OxyCycler Model A84XOV
MANUAL

BioSpherix

BioSpherix

Technical Support

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OxyCycler Model A84 Manual

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The OxyCycler model A84XOV is a dynamic gas oxygen controller for people who do oxygen sensitive work.

The OxyCycler model A84XOV can simultaneously and independently control up to four chambers. You can choose to operate all chambers together or you can operate each one independent of the others.

Though designed to work with BioSpherix chambers, this system will work with practically any semi-sealable enclosure. Any manufactured or custom-made chamber can be fitted in minutes.

The unit works from outside of the host chamber by remotely sensing oxygen in each independent chamber and infusing gas to raise or lower oxygen levels. A monitor pod can be used to move between chambers and keep track of PPM CO_2, temperature, and humidity over the time of exposure.

Nominal range of oxygen concentration is 0.1-99.9%, depending on chamber size.

The OxyCycler Model A84XOV can control oxygen profiles with multiple setpoints. You can hold any setpoint for any length of time and the rate of change between any two setpoints is adjustable. Profiles can be adjusted to cycle any fixed number of times, or they can be programmed to run continuously.

Installation is easy. Operation is simple. The unit moves easily from one host chamber to another.

Please read and follow the safety and operational instructions on the following pages. Be careful. Any pressurized gas can be dangerous. Know what you are doing and do it safely.

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! Anyone who has not thoroughly read and understood this manual must never attempt to operate the equipment. **!**

OxyCycler model A84

This manual is intended to guide system installers, users and maintenance personnel to efficiently setup, maintain, and operate BioSpherix, Ltd. equipment. All personnel who will be working with the OxyCycler model A84 should read this manual thoroughly. Keep it handy and refer to it whenever questions arise. If you have any problems or questions, please do not hesitate to contact BioSpherix, Ltd. We are here to help.

IMPORTANT: WARNINGS, CAUTIONS, AND NOTES

Throughout this manual special references are made when deemed important. Three classifications are used to separate these references by order of importance:

WARNING

Used in connection with a procedure or situation that may result in serious injury or death.

CAUTION

Used in connection with a procedure or situation that will result in damage to the equipment.

NOTE

Used to emphasize important information.

At BioSpherix, Ltd. we are continuously improving our equipment documentation, making it both easier to navigate understand. One of the best ways to make these improvements is to receive feedback from you, the end user of the equipment. Therefore, we request any and all feedback regarding this manual. Please feel free to forward comments and questions to documentation@ biospherix.com

Table of Contents

1 Safety Instructions

System Safety Concerns and Safety Guidelines must be strictly adhered to.

Power Source
Unit should be connected to a power supply, only of the type described in the operating instructions or as marked on unit. Power Supply Cords should be routed so that they are not likely to be walked on or pinched by items placed upon or against them. Power Cord of the unit should be unplugged from the electrical outlet when left unused for long periods of time.

CAUTION

ELECTRIC SHOCK Unit should never be used where it can fall or be pushed into water. When modifying host chamber, be careful not to drill or cut into electrical wires hidden behind chamber wall. Never drill or cut blindly.

WARNING

DO NOT remove cover of the OxyCycler model A84 due to presence of uninsulated “dangerous voltage” within product’s enclosure.

NOTE

Secure all pressurized gas connections with hose clamps. Never exceed pressure limits. Bleed all lines before disconnecting. Wear safety glasses at all times.

WARNING

Unit should be situated so that its location or position does not interfere with proper ventilation. Neither OxyCycler model A84 nor host chamber should be in poorly ventilated areas.

Falling Objects and Liquid Splash
Care should be taken so that objects do not fall on equipment and liquids do not spill, splash, or drip onto or into unit enclosure or power cord.

CAUTION

Unit should be situated away from heat sources such as radiators, heat registers, stoves, or other appliances or processes that produce heat.

Low Oxygen Atmospheres
Never enter a chamber which has a low oxygen atmosphere because of severe danger of suffocation. Host chamber should be in a well ventilated room. Control gas (nitrogen or other low oxygen gas) continuously leaks out of chamber and should never be allowed to build up in room or outside of the chamber.

High Oxygen Atmospheres
Never enter a chamber which has a high oxygen atmosphere due to danger of oxygen toxicity. Never smoke or allow any source of fire in or around a chamber with high oxygen atmosphere. Oxygen radically promotes combustion and can be explosive. Host chamber should always be in a well ventilated room. Oxygen continuously leaks out of chamber and should never be allowed to build up in room or outside of chamber.

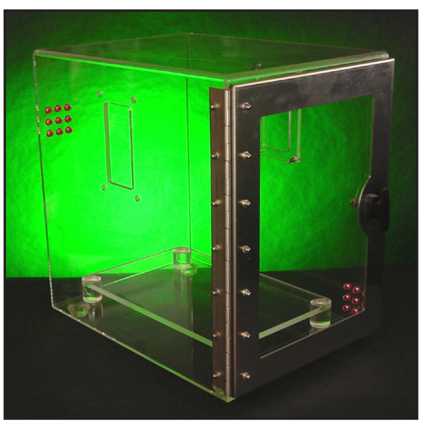
Cleaning
Do not immerse unit in water. Do not wipe unit with wet cloth or sponge or paper. Clean only with a dry cloth.

2 Required Supplies

BioSpherix Supplied Parts

This is a list of all supplies that are provided with the OxyCycler model A84 System. Depending on system configuration, the supplied parts needed for your system may vary.

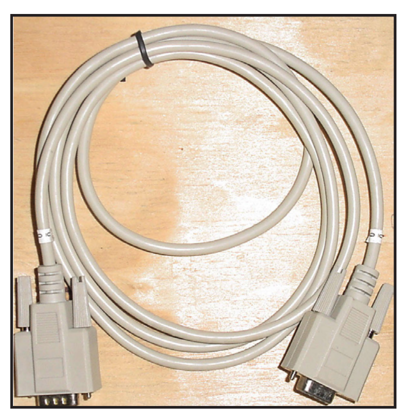
OxyCycler Model A84 unit



A-Chamber(s)

Actuator Pod(s)

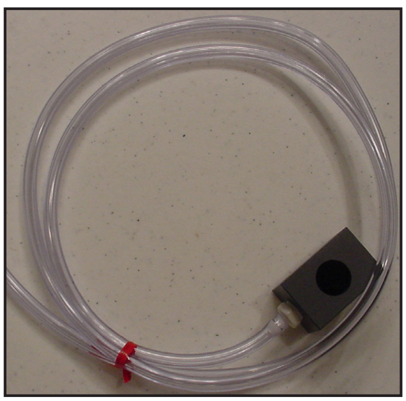
12 VDC Regulated Power Supply and Power Cord



