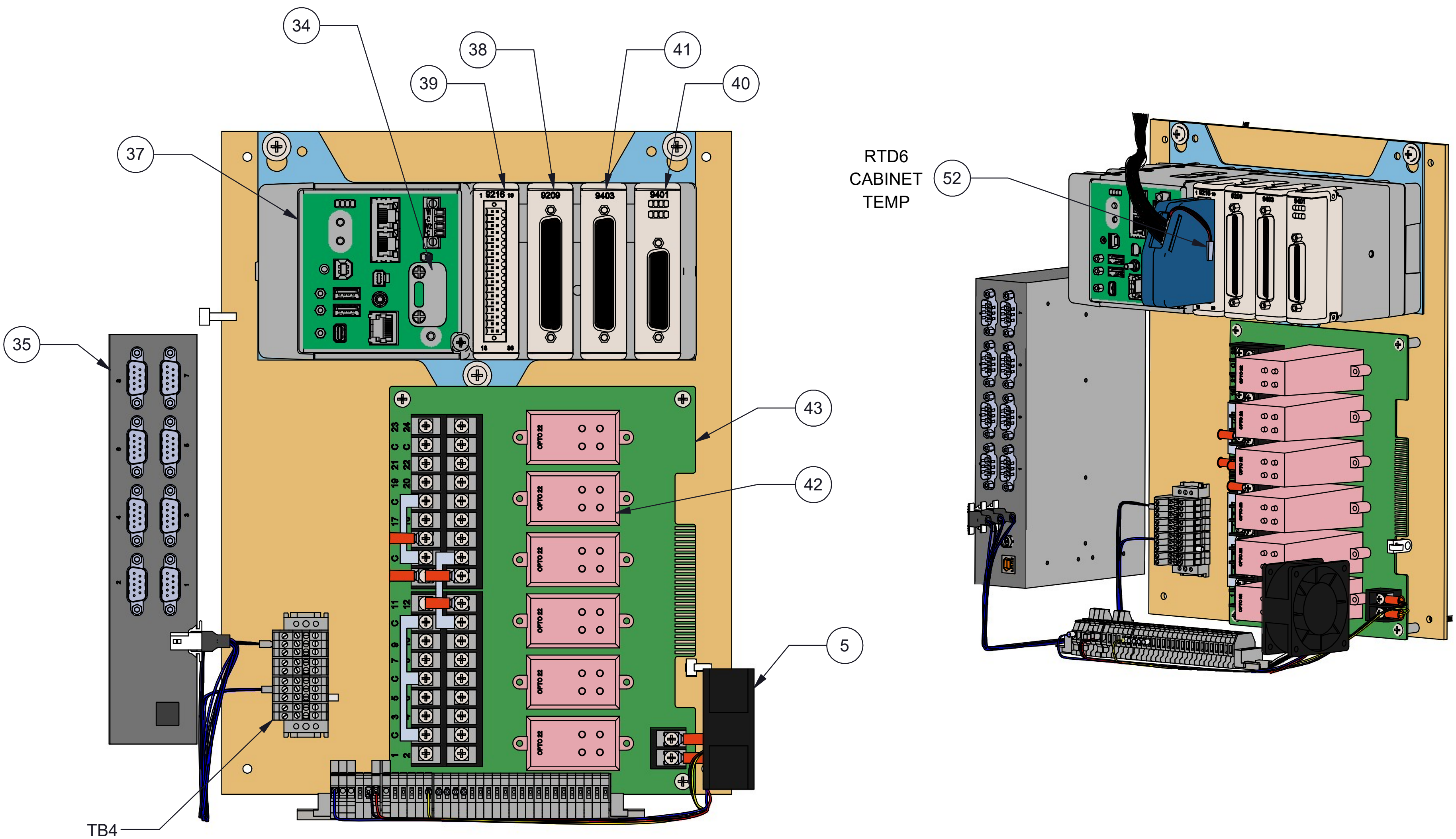
SIZE	DWG. NO.	REV
A	9500D901	B
	WT. 1031.47	SHEET 11 OF 14



DO NOT SCALE FROM DRAWING	THIRD ANGLE PROJECTION	PROPRIETARY NOTICE THIS DRAWING AND INFORMATION CONTAINED WITHIN IS PROPRIETARY TO THUNDER SCIENTIFIC AND CANNOT BE COPIED OR REPRODUCED WITHOUT SPECIFIC WRITTEN PERMISSION		**Thunder Scientific Corporation** 623 Wyoming S.E. Albuquerque, NM 87123
	TOLERANCES .XXX ±.010 .XX ±.015 ∠ ±.50° UNLESS NOTED OTHERWISE	DRAWN FURRY	4/7/2016	Electrical Main Panel
9500		APPROVED BB	4/7/2016	SIZE A / DWG. NO. 9500D901 / REV B
NEXT ASSY / USED ON		ISSUED DWF	5/24/2016	WT. 1031.47 / SHEET 12 OF 14
APPLICATION				



DO NOT SCALE FROM DRAWING	THIRD ANGLE PROJECTION	**PROPRIETARY NOTICE** THIS DRAWING AND INFORMATION CONTAINED WITHIN IS PROPRIETARY TO THUNDER SCIENTIFIC AND CANNOT BE COPIED OR REPRODUCED WITHOUT SPECIFIC WRITTEN PERMISSION		**Thunder Scientific Corporation** 623 Wyoming S.E. Albuquerque, NM 87123	
	TOLERANCES .XXX ±.010 .XX ±.015 ∠ ±.50° UNLESS NOTED OTHERWISE	DRAWN FURRY	4/7/2016	Electrical Sub Panel	
9500		APPROVED BB	4/7/2016	SIZE A	DWG. NO. 9500D901 REV B
NEXT ASSY / USED ON		ISSUED DWF	5/24/2016	WT. 1031.47	SHEET 13 OF 14
APPLICATION					



DO NOT SCALE FROM DRAWING		THIRD ANGLE PROJECTION	PROPRIETARY NOTICE THIS DRAWING AND INFORMATION CONTAINED WITHIN IS PROPRIETARY TO THUNDER SCIENTIFIC AND CANNOT BE COPIED OR REPRODUCED WITHOUT SPECIFIC WRITTEN PERMISSION
	9500		
NEXT ASSY	USED ON		
APPLICATION			

Thunder Scientific Corporation
623 Wyoming S.E. Albuquerque, NM 87123

Computer Components

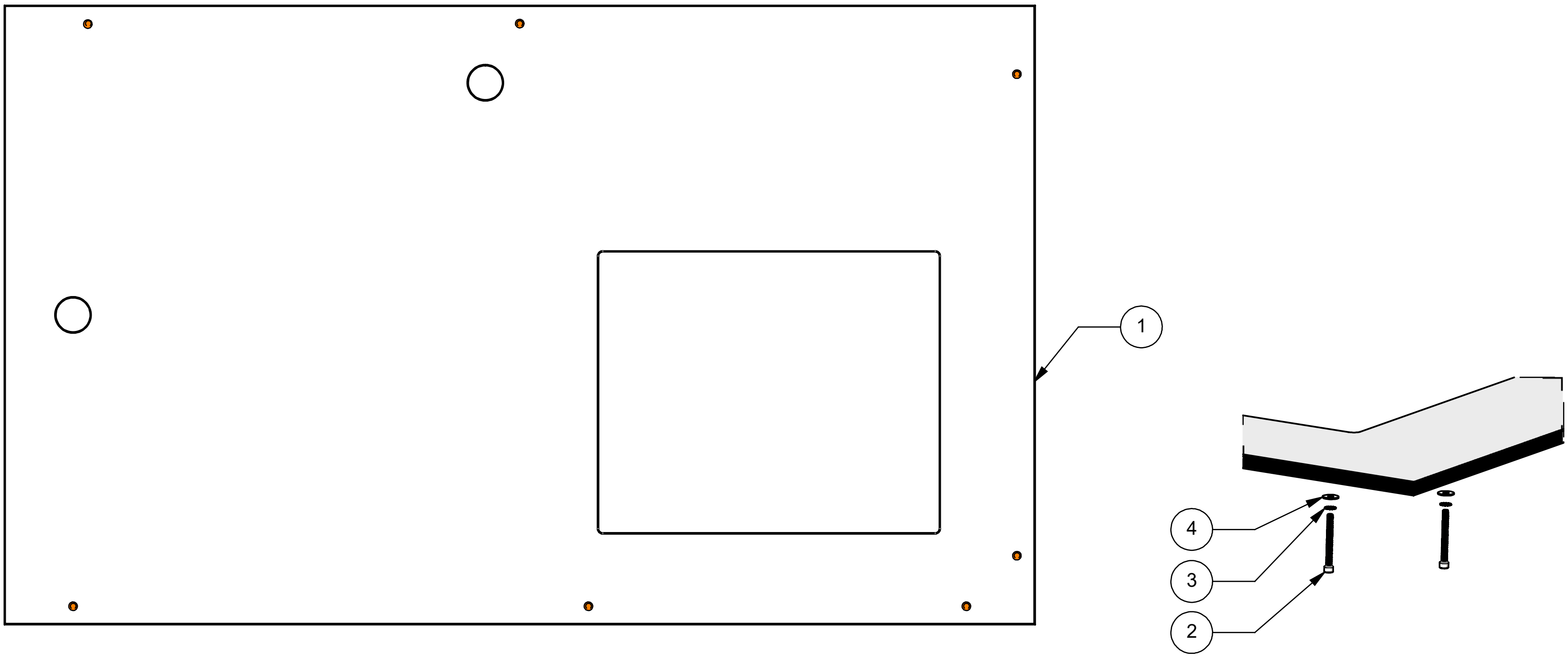
TOLERANCES			
.XXX ±.010	DRAWN	FURRY	4/7/2016
.XX ±.015	APPROVED	BB	4/7/2016
∠ ±.50°	ISSUED	DWF	5/24/2016
UNLESS NOTED OTHERWISE			