RS485 Communications Cable (Optional)

Monitor Pod (Optional)

Quick Disconnect with Remote Oxygen Sensor Attached (Optional)



Calibration Chamber and Tubing (Included with Monitor Pod only)

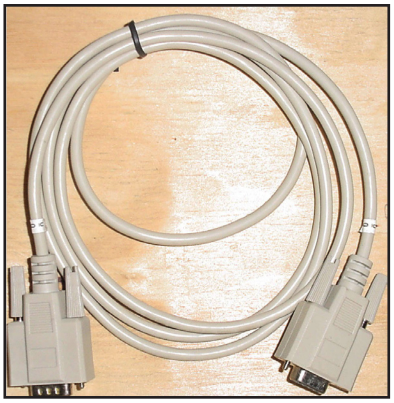
Computer Setup (Optional)
(Actual model may vary)

In order for the OxyCycler model A84 to communicate with the control computer, the following supplies are required:

Sealevel RS485 to USB Converter

Recovery Software Installation

Sealevel USB Cable



RS485 Communication Cable(s)

Customer Supplied Parts

This section will list the parts that the user will need to supply in order to operate the equipment.

1. Qty. (1) compressed gas source of oxygen.
2. Qty. (1) compressed gas source of nitrogen.
3. Qty. (1) compressed gas source of carbon dioxide/oxygen mix, with a ratio of approximately; 1% carbon dioxide - 99% oxygen.
4. Qty. (3) regulators, one for each compressed gas source. If the system is not equipped with a monitor pod, then only (2) regulators will be required. Make sure each regulator is either a one or a two stage regulator. Either way the unit requires two gauges (2500 psi input, 0-60 psi gauged output, recommended). It is best to have two gauges in order to monitor the amount of gas in the compressed source and also monitor the amount passing through the output.
5. 1/4” ID tubing to connect the compressed supply gas sources to the unit.
6. Qty. (1) heavy gauge wire for grounding the unit (optional, but recommended).
7. Qty. (1) Thermometer for calibration purposes. (Thermometer is only applicable if a monitor pod was purchased with the OxyCycler model A84.)

NOTE

Secure all pressurized gas connections with hose clamps. Never exceed pressure limits. Bleed all lines before disconnecting. Wear safety glasses at all times.

This is the list of all gas supplies that are required for the OxyCycler model A84 system.

CAUTION

All gas supplies must be Medical grade or appropriately filtered (particle and oil) industrial grade.

Gas Supply Descriptions / Requirements:

100% N2, Nitrogen – Used to reduce process variables below current or ambient levels, also used for zero calibration of sensors. BioSpherix, Ltd. recommends beginning with High Pressure Tank(~2200 – 2500psig). Once comfortable with gas usage of the system and protocol, options for Low Pressure Liquid (~200psig), or Generator with Surge Tank are available.

100% O2, Oxygen – Used to raise oxygen process levels above ambient, >21%. BioSpherix, Ltd. recommends beginning with High Pressure Tank (~2200 – 2500psig). Once comfortable with gas usage of the system and protocol, options for Generator with Surge Tank are available.

CO2/O2, Premix of Carbon Dioxide and a balance of Oxygen, certified to 0.01%. BioSpherix, Ltd. recommends a mix of 1% CO2, 99% O2. Used for span calibration of O2 and CO2 sensors. This is a low consumption gas used only during calibration, therefore a small tank is appropriate.

Gas Pressure Regulators

Gas Pressure Regulators

Gas pressure regulators are used to reduce the pressure of gas supplied from a high-pressure source of gas to a workable level that can be safely used for equipment.

For BioSpherix, Ltd. equipment, regulators should be 2500 PSIG input 0-60 PSIG output regulator at the source of the compressed gas. PSIG stands for Pounds per Square Inch Gauge as opposed to PSIA which stands for Pounds per Square Inch Absolute.

Dual gauge regulators are recommended; this allows users to monitor the amount of gas pressure coming from the gas source, and at the same time monitor the output pressure to the system.

There are two basic types of gas pressure regulators: single-stage regulators and two-stage regulators. Single-stage regulators reduce the gas source pressure to the delivery or outlet pressure in one step. Two-stage regulators reduce the cylinder pressure to a working level in two steps. Two-stage regulators are typically used when more stability of operation is required. Two-stage regulators are recommended.

NOTE

If the regulator is not near the system, then an additional shut off valve should be placed on the tube between the system unit and the compressed gas source.

CAUTION

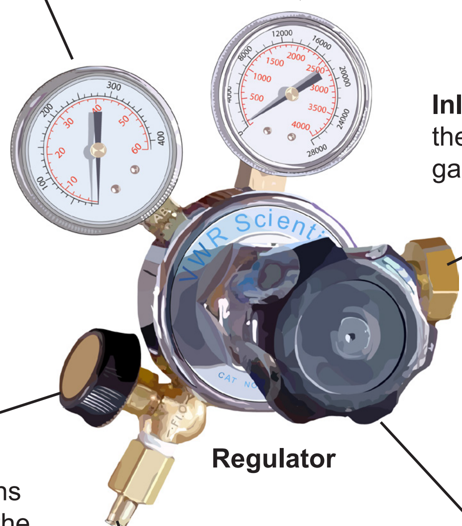
When removing gas supply tubes from the system, always make sure to shut off the compressed gas at the source first; then bleed the pressure out of the line and finally, remove the tube from back of OxyCycler model A84

Regulator

Outlet Pressure Gauge – This gauge displays the current outlet pressure that is going to the equipment. The pressure must be regulated to 0-60 PSIG.

Inlet Pressure Gauge – This gauge displays the current pressure of the gas source. As the gas source is depleted, this gauge will reflect lower pressure. When the gas source is completely empty, or shut off, this gauge will read zero. For BioSpherix, Ltd. equipment, regulators should be 2500 PSIG input.

Inlet Connection – This is where the regulator is attached to the gas source with the CGA Fitting.



Needle Valve for Flow Control – This valve turns on/off the gas supply at the outlet.

Regulator

Pressure Adjusting Handle – This handle is used to turn on the gas supply into the regulator.

Outlet Connection – This is where the outlet hose, going to the equipment, is attached to the regulator.

Compressed Gas Association (CGA) Fittings

CGA fittings are a standardized system for the attachment of a compressed gas cylinder to the required regulator. These fitting standards are designed to make the gas connections leak tight and also prevent different fittings from being mixed up. For example, flammable gas fittings have left hand threads. Oxygen and inert gases have right hand threads. Since a left hand thread fitting cannot be threaded onto a right hand fitting, it is impossible to connect fuel gas to the oxygen and vise versa. **Always get the correct CGA fitting from you gas supplier. Different tank sizes and pressures may have different CGA fittings.**

Examples of CGA fittings:

- CGA-580 for Nitrogen
- CGA-540 for Oxygen
- CGA-320 for Carbon Dioxide

Gas Consumption

A common customer request is an estimate of gas consumption. It is virtually impossible to estimate the gas consumption requirements ahead of time because requirements vary significantly based on how the customer operates the system. It is assumed that gas consumption is a simple engineering issue - a simple matter of calculating the gas infusion, calculating the size of the box, and coming up with the answer. If that is all there was to do, then it would be possible. In reality, operating the system in different ways has a huge and unpredictable impact on gas consumption. Therefore, it is unfortunately impossible to provide an accurate estimate. How then does the customer prepare? There are two options:

Option #1
Prepare in a way that anticipates a learning curve - anticipate mistakes and anticipate running out of gas. Therefore, do not perform any critical experiments until the gas consumption is determined. This is not incompatible with the learning curve that is required to operate the rest of the system.

The strategy is to start with compressed gas tanks for all gases and have several backup tanks on site. The reason for using tanks is to easily quantitate the amount of gas used.

You cannot quantitate the gas used with liquid supplies. Liquid supplies are more practical because the consumption costs are lower. Liquid is usually half the cost per foot and usually ten times more quantity per tank. However, as liquid evaporates and releases unknown amounts of gas into the environment, it prevents you from quantitating the amount of gas that is actually being used by the system.

Over a course of weeks and maybe months, someone will have to perform the task of changing tanks. Once a gas consumption pattern is established, it will be very easy to predict what future gas consumption is going to be and the gas supply can be designed accordingly.

Option #2
Simply over design with excess capacity; this option is likely to lead to wasted gas and added costs. BioSpherix, Ltd. will be able to help by providing excessive estimates that will probably never be exceeded. But understand that it is probably going to cost more up front and cost more over time.

Supply options are a generator or dual liquid tanks. If dual liquid tanks are used and the supply is not used fast enough, then the excess gas just blows off.

As the cold liquid inside the insulated tanks slowly warms, it evaporates. The evaporated gas is stored in the head space of the tank, this is the gas supply. As the liquid continues to evaporate, the pressure in the head space increases. For safety reasons, the head space pressure is limited to 200psi. Any excess gas pressure is released as blow off through the two pressure relief valves located on the top of the tank.

The gas is rarely used as fast as it evaporates, so some blow off will occur. If none of the gas is used, the tank will eventually completely empty.

With dual redundant tanks, when one tank empties, the next tank comes online, this is the fail safe.

These are the two options that are available. Are you willing to go through the gas supply learning curve, patiently and slowly? Or would you rather over design the gas supply and incur the excess costs?

3 Setup of Gas Supply

This section will describe how to setup the gas supply.

Gas must be supplied through a 1/4" ID tube to the back panel of the OxyCycler model A84. The pressure must be regulated to 0-60 PSIG. For maximum speed, BioSpherix, Ltd. recommends regulating the pressure to 40 PSIG.

CAUTION

Never allow the pressure coming out of the compressed source to exceed 40 PSIG or damage will occur to the OxyCycler model A84 unit.

Use a one or a two stage, 2500 PSIG input, 0-60 PSIG output regulator at the source of the compressed gas. It is best to have two gauges, one gauge to monitor the amount of gas in the compressed source and another gauge to monitor the amount passing through the output.

If the regulator is not near the OxyCycler model A84, then there should be a shutoff valve placed on the tube between the OxyCycler model A84 and the compressed gas source. When taking off the gas supply tube always make sure to shut off the compressed gas at the source first, bleed the pressure out of the line and then take off the tube from the back of the OxyCycler model A84.

The amount of gas used is determined by how the chamber is used, not the OxyCycler model A84. The OxyCycler model A84 uses the least amount of gas possible, which is only what the chamber needs. The amount of gas used is dependent on: (1) The size and leakiness of the chamber, (2) The amount of times and how long the chamber door(s) are opened, (3) The oxygen level being controlled.

WARNING

Do not open any of the regulators at this time. Wait until the "Calibration" and "Single Setpoint Control" sections.

NOTE

BioSpherix, Ltd. strongly encourages all customers to perform a test run on the system prior to beginning any actual experiments. Doing so will enable the user to understand how the system performs and estimate the amount of gas consumption.

Connecting the Regulators to the Compressed Gas Supplies:

1. Completely close the regulator and the compressed gas source.
2. Screw the regulator onto the compressed gas source.
3. Repeat the first two steps for all three compressed gas sources (nitrogen, oxygen and carbon dioxide/oxygen mix).
4. Attach one end of the 1/4” ID tubing to the regulator and attach the other end to the appropriate hose barb on the back panel of the OxyCycler model A84.
5. The compressed nitrogen gas source tubing connects to the hose barb labeled **NITROGEN**.
6. The compressed oxygen gas source tubing connects to the hose barb labeled **OXYGEN**.
7. The compressed carbon dioxide/oxygen mix tubing connects to the hose barb labeled **MIX**.