SIZE	DWG. NO.	REV
A	9500D901	B
	WT. 1031.47	SHEET 14 OF 14

REVISIONS				
DWN	REV.	DESCRIPTION	DATE	APP. BY
DWF	A	NEW ASSEMBLY FOR .50 THICK TOP	12/13/2021	BB

NOTES:

1. INTERPRET DRAWING PER ASME Y14.100-2013
2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5-2018
3. ALL UNITS ARE INCHES U.N.O.
4. REMOVE ALL BURRS AND SHARP EDGES



ITEM NO.	TSC STOCKCODE	DESCRIPTION	MATERIAL SPEC / MFG. PART NUMBER	QTY
4	** N S I **	#10 FLAT WASHER	STEEL	7
3	** N S I **	#10 EXTERNAL TOOTH LOCK WASHER	STEEL	7
2	** N S I **	#10-32 X 1 7/8" SOCKET HEAD CAP SCREW	STAINLESS STEEL	7
1	D9500M299	9500 COUNTER TOP - .50	1/2" GRAY PHENOLIC RESIN	1

DO NOT SCALE FROM DRAWING

9500A001	9500
NEXT ASSY	USED ON
APPLICATION	

THIRD ANGLE PROJECTION

PROPRIETARY NOTICE

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TOLERANCES

.XXX ±.010
.XX ±.015
∠ ±.50°
UNLESS NOTED OTHERWISE

DRAWN	FURRY	5/10/2016
APPROVED	BB	5/10/2016
ISSUED	DWF	5/26/2016

Thunder Scientific Corporation

623 Wyoming S.E. Albuquerque, NM 87123

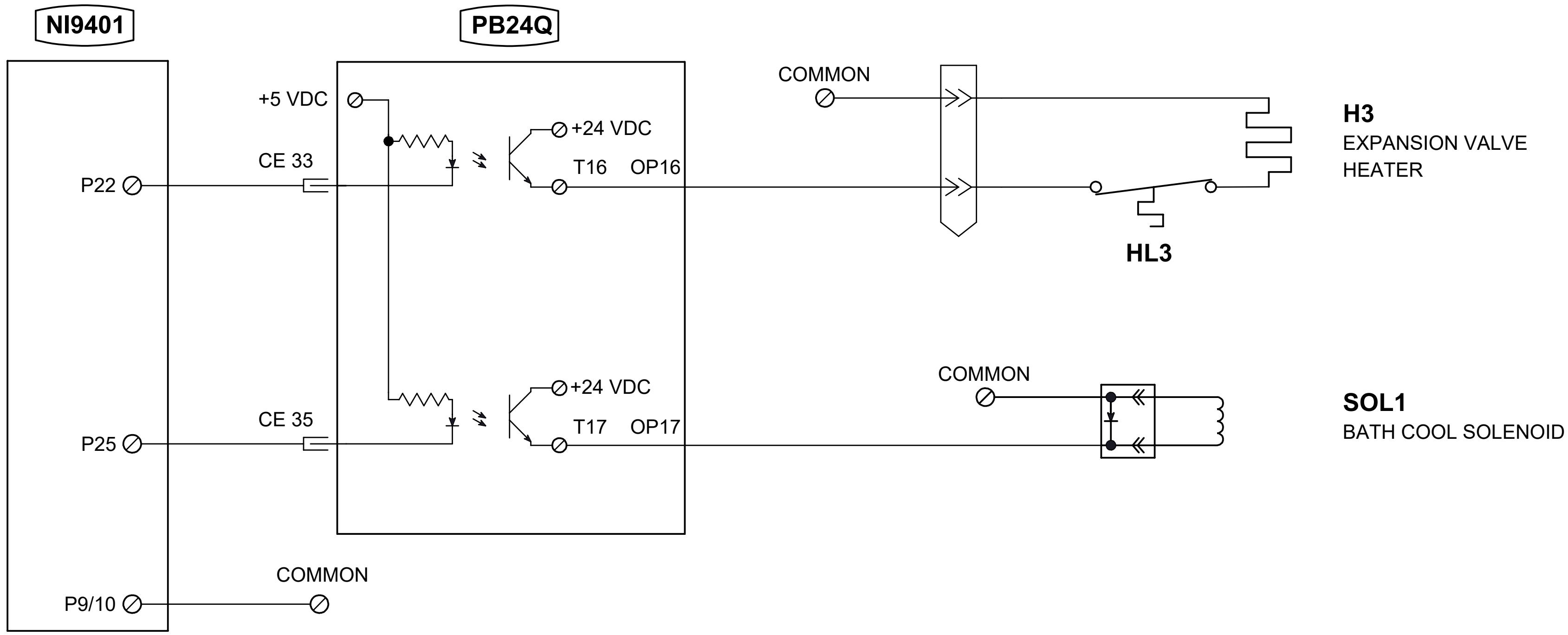
Counter Top Mounting Locations

SIZE	DWG. NO.	REV
A	9500D903	A
	WT. 46.56	SHEET 1 OF 1

NOTES:

1. INTERPRET DRAWING PER ASME Y14.100-2013
2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5-2018
3. ALL UNITS ARE INCHES U.N.O.
4. REMOVE ALL BURRS AND SHARP EDGES