4 Equipment Overview

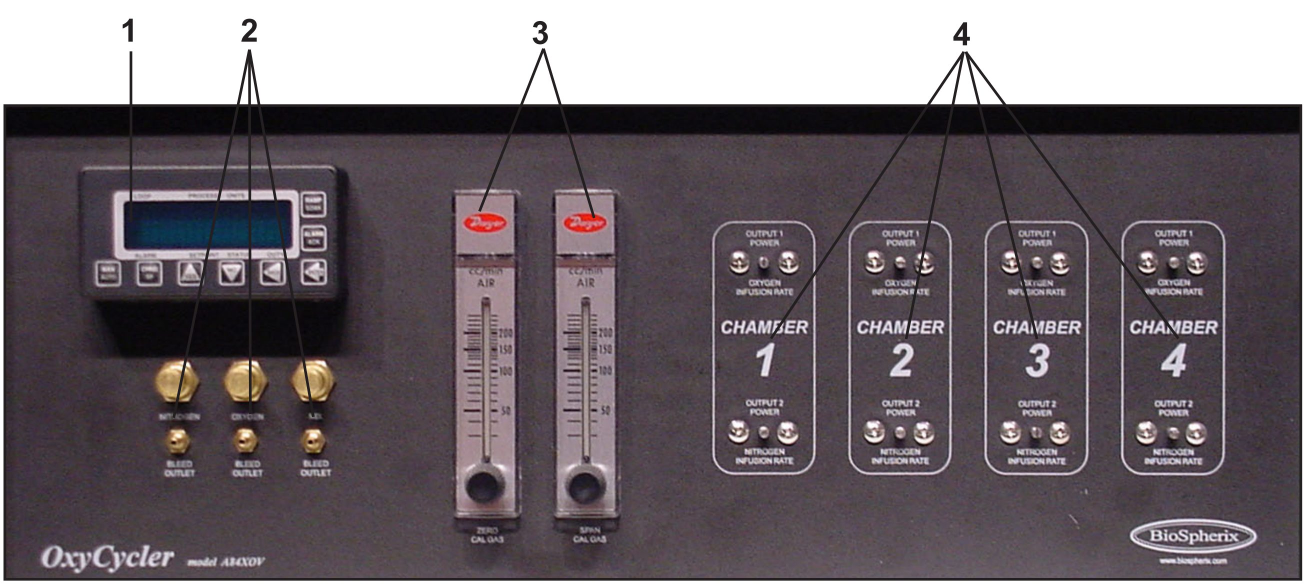
Front Panel Components

1. **Controller -** This controller acts as the “brain” of the unit, controlling a variety of variables. Some of these variables include: telling the unit when to infuse gas into the chamber(s), what specific gas to infuse into the chamber(s) and how much gas is needed to be infused to reach the specific setpoint.

2. **Bleed Valves/Bleed Barbs -** Used to check the compressed gas supplies. *(See the “Preparation for Calibration” section for information on how to check the compressed gas supply.)*

3. **Gas Flowmeters -** The ZERO CAL GAS and SPAN CAL GAS flowmeters are used during the calibration procedures. The flowmeters adjust the flow rate of the gas during the calibration process.

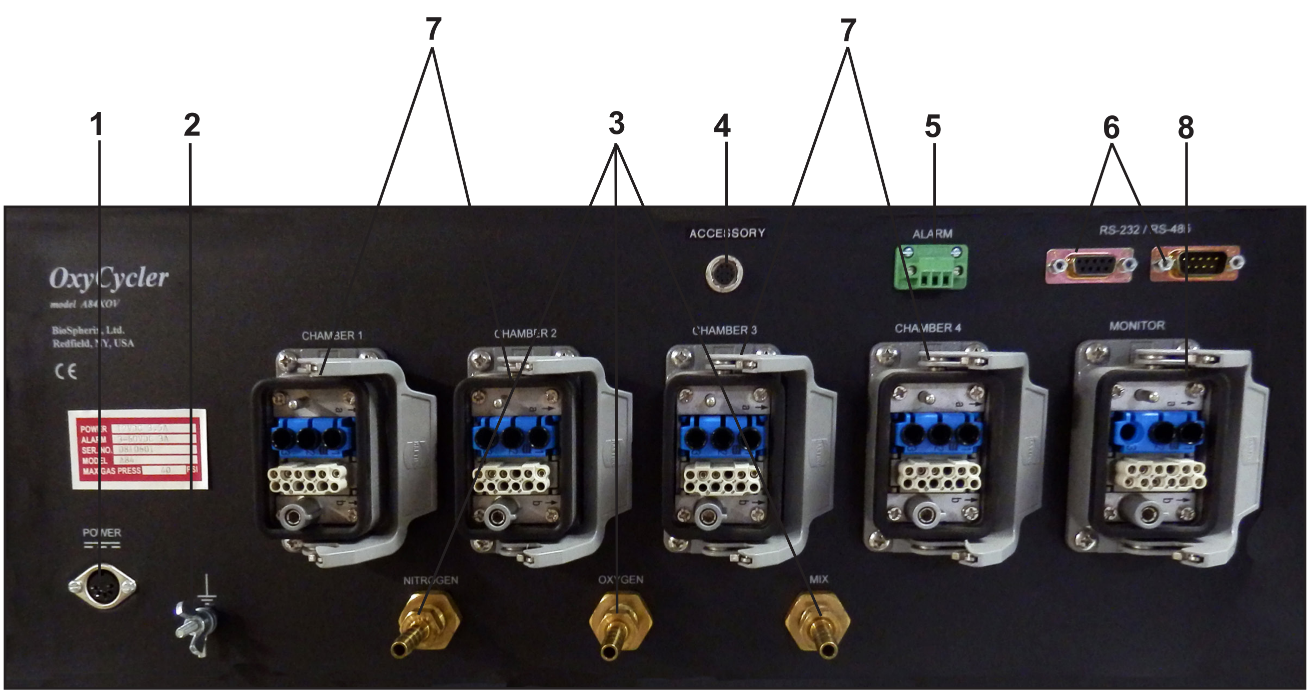
4. **Needle Valves -** The function of the needle valve is to raise or lower the infusion rate of that particular gas going into that particular chamber. Each set of needle valves corresponds to a Chamber (Chambers 1 through 4). Each Chamber has two needle valves: one for oxygen control and one for nitrogen control. The needle valves are preset at the factory, so you should not have to adjust them. In the case that you do, you will need a flathead screwdriver. With the screwdriver, turn the needle valve counterclockwise to increase the infusion rate and turn it clockwise to decrease the infusion rate.



Front Panel

Back Panel Components

1. **Power Receptacle -** Receptacle for the supplied 12VDC regulated power supply.
2. **Ground Stud -** This stud is for grounding the unit.
3. **Supply Gas Hose Barbs -** This is where the 1/4" ID tubings extending from the compressed gas sources attach to the unit.
4. **Accessory Port -** Used for custom units such as the BioSpherix, Ltd. Activent and/or the BioSpherix, Ltd. High-Speed Profiler.
5. **Alarm Receptacle -** Receptacle for user-supplied alarm, light, buzzer etc.
6. **RS232/485 Connections -** RS485 Communication Cable connection. The RS485 Communication Cable will supply communication from the computer to the unit. *Please refer to the "Communications" section in this manual for instructions on installing and connecting the software to this unit.*
7. **Actuator Pod Umbilical Port(s) -** This is where the actuator pod umbilicals connect to the unit.
8. **Monitor Pod Umbilical Port -** This is where the monitor pod umbilical connects to the unit.