REVISIONS				
DWN	REV.	DESCRIPTION	DATE	APP. BY
DWF	A	UPDATED OPTO PIN #	6/24/2021	BB

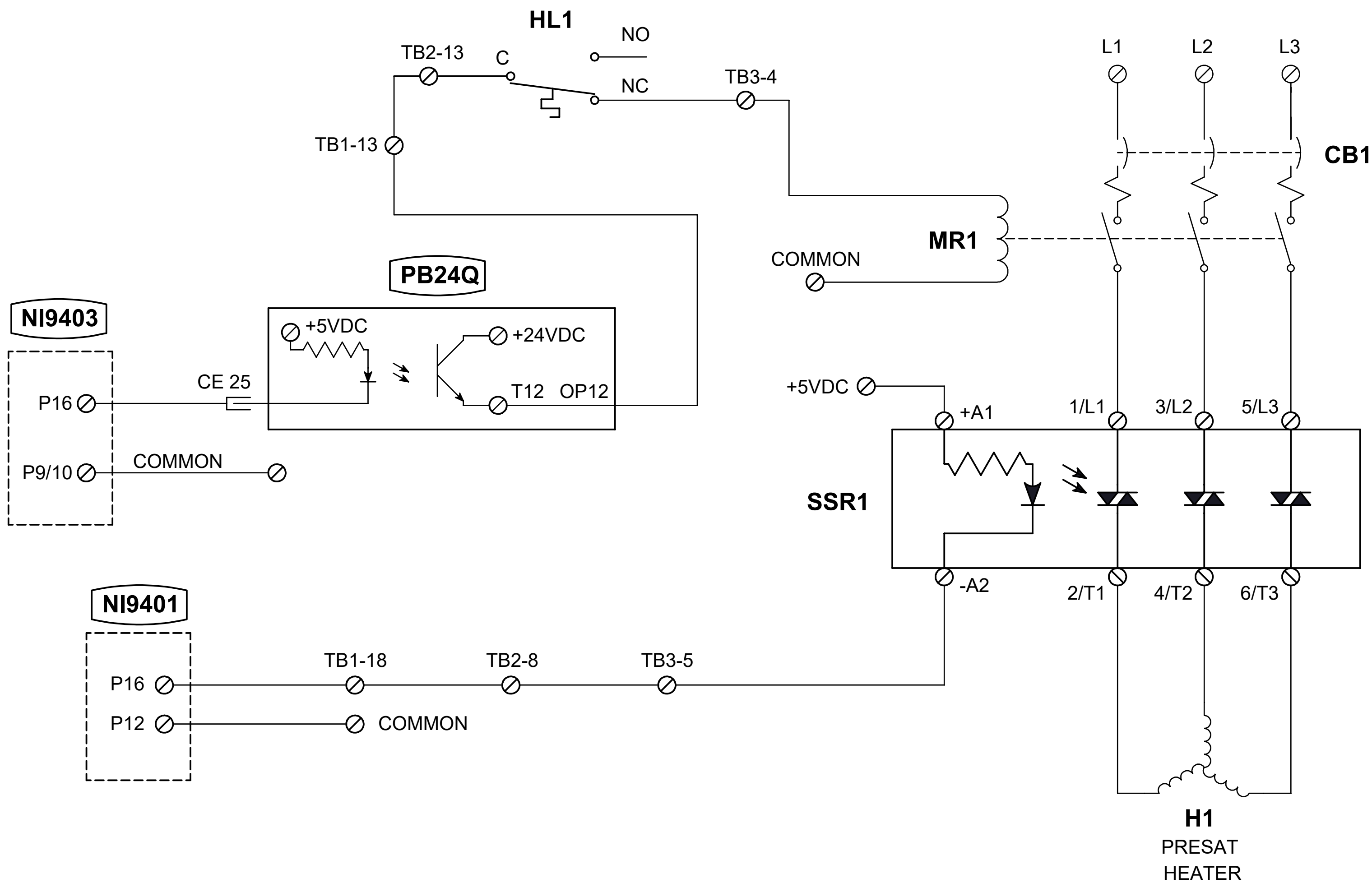


DO NOT SCALE FROM DRAWING		THIRD ANGLE PROJECTION	PROPRIETARY NOTICE THIS DRAWING AND INFORMATION CONTAINED WITHIN IS PROPRIETARY TO THUNDER SCIENTIFIC AND CANNOT BE COPIED OR REPRODUCED WITHOUT SPECIFIC WRITTEN PERMISSION			**Thunder Scientific Corporation** 623 Wyoming S.E. Albuquerque, NM 87123
		TOLERANCES .XXX ±.010 .XX ±.015 ∠ ±.50° UNLESS NOTED OTHERWISE	DRAWN	FURRY	5/12/2016	Exp. Heat / Solenoid Valve Control
	9500		APPROVED	BB	5/12/2016	SIZE A — DWG. NO. 9500S911 — REV A
NEXT ASSY	USED ON		ISSUED	DWF	5/26/2016	WT. N/A — SHEET 1 OF 1
APPLICATION						

NOTES:

1. INTERPRET DRAWING PER ASME Y14.100-2013
2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5-2018
3. ALL UNITS ARE INCHES U.N.O.
4. REMOVE ALL BURRS AND SHARP EDGES

REVISIONS				
DWN	REV.	DESCRIPTION	DATE	APP. BY
DWF	A	UPDATED OPTO & SSR PIN #	6/24/2021	BB



DO NOT SCALE FROM DRAWING

NEXT ASSY	USED ON
APPLICATION	

THIRD ANGLE PROJECTION

PROPRIETARY NOTICE

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TOLERANCES
.XXX ±.010
.XX ±.015
∠ ±.50°
UNLESS NOTED OTHERWISE

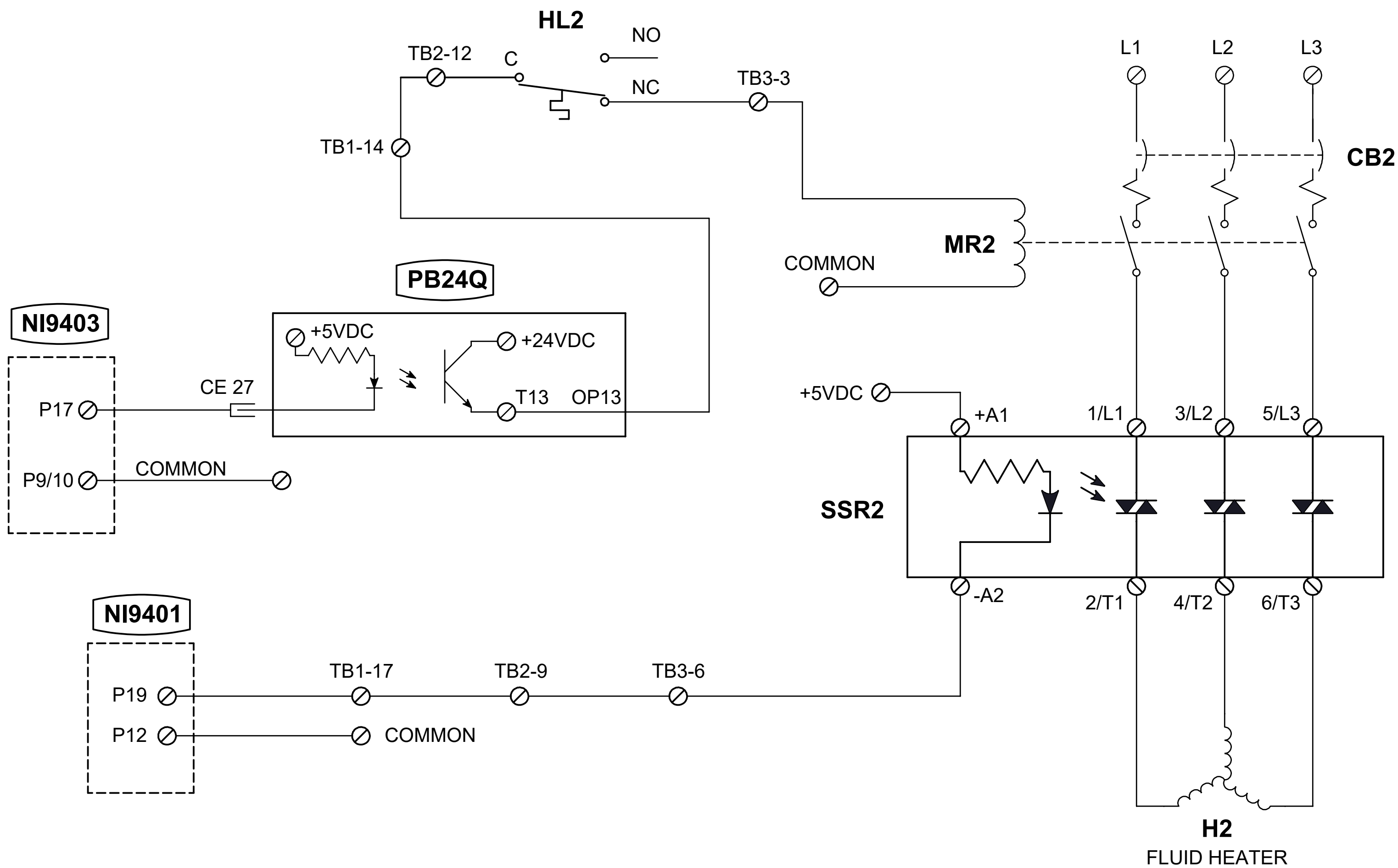
DRAWN	FURRY	5/11/2016
APPROVED	BB	5/12/2016
ISSUED	DWF	5/26/2016

Thunder Scientific Corporation
623 Wyoming S.E. Albuquerque, NM 87123

Pre Saturator Heater Schematic

SIZE	DWG. NO.	REV
A	9500S912	A
	WT. N/A	SHEET 1 OF 1

REVISIONS				
DWN	REV.	DESCRIPTION	DATE	APP. BY
DWF	A	UPDATED OPTO PIN #	8/2/2021	BB



DO NOT SCALE FROM DRAWING	
	9500
NEXT ASSY	USED ON
APPLICATION	

THIRD ANGLE PROJECTION

PROPRIETARY NOTICE

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TOLERANCES
.XXX ±.010
.XX ±.015
∠ ±.50°
UNLESS NOTED OTHERWISE

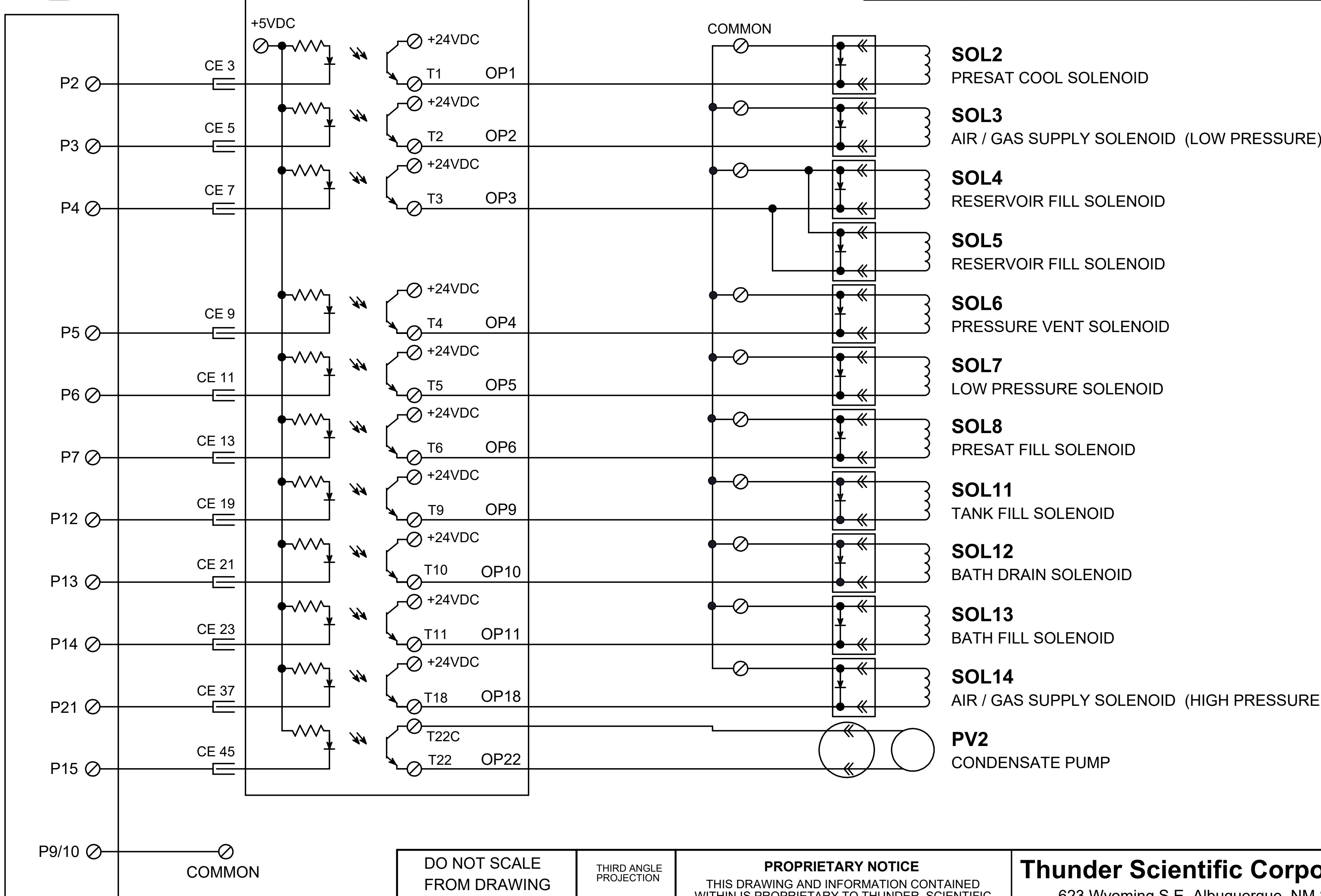
DRAWN	FURRY	5/11/2016
APPROVED	BB	5/11/2016
ISSUED	DWF	5/26/2016

Thunder Scientific Corporation
623 Wyoming S.E. Albuquerque, NM 87123

Bath Heater Schematic

SIZE	DWG. NO.	REV
A	9500S913	A
	WT. N/A	SHEET 1 OF 1

REVISIONS				
DWN	REV.	DESCRIPTION	DATE	APP. BY
DWF	A	UPDATED OPTO PIN #s - ADD SOL 14	8/2/2021	BB



DO NOT SCALE FROM DRAWING

	9500
NEXT ASSY	USED ON
APPLICATION	

THIRD ANGLE PROJECTION

PROPRIETARY NOTICE

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TOLERANCES
.XXX ±.010
.XX ±.015
∠ ±.50°
UNLESS NOTED OTHERWISE

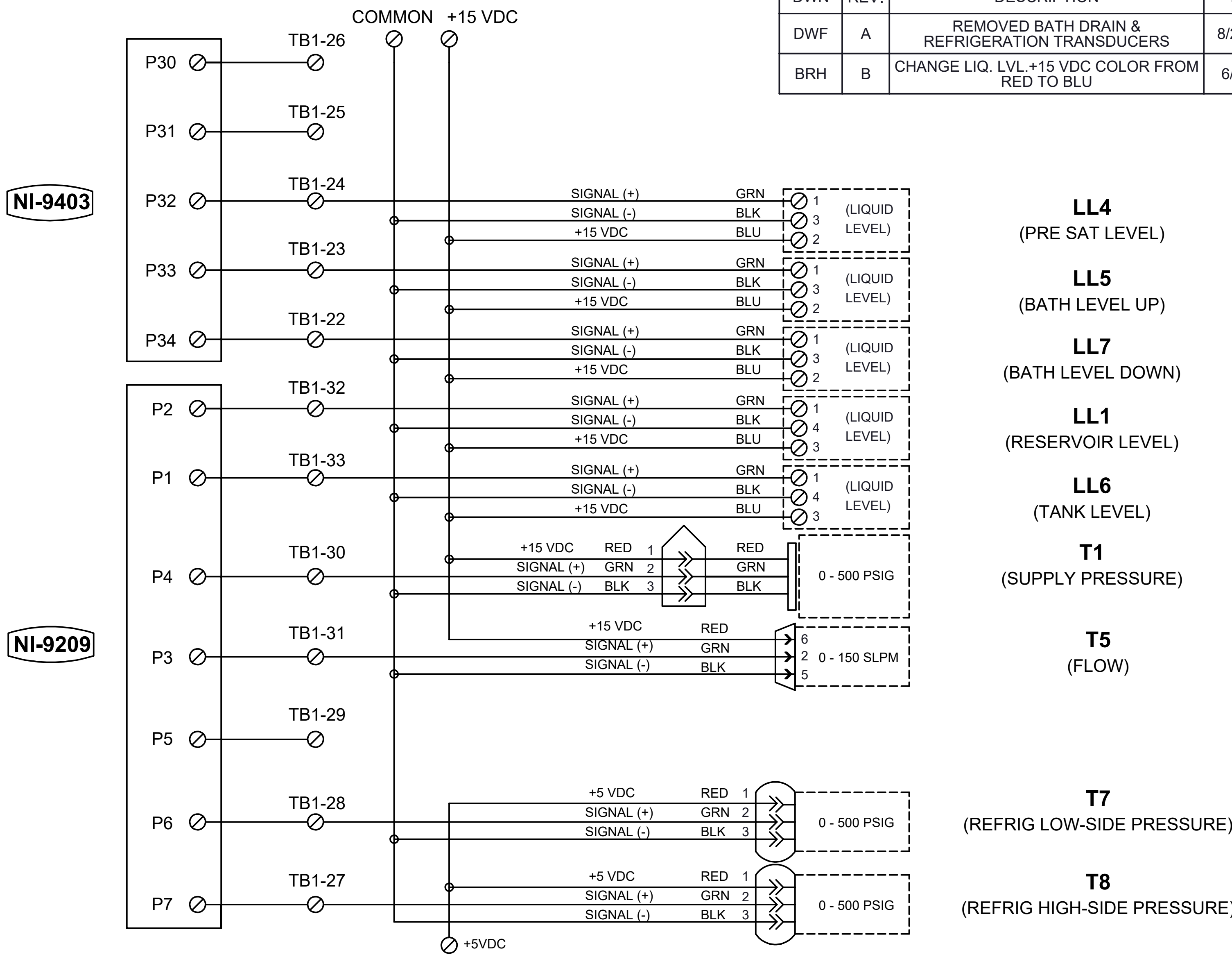
DRAWN	FURRY	5/12/2016
APPROVED	BB	5/12/2016
ISSUED	DWF	5/26/2016

Thunder Scientific Corporation
623 Wyoming S.E. Albuquerque, NM 87123

Solenoid Valve Control Schematic

SIZE	DWG. NO.	REV
A	9500S914	A
	WT. N/A	SHEET 1 OF 1

REVISIONS				
DWN	REV.	DESCRIPTION	DATE	APP. BY
DWF	A	REMOVED BATH DRAIN & REFRIGERATION TRANSDUCERS	8/26/2021	BB
BRH	B	CHANGE LIQ. LVL.+15 VDC COLOR FROM RED TO BLU	6/8/2022	BB



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		THIS DRAWING AND INFORMATION CONTAINED WITHIN IS PROPRIETARY TO THUNDER SCIENTIFIC AND CANNOT BE COPIED OR REPRODUCED WITHOUT SPECIFIC WRITTEN PERMISSION	623 Wyoming S.E. Albuquerque, NM 87123