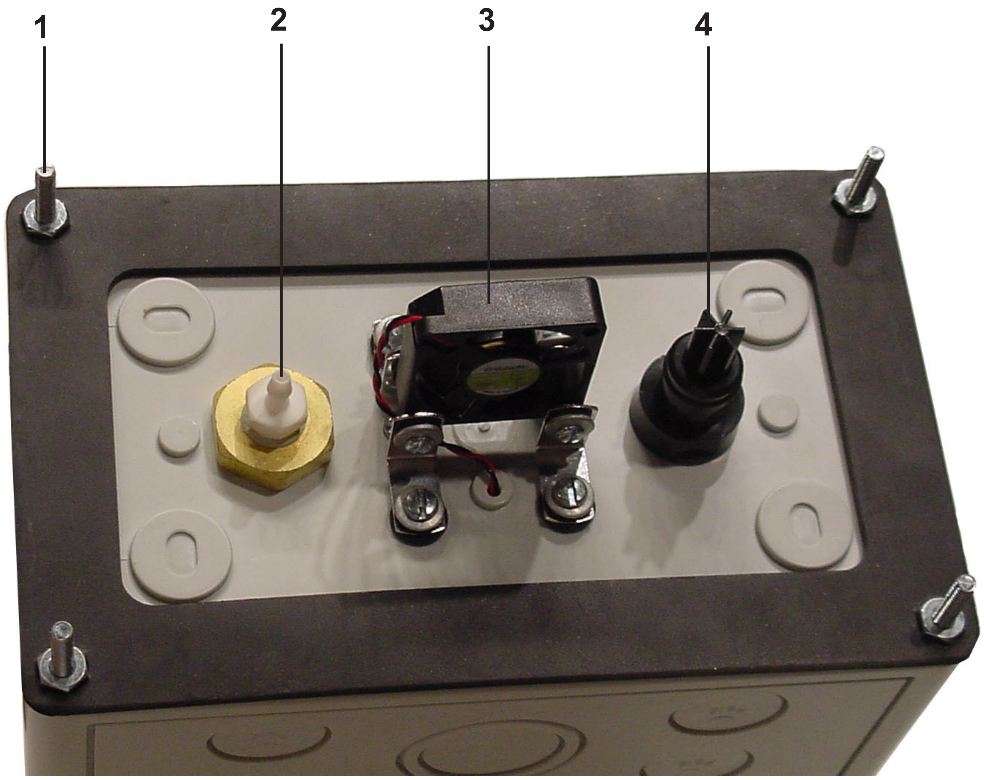


Back Panel

Actuator Pod Components

The actuator pod's function is to infuse the compressed gas source into the chamber, provide homogenization and measure oxygen levels.

1. **Bolts -** These four bolts are for mounting the actuator pod to the chamber. Wingnuts are provided to tighten.
2. **Infusion Port -** This is the port where the gas is infused into the chamber.
3. **Fan -** This fan mixes the gases inside of the chamber. This fan is turned on by the toggle switch located on the side of the actuator pod.
4. **Oxygen Sensor Tip -** This is where the oxygen sensor (within the pod) measures the oxygen levels inside of the chamber.

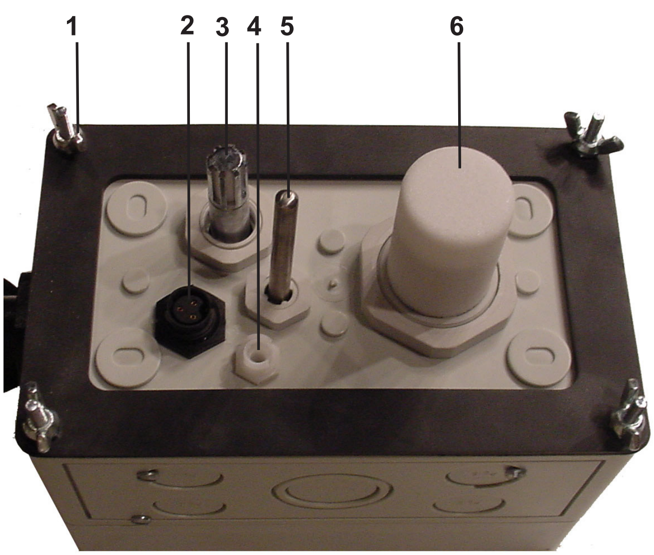


Back Panel

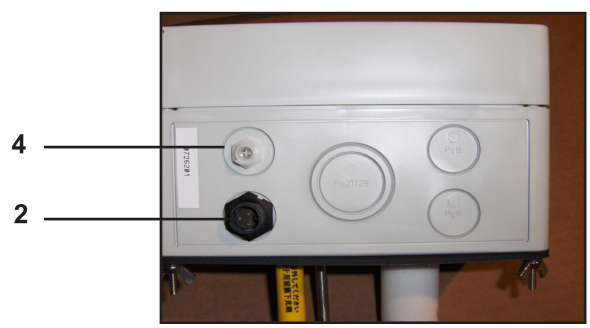
Monitor Pod Components

The monitor pod's function is to monitor the carbon dioxide, relative humidity, temperature and oxygen levels. The oxygen level is monitored in specific areas via the remote oxygen sensor. ***(This section is only applicable if a monitor pod was purchased.)***

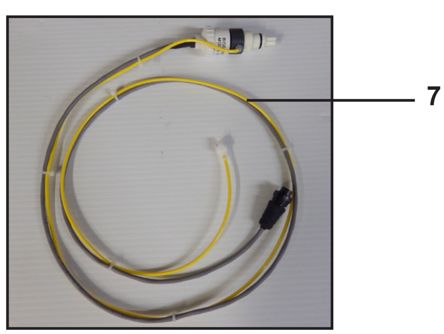
1. **Bolts -** These four bolts are for mounting the monitor pod to the chamber. Wingnuts are provided to tighten.
2. **Electrical Receptacle -** This is where the remote oxygen sensor's electrical cable attaches to the monitor pod. The remote oxygen sensor can be used inside of the chamber or as an external room oxygen sensor.
3. **Relative Humidity Sensor Tip -** This is where the relative humidity sensor (within the pod) monitors the relative humidity inside of the chamber.
4. **Pneumatic Quick Disconnect -** The remote oxygen sensor's calibration tubing connects to the monitor pod using this quick disconnect.
5. **Temperature Sensor Tip -** This is where the temperature sensor (within the pod) monitors the temperature levels inside of the chamber.
6. **Carbon Dioxide Sensor Tip -** This is where the carbon dioxide sensor (within the pod) monitors the carbon dioxide levels inside of the chamber.
7. **Quick Disconnect with Remote Oxygen Sensor -** Can be used inside of the chamber or as an external room oxygen sensor.