	9500
NEXT ASSY	USED ON
APPLICATION	

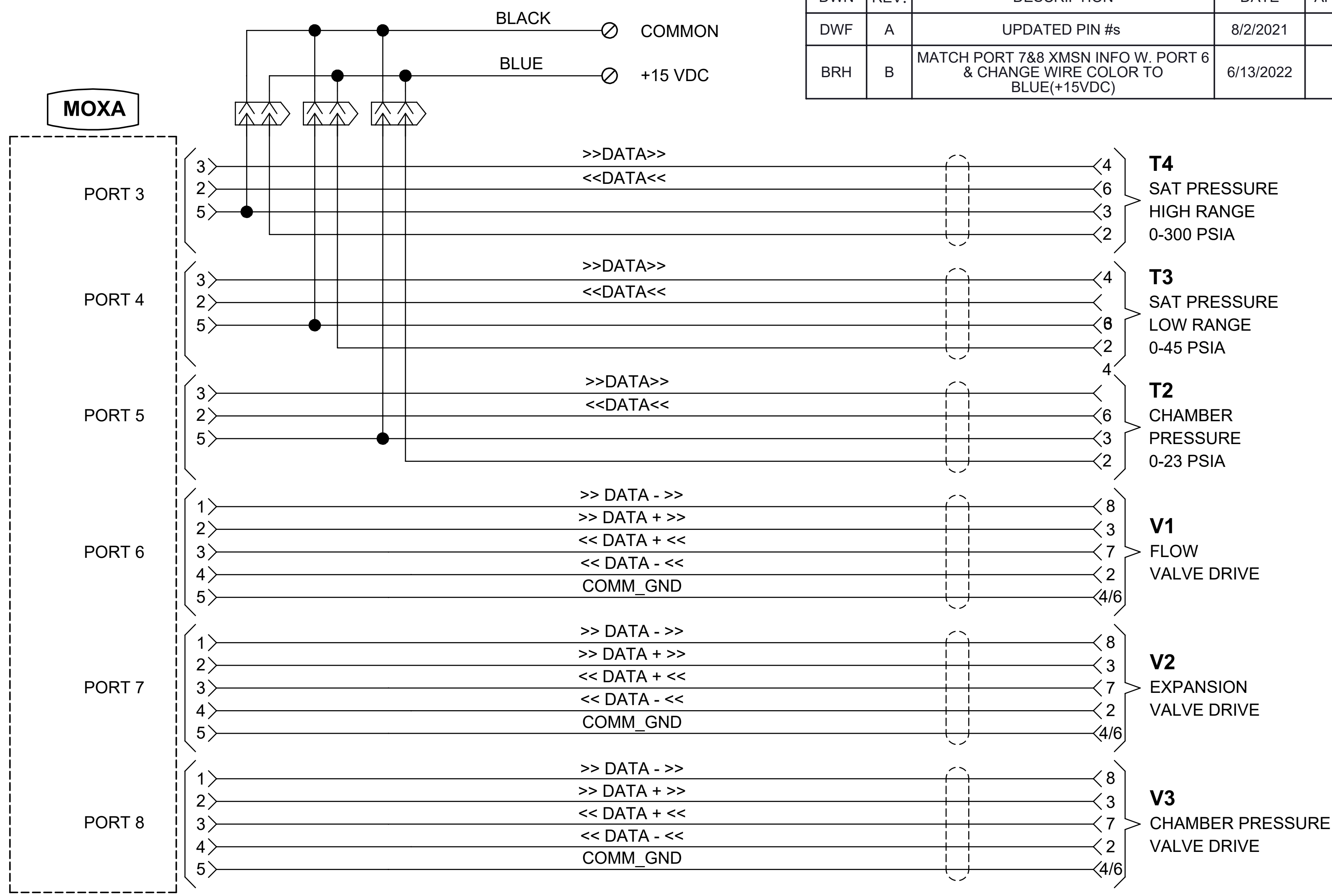
TOLERANCES
.XXX ±.010
.XX ±.015
∠ ±.50°
UNLESS NOTED OTHERWISE

DRAWN	FURRY	5/12/2016
APPROVED	BB	5/12/2016
ISSUED	DWF	5/26/2016

Transducer Schematic

SIZE	DWG. NO.	REV
A	9500S915	B
	WT. N/A	SHEET 1 OF 1

REVISIONS				
DWN	REV.	DESCRIPTION	DATE	APP. BY
DWF	A	UPDATED PIN #s	8/2/2021	BB
BRH	B	MATCH PORT 7&8 XMSN INFO W. PORT 6 & CHANGE WIRE COLOR TO BLUE(+15VDC)	6/13/2022	BB



DO NOT SCALE FROM DRAWING	
	9500
NEXT ASSY	USED ON
APPLICATION	

THIRD ANGLE PROJECTION

PROPRIETARY NOTICE

TOLERANCES
.XXX ±.010
.XX ±.015
∠ ±.50°
UNLESS NOTED OTHERWISE

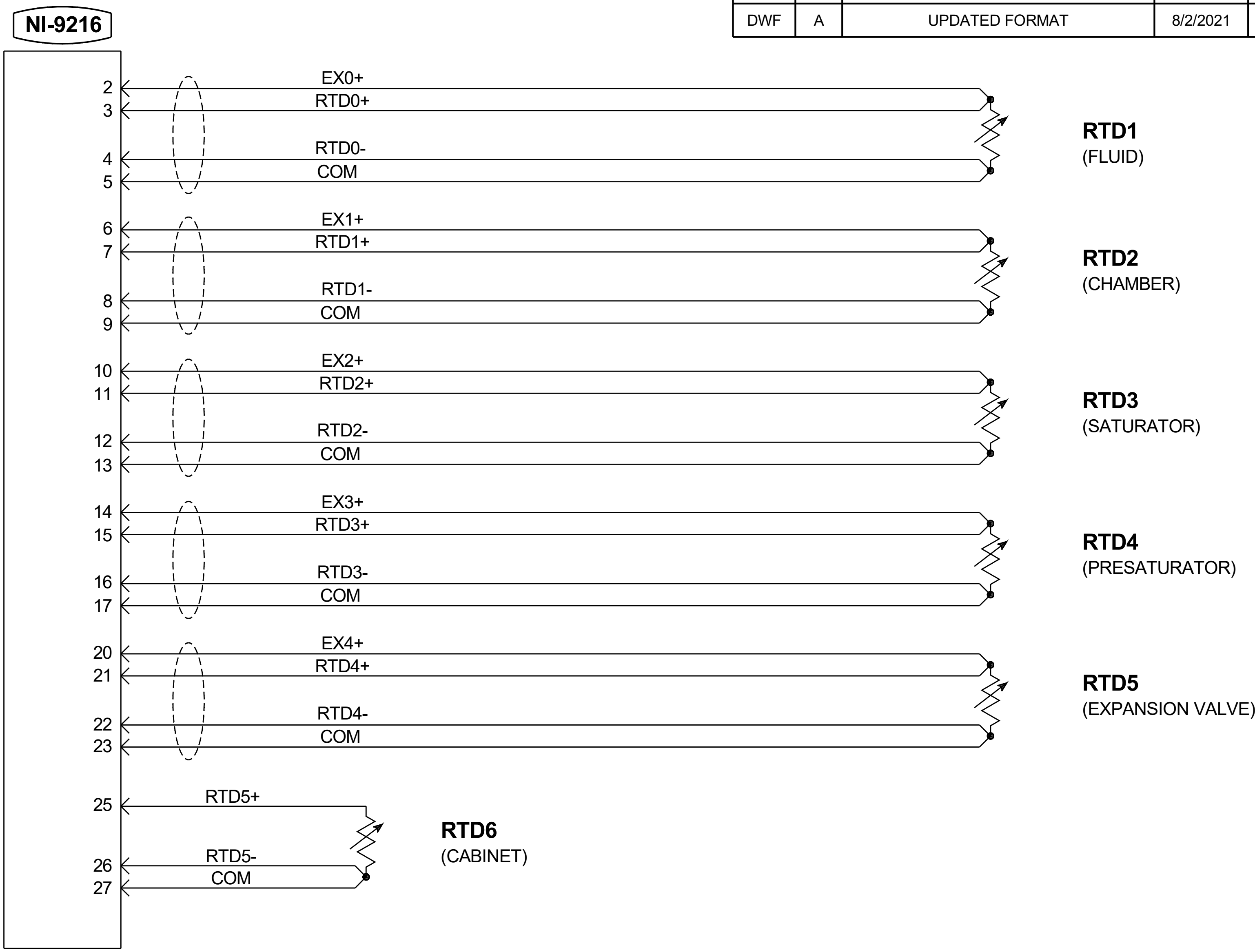
DRAWN	FURRY	5/27/2016
APPROVED	BB	5/27/2016
ISSUED	DWF	5/27/2016

Thunder Scientific Corporation
623 Wyoming S.E. Albuquerque, NM 87123

Pres Tran/Stepper Drive Schematic

SIZE	DWG. NO.	REV
A	9500S916	B
	WT. N/A	SHEET 1 OF 1

REVISIONS				
DWN	REV.	DESCRIPTION	DATE	APP. BY
DWF	A	UPDATED FORMAT	8/2/2021	BB



DO NOT SCALE FROM DRAWING	
	9500
NEXT ASSY	USED ON
APPLICATION	

THIRD ANGLE PROJECTION

PROPRIETARY NOTICE

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TOLERANCES
.XXX ±.010
.XX ±.015
∠ ±.50°
UNLESS NOTED OTHERWISE

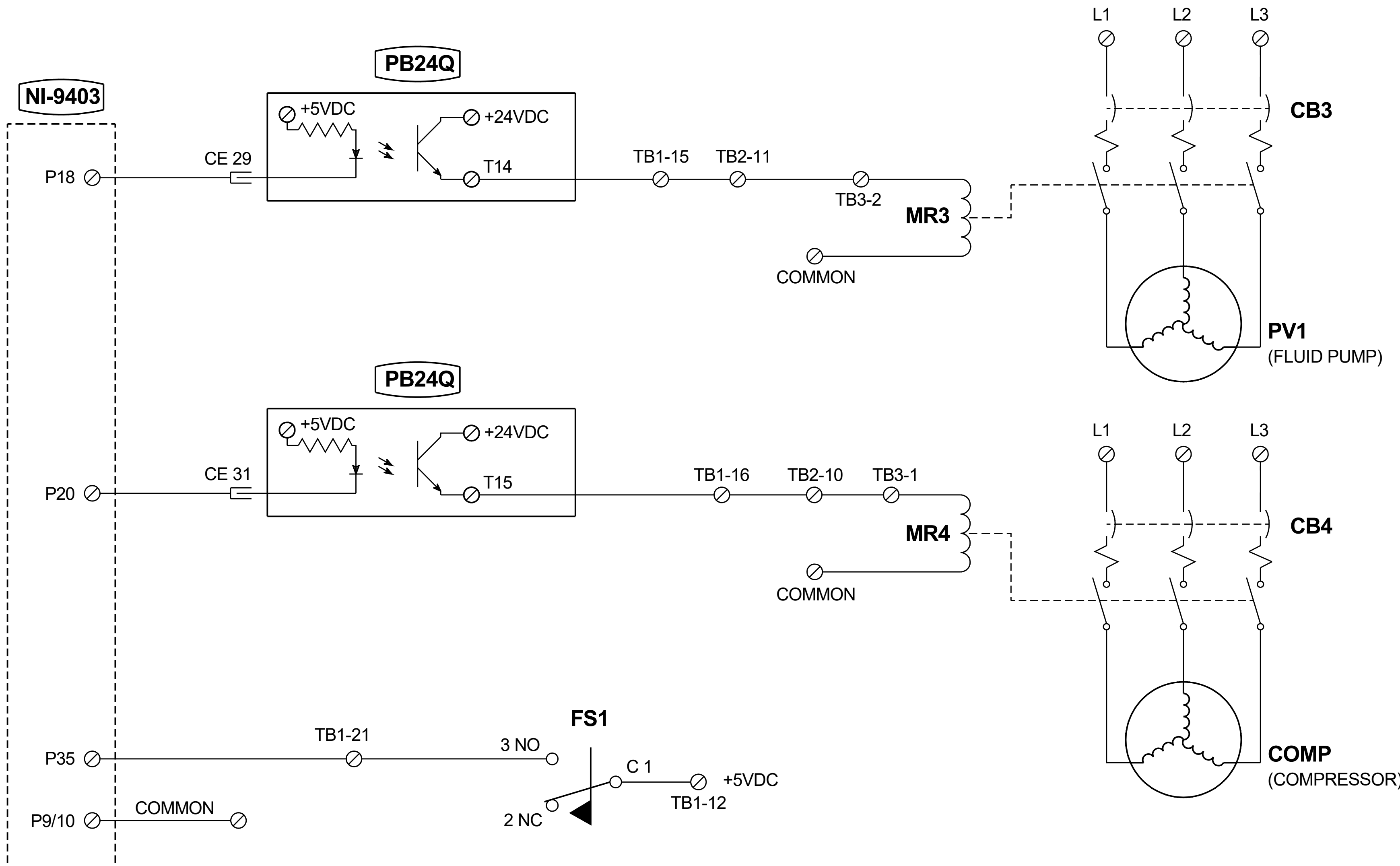
DRAWN	FURRY	5/31/2016
APPROVED	BB	5/31/2016
ISSUED	DWF	5/31/2016

Thunder Scientific Corporation
623 Wyoming S.E. Albuquerque, NM 87123

Temperature Probe Schematic

SIZE	DWG. NO.	REV
A	9500S917	A
	WT. N/A	SHEET 1 OF 1

REVISIONS				
DWN	REV.	DESCRIPTION	DATE	APP. BY
DWF	A	REMOVED HOURMETER	8/2/2021	BB



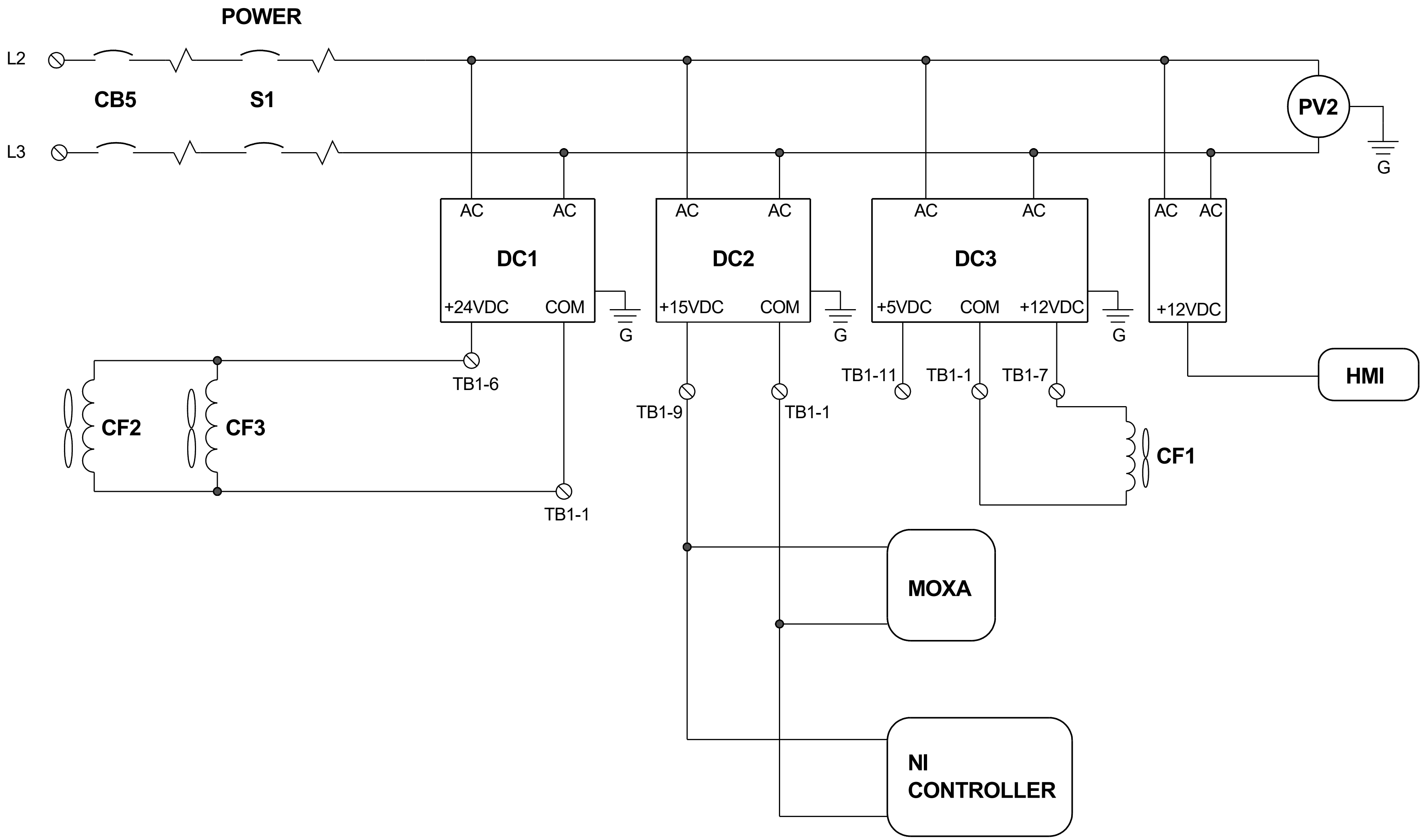
DO NOT SCALE FROM DRAWING		THIRD ANGLE PROJECTION	PROPRIETARY NOTICE THIS DRAWING AND INFORMATION CONTAINED WITHIN IS PROPRIETARY TO THUNDER SCIENTIFIC AND CANNOT BE COPIED OR REPRODUCED WITHOUT SPECIFIC WRITTEN PERMISSION		
	9500	TOLERANCES .XXX ±.010 .XX ±.015 ∠ ±.50° UNLESS NOTED OTHERWISE	DRAWN	FURRY	6/2/2016
NEXT ASSY	USED ON		APPROVED	BB	6/2/2016
APPLICATION			ISSUED	DWF	6/2/2016