Monitor Pod



If purchased, your monitor pod may contain an additional electrical receptable and pneumatic quick disconnect on the side of the pod.



Quick Disconnect with Remote Oxygen Sensor

System Sensors

All sensors are all affected by variables other than the target variable. Temperature, pressure and cross reactions to other gases can affect sensor output. The best way to account for these variables is to understand them and compensate for them when necessary.

Generally, sensor inaccuracy is consistent and repeatable, so by understanding the effect of variables and keeping them consistent, measurable and repeatable conditions can be easily attained and accurately tracked.

This is the list of all the sensors that are required for the OxyCycler Model A84 System.

Oxygen Sensors
Oxygen sensors are consumable items that typically last between 9-24 months, depending on the application and usage. Frequent calibration is essential for accurate and consistent readings over the life of the oxygen sensor.

Oxygen sensors are depleting electrochemical sensors. Each oxygen sensor detects oxygen levels using an electrochemical charge, similar to a battery; so the more oxygen that is detected, the shorter the lifespan of the sensor. In contrast, the less oxygen that is detected, the longer the lifespan of the sensor. So a sensor will generally have a longer lifespan in a low oxygen environment and a shorter lifespan in a high oxygen environment.

Carbon Dioxide Sensors - only applicable if system was purchased with a monitor pod.
The carbon dioxide sensor’s lifespan is indefinite. If used properly and checked/re-calibrated, the carbon dioxide sensor can last throughout the life of the system.

5 OxyCycler Model A84 Installation

This next section contains instructions on the hardware installation of the OxyCycler model A84 unit.

1. Set the OxyCycler model A84 unit and the A-Chamber(s) on a level, secure surface. Make sure the chambers are within 10 feet of the unit, which is the length of the umbilical(s).
2. It is recommended to attach one end of a bonding strap or a heavy gauge wire (approximately 8-10 AWG) to the ground stud on the back panel of the unit and attach the other end to an acceptable ground source.
3. The compressed gas supplies should be connected to the appropriately labeled hose barbs on the back panel of the unit. *Please refer to the "Setup of Gas Supply" section for instructions on how to hook up the gas supply.*

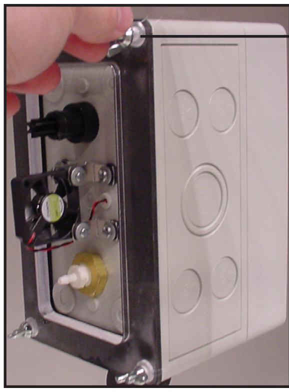
> **CAUTION**
>
> *Do not turn the gas on yet; wait until the "Calibration" and "Single Setpoint Control" sections.*

> **NOTE**
>
> In order to prepare the actuator pods and monitor pod for installation, carefully uncoil the umbilicals. When connecting the umbilicals, the pneumatic connection (blue) and the electrical connection (tan) must be lined up with the corresponding connection on the receptacle.

4. Connect the actuator pod umbilicals to the **CHAMBER** connectors on the back panel of the unit. The chamber connectors are labeled 1 through 4 and are interchangeable. When connecting the umbilicals to the connectors on the back panel, push the umbilicals in, then pull the gray latch on the panel connector over, to lock the umbilical into place.

Connecting the Actuator Pod(s)

5. Attach each actuator pod to an A-Chamber. Insert the four bolts into the four holes on the chamber. Twist the four wingnuts onto the four bolts until finger tight.



Actuator Pod

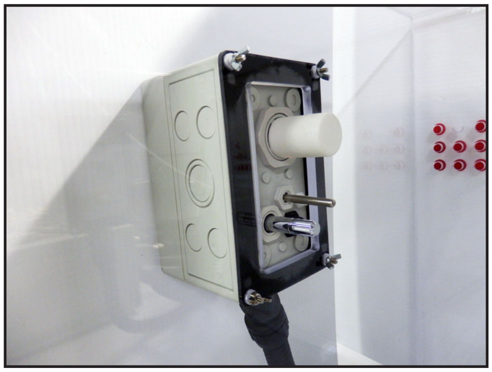
If your system was purchased with a monitor pod then continue with steps 6-10.
If your system was not purchased with a monitor pod, then skip to step 11.

6. Connect the monitor pod umbilical to the connector labeled **MONITOR** on the back panel of the unit. When connecting the umbilical to the connector on the back panel, push the umbilical in, then pull the gray latch on the panel connector over, to lock the umbilical into place.

Connecting the Monitor Pod

7. In order to mount the monitor pod to the desired chamber, remove the plastic blank on the chamber.

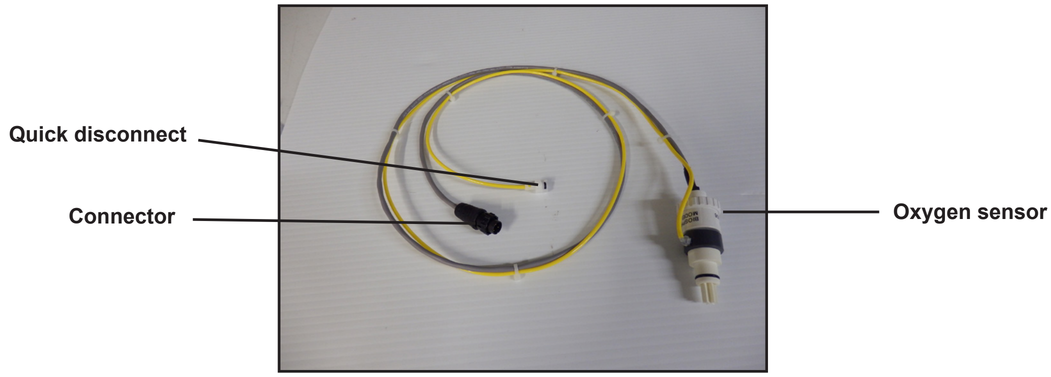
8. With the plate removed, attach the monitor pod to the chamber. Insert the four bolts into the four holes on the chamber. Twist the four wingnuts onto the four bolts until finger tight.