Thunder Scientific Corporation
623 Wyoming S.E. Albuquerque, NM 87123

Pump / Comp / Flow Schematic

SIZE	DWG. NO.	REV
A	9500S918	A
	WT. N/A	SHEET 1 OF 1

REVISIONS				
DWN	REV.	DESCRIPTION	DATE	APP. BY
DWF	A	UPDATED POWER LINES - ADDED FAN	8/2/2021	BB

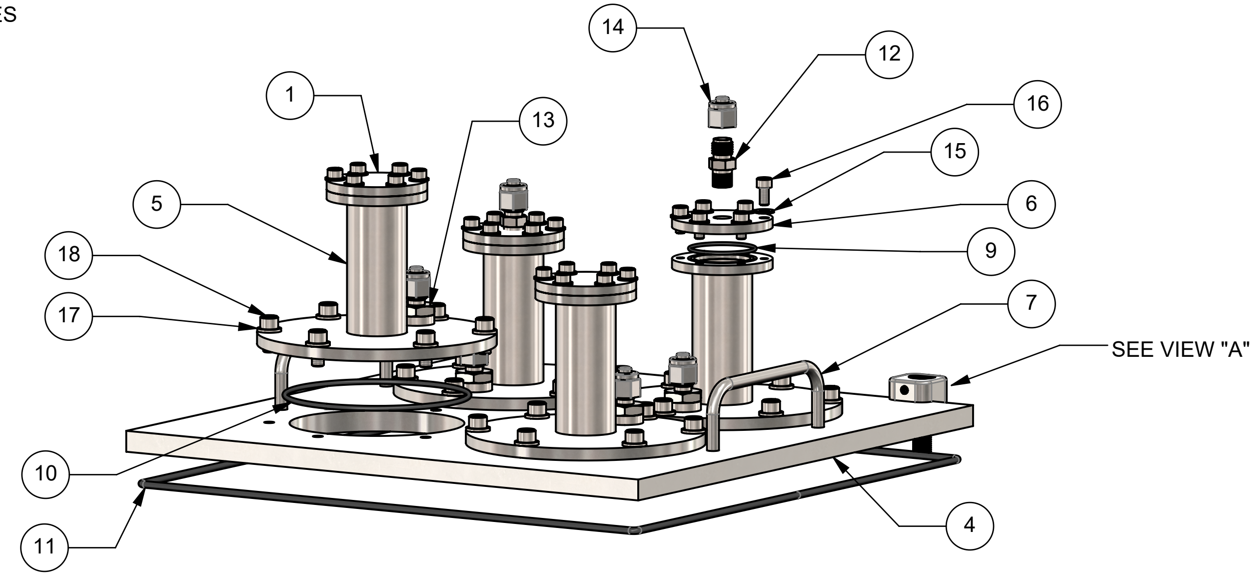


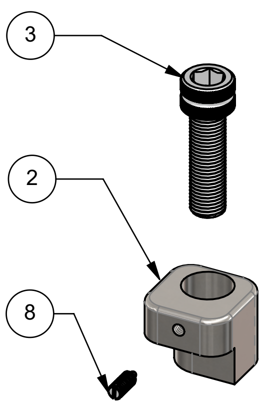
DO NOT SCALE FROM DRAWING	THIRD ANGLE PROJECTION	**PROPRIETARY NOTICE** THIS DRAWING AND INFORMATION CONTAINED WITHIN IS PROPRIETARY TO THUNDER SCIENTIFIC AND CANNOT BE COPIED OR REPRODUCED WITHOUT SPECIFIC WRITTEN PERMISSION		**Thunder Scientific Corporation** 623 Wyoming S.E. Albuquerque, NM 87123
				AC / DC Power Distribution
9500	TOLERANCES .XXX ±.010 .XX ±.015 ∠ ±.50° UNLESS NOTED OTHERWISE	DRAWN FURRY	6/6/2016	SIZE A
NEXT ASSY / USED ON		APPROVED BB	6/6/2016	DWG. NO. 9500S919
APPLICATION		ISSUED DWF	6/6/2016	REV A
				WT. N / A
				SHEET 1 OF 1

NOTES:

1. INTERPRET DRAWING PER ASME Y14.100-2017
2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5-2018
3. ALL UNITS ARE INCHES U.N.O.
4. REMOVE ALL BURRS AND SHARP EDGES

REVISIONS				
DWN	REV.	DESCRIPTION	DATE	APPROVED





VIEW "A"

TYPICAL OF 12
SEPARATE
HOLD DOWNS

ITEM NO.	TSC STOCKCODE	DESCRIPTION	MATERIAL SPEC	QTY
18	** N S I **	1/4-28 X 1/2" SOCKET HEAD CAP SCREW	STAINLESS STEEL	24
17	** N S I **	1/4" NARROW FLAT WASHER - NAS620-C416	STEEL	24
16	** N S I **	#10-32 X 3/8" HEX SHCS	STAINLESS STEEL	24
15	** N S I **	#10 NARROW FLAT WASHER - NAS620-C10	STEEL	24
14	S4-P	1/4" TUBE PLUG	SS-400-P	6
13	S4-1-OR	1/4" X 7/16-20 ST O-RING ADAPTER	316 STAINLESS STEEL	4
12	S4-1-2	1/4" TUBE X 1/8" NPT ADAPTER	SS-400-1-2	2
11	OR282V	16.02" MEAN O RING	VITON	1
10	OR154V	3.94" MEAN O RING	VITON	4
9	OR027V	1.44" MEAN O RING	VITON	4
8	CL22	SPRING LOADED SET SCREW	8-32 X .375 - STAINLESS STEEL	12
7	D96M90204	CHAMBER LID HANDLE	Ø.25 X 6.756, 304 STAINLESS STEEL	2
6	D96M00223	THREADED ACCESS PORT CAP	304 STAINLESS STEEL	2
5	D96A90024	ACCESS PORT ASSEMBLY	304 STAINLESS STEEL	4
4	D95M90192	4 PORT CHAMBER LID	304 STAINLESS STEEL	1
3	D94M00165	CHAMBER LID HOLD DOWN SCREW	STAINLESS STEEL	12
2	D94M00163	CHAMBER LID HOLDDOWN	316 STAINLESS STEEL	12
1	D92M00021	ACCESS PORT CAP	316 STAINLESS STEEL	2

DO NOT SCALE FROM DRAWING

9500A001	9500
NEXT ASSY	USED ON
APPLICATION	

THIRD ANGLE PROJECTION

PROPRIETARY NOTICE

TOLERANCES
.XXX ±.010
.XX ±.015
∠ ±.50°
UNLESS NOTED OTHERWISE

DRAWN	FURRY	5/10/2016
APPROVED	BB	5/10/2016
ISSUED	DWF	5/24/2016

Thunder Scientific Corporation
623 Wyoming S.E. Albuquerque, NM 87123

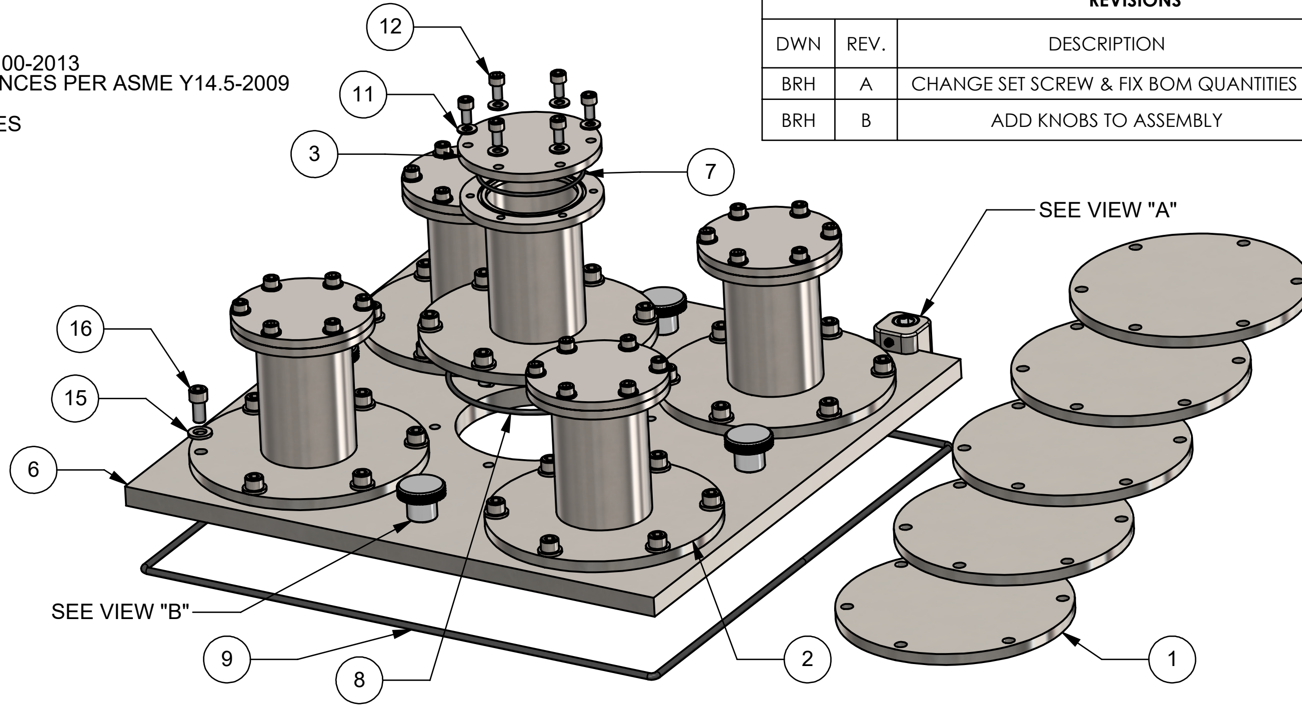
4 Port Chamber Lid Assembly

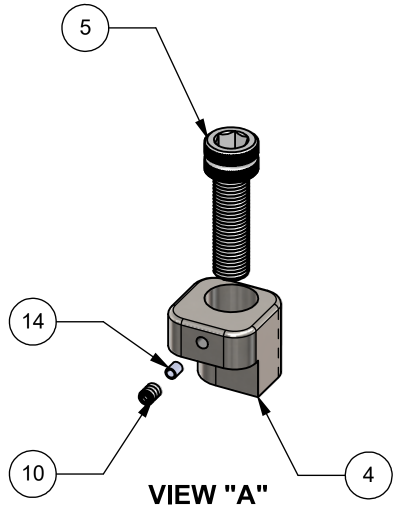
SIZE	DWG. NO.	REV
A	9500D905	-
	WT. 22.82 lb	SHEET 1 OF 1

NOTES:

1. INTERPRET DRAWING PER ASME Y14.100-2013
2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5-2009
3. ALL UNITS ARE INCHES U.N.O.
4. REMOVE ALL BURRS AND SHARP EDGES

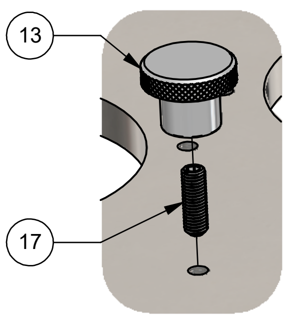
REVISIONS				
DWN	REV.	DESCRIPTION	DATE	APP.
BRH	A	CHANGE SET SCREW & FIX BOM QUANTITIES	6/10/2022	BB
BRH	B	ADD KNOBS TO ASSEMBLY	6/28/2022	BB





VIEW "A"

TYPICAL OF 12
SEPARATE
HOLD DOWNS



VIEW "B"

TYPICAL OF 4
HANDLES

ITEM NO.	TSC STOCKCODE	DESCRIPTION	MATERIAL SPEC / MFG. PART NUMBER	QTY
17	** N S I **	1/4"-28 X 3/4" CUP-POINT SET SCREW	STAINLESS STEEL - MCMASTER-CARR : 92311A562	4
16	** N S I **	1/4"-28 X 1/2" SOCKET HEAD CAP SCREW	STAINLESS STEEL	30
15	** N S I **	1/4" NARROW FLAT WASHER - NAS620-C416	STEEL	30
14	** N S I **	Ø1/8" NYLON TUBING	0.150" LONG	12
13	** N S I **	Ø1" HEAD X 1/2" DEEP KNURLED KNOB	STAINLESS STEEL - MCMASTER-CARR : 60205K46	4
12	** N S I **	#10-32 X 3/8" SOCKET HEAD CAP SCREW	STAINLESS STEEL	30
11	** N S I **	#10 NARROW FLAT WASHER - NAS620-C10	STEEL	30
10	** N S I **	#8-36 X 1/4" CUP-POINT SET SCREW	STAINLESS STEEL - MCMASTER-CARR : 92311A297	12
9	OR281V	15.05" MEAN O-RING	VITON	1
8	OR154V	3.94" MEAN O RING	VITON	5
7	OR034V	2.125 I.D. O RING	VITON	5
6	D9500M199	5 PORT CHAMBER LID	316 STAINLESS STEEL	1
5	D94M00165	CHAMBER LID HOLD DOWN SCREW	STAINLESS STEEL	12
4	D94M00163	CHAMBER LID HOLDDOWN	316 STAINLESS STEEL	12
3	D21M00020	2.00" ACCESS PORT CAP	316 STAINLESS STEEL	5
2	D21A00025	2.00" ACCESS PORT ASSEMBLY		5
1	D08M00337	CHAMBER ACCESS PORT BLANK	316 STAINLESS STEEL	5

DO NOT SCALE FROM DRAWING

NEXT ASSY	USED ON

APPLICATION

THIRD ANGLE PROJECTION

TOLERANCES

.XXX ±.010
.XX ±.015
∠ ±.50°
UNLESS NOTED OTHERWISE

DRAWN	FURRY	12/13/2021
APPROVED	BB	12/13/2021
ISSUED	DWF	1/4/2022

Thunder Scientific Corporation

623 Wyoming S.E. Albuquerque, NM 87123

5 Port Chamber Lid Assembly

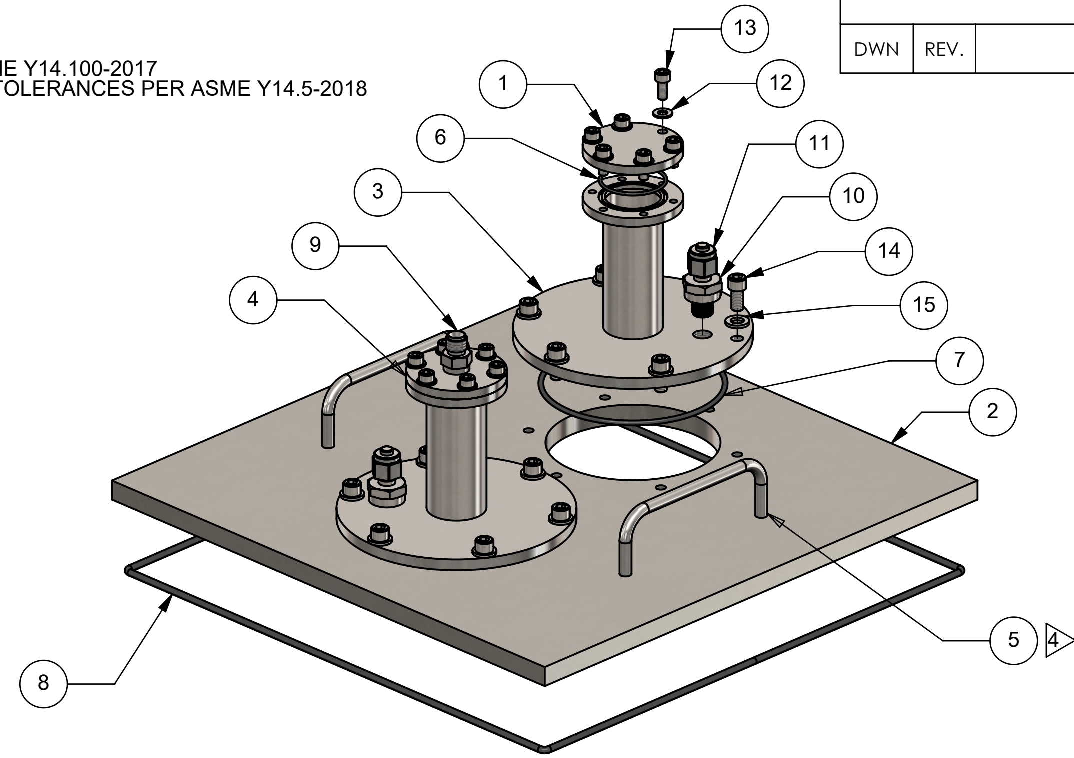
SIZE	DWG. NO.	REV
A	9500D906	B
	WT. 32.28	SHEET 1 OF 1

NOTES:

1. INTERPRET DRAWING PER ASME Y14.100-2017
2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5-2018
3. ALL UNITS ARE INCHES U.N.O.

4 USE LOCTITE 262

REVISIONS				
DWN	REV.	DESCRIPTION	DATE	APP.



ITEM NO.	TSC STOCKCODE	DESCRIPTION	MATERIAL SPEC / MFG. PART NUMBER	QTY
15	** N S I **	1/4" NARROW FLAT WASHER - NAS620-C416	STAINLESS STEEL	12
14	** N S I **	1/4-28 X 1/2" SOCKET HEAD CAP SCREW	STAINLESS STEEL	12
13	** N S I **	#10-32 X 7/16" HEX SHCS	STAINLESS STEEL	12
12	** N S I **	#10 NARROW FLAT WASHER - NAS620-C10	STAINLESS STEEL	12
11	S4-P	1/4" TUBE PLUG	SS-400-P	2
10	S4-1-OR	1/4" X 7/16-20 ST O-RING ADAPTER	316 STAINLESS STEEL	2
9	S4-1-2RS	1/4" TUBE X 1/8" ISO PARALLEL THREAD	SS-400-1-2RS	1
8	OR281V	15.05" MEAN O-RING	VITON	1
7	OR154V	3.94" MEAN O RING	VITON	2
6	OR027V	1.44" MEAN O RING	VITON	2
5	D96M90204	CHAMBER LID HANDLE	Ø.25 X 6.756, 304 STAINLESS STEEL	2
4	D96M00223	THREADED ACCESS PORT CAP	304 STAINLESS STEEL	1
3	D96A90024	ACCESS PORT ASSEMBLY	304 STAINLESS STEEL	2
2	D95M90163	2 PORT CHAMBER LID	304 STAINLESS STEEL	1
1	D92M00021	ACCESS PORT CAP	316 STAINLESS STEEL	1

DO NOT SCALE FROM DRAWING

NEXT ASSY	USED ON
APPLICATION	

THIRD ANGLE PROJECTION

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TOLERANCES
.XXX ±.010
.XX ±.015
∠ ±.50°
UNLESS NOTED OTHERWISE

DRAWN	BRH	6/12/2023
APPROVED	BB	6/12/2023
ISSUED	BRH	6/13/2023

Thunder Scientific Corporation
623 Wyoming S.E. Albuquerque, NM 87123

Two Port Chamber Lid Assembly

SIZE	DWG. NO.	REV
A	9500D907	-
	WT. 21.65 lb	SHEET 1 OF 1