Monitor Pod

9. Attach the remote oxygen sensor to the monitor pod. Line up the key on the connector of the cable to the key on the connector of the electrical receptacle on the pod. Insert and twist on the ring.

10. Connect the tubing to the monitor pod using the quick disconnect. Push on the quick disconnect and turn clockwise to lock into place.

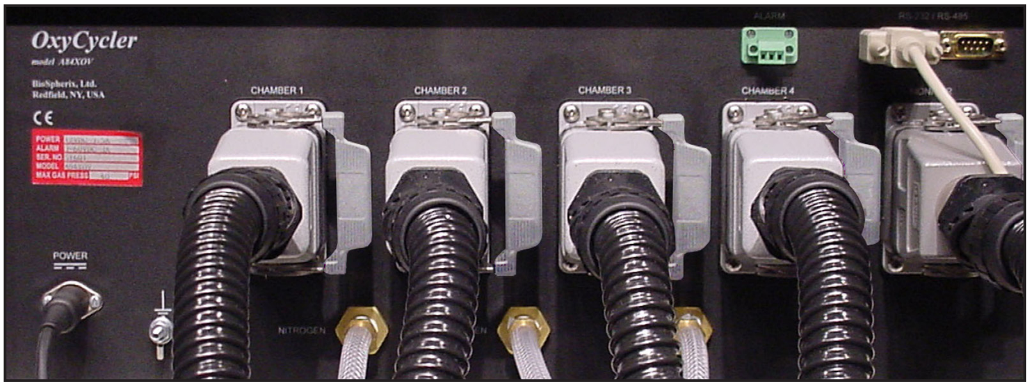


Remote Oxygen Sensor

11. Connect the 12VDC regulated power supply by attaching the 5 pin 12 volt connector to the receptacle labeled **POWER** on the back panel of the unit. Make sure to line up the 5 pins on the plug with the 5 sockets on the receptacle, then insert.

12. Attach the other end of the 12VDC regulated power supply to a wall outlet, power strip, battery backup, etc. (An uninterruptible backup power supply is strongly recommended.) The display on the controller should respond once the unit is powered.

This is what the back panel will look like after installation is complete.



Back Panel Connections

For information on how to setup the computer, please refer to the computer installation instructions located with the supplied computer. Any further questions, please contact the BioSpherix, Ltd. Service Department.

> **NOTE**
>
> *Do not continue with the "Calibrations" section of this manual until you read the "Communications" section and properly install the software and hardware for the OxyCycler model A84 unit.*

6 Communications

The main operator control interface is the control computer. The control computer is connected to each of the system controllers. The front panel of each controller has an interface that can be used for manual control, if necessary. However, the recommended system control option is the computer. The Human Machine Interface provided with the computer consolidates controls for each system, distributes information between controllers, allows global parameters to be set or modified and customizes critical, continuous system-wide data tracking and data recording functions.

The control computer should be located in close proximity to the system controllers.

> **NOTE**
>
> BioSpherix, Ltd. highly recommends that the System Control PC be configured with the Microsoft Windows English Language Package. When configured for languages other than English, the System Control Software may become unstable.

Each controller front panel interface provides the ability to scroll through extensive menus and change parameters. The controllers also have LED readouts that continuously display general operating conditions and alarm conditions, when applicable. However, on a day to day basis, the front panel controls are rarely used.

Introduction to the Software

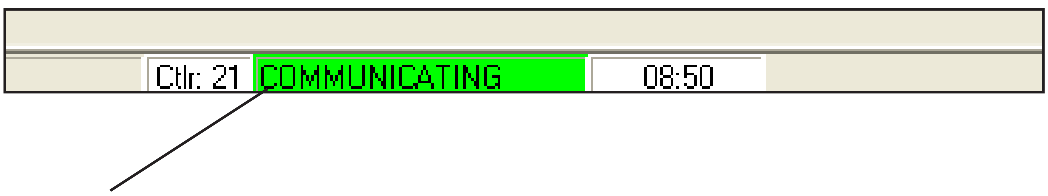
The software used for system control is a Windows based interface consisting of customized screens that are system specific, as well as standardized screens that are used for *viewing process graph information, setting system parameters and data logging.*

Ensure Proper Communications

When the **Ctlr:** field on the bottom of the *Control* screen is green and reads **COMMUNICATING**, it means that all controllers are properly connected, powered up and communicating with the control PC.

When the **Ctlr:** field on the bottom of the *Control* screen is yellow and reads **INCOMPLETE COMMUNICATION**, it means that one or more of the controllers are not connected properly. In order to setup Watview software to communicate with the controller please refer to the *Communications* section of this manual.

When the **Ctlr:** field on the bottom of the *Control* screen is red and reads **NOT COMMUNICATING**, it means that none of the controllers are connected. In order to setup Watview software to communicate with the controller please refer to the *Communications* section of this manual.



NOTE

Prior to beginning any experiments with your system(s) it is important that you review the "Data Logging" and "Trend Plotting" sections. These sections will provide detailed descriptions of each feature as well as procedures on how to store and backup your data.

NOTE

Data logging is not setup to log your data automatically - this feature must be enabled by the user. **If the appropriate settings are not set prior to beginning an experiment, then there will be potential for data loss.**

NOTE

By default, the trend plot graph will only store your data for 30 days and any data that is older than 30 days will be deleted automatically, unless these settings are manually changed.

RS485 Connection

The Sealevel Converter is a communications tool used to convert RS485 communications to USB. Using the Sealevel Converter allows communication with one or more machines from a single computer. If your system was purchased with a computer, then the Sealevel software has been pre-installed at the factory. If your software was not pre-installed, then the following section will describe how to properly install, connect and use this equipment.

If your computer does not support Windows XP then you will need to install Windows Virtual PC-XP Mode prior to downloading and installing the Sealevel software. In order to install Windows XP Mode please read the *Windows XP Addendum* section of this manual. **After XP Mode has been installed, then you can download and run your Sealevel software.**

Sealevel Converter Package

Sealevel Software Installation

> **NOTE**
>
> Be sure to install the Sealevel Software *before* connecting any hardware.

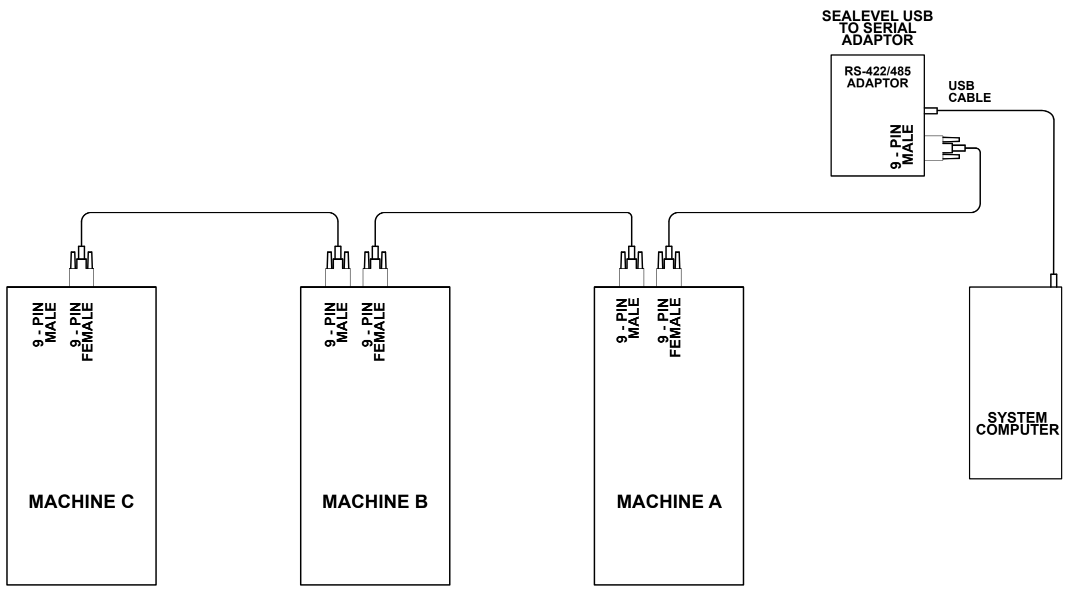
1. Insert the Recovery Software CD into the CD-Rom.
2. Open the CD folder.
3. Locate the Sealevel folder and open.
4. Double click **autorun.exe.**
5. Click the **Install** button.
6. Select the part number of the Sealevel Converter that is being used. In most cases the part number is 2113. Verify this on the back of the converter.
7. Click the **Install Drivers** button.
8. Click the **Finish** button.
9. Now insert the USB cable extending from the Sealevel converter into the computer.
10. Now, navigate to the control panel and click on the **System** icon.
11. Click on the **Hardware** tab.
12. Select **Device Manager**.
13. Double click on **Ports**. Take note of the *COM* number that is in parentheses after *Communications Port*; this will indicate what *COM* port the Sealevel will be reading the data on.

> **NOTE**
>
> All eight dip switches on the back of the Sealevel converter are set to **ON.** This is set at the factory.

Physical Connection Setup

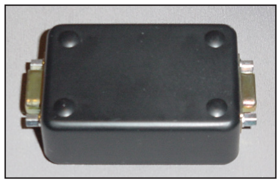
Use the diagram for assistance in properly connecting the RS485 connections.

1. Insert the supplied Sealevel USB Cable into an open USB port on the computer and into the RS485 Sealevel Converter. When connecting the Sealevel USB Cable to the Sealevel Converter be sure to thread in the screw attached to the Sealevel USB Cable.
2. Attach one end of the RS485 Communications Cable to the Sealevel Converter and the other end to **Machine A.** Once attached, be sure to secure the connection by threading the screw terminals into the receptacle. In order to connect two machines to the computer, connect another RS485 Communications Cable from **Machine A** to **Machine B.** It is possible to connect more than two machines to one computer using this daisy chain method.



NOTE

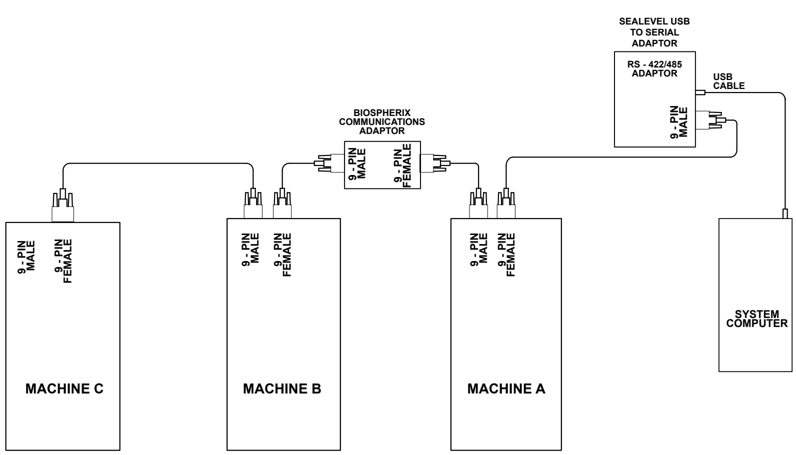
This page is only applicable if you are currently using a BioSpherix, Ltd. System, purchased before April 26, 2012, that utilizes a Communications Adapter (pictured below) and want to connect new, additional BioSpherix, Ltd. System(s).



Communications Adapter

Use the diagram for assistance in properly connecting the RS485 connections.

1. Remove the current system connections. Insert the supplied Sealevel USB Cable into an open USB port on the computer and into the RS485 Sealevel Converter. When connecting the Sealevel USB Cable to the converter, be sure to thread in the screw attached to the Sealevel USB Cable.
2. Attach one end of the RS485 Communications Cable to the RS485 Sealevel Converter and the other end to **Machine A** (the new machine being added to the system). Once attached, be sure to secure the connection by threading the screw terminals into the receptacle. In order to connect additional, new machines to the computer, keep connecting RS485 Communication Cables to the next machine in line using the daisy chain method.
3. Once the recently purchased system(s) is installed, it is ready to chain to the older setup. Attach one end of a RS485 Communications Cable to the last machine connected in step 2. Attach the other end of the RS485 Communications Cable to the BioSpherix, Ltd. Communications Adapter. Once attached, be sure to secure the connection by threading the screw terminals into the receptacles.
4. Attach another RS485 Communications Cable to the BioSpherix, Ltd. Communications Adapter and connect the other end to **Machine B** (the first of the older machines). Once attached, be sure to secure the connection by threading the screw terminals into the receptacles. Continue using the daisy chain method if multiple older machines need to be connected to the setup.



For assistance installing your system, please contact the BioSpherix, Ltd. Service Department using the contact information at the beginning of this manual.

NOTE

Any new machine added to the system has to be re-addressed so it can communicate with the software. Follow the instructions below to assign addresses to each new controller.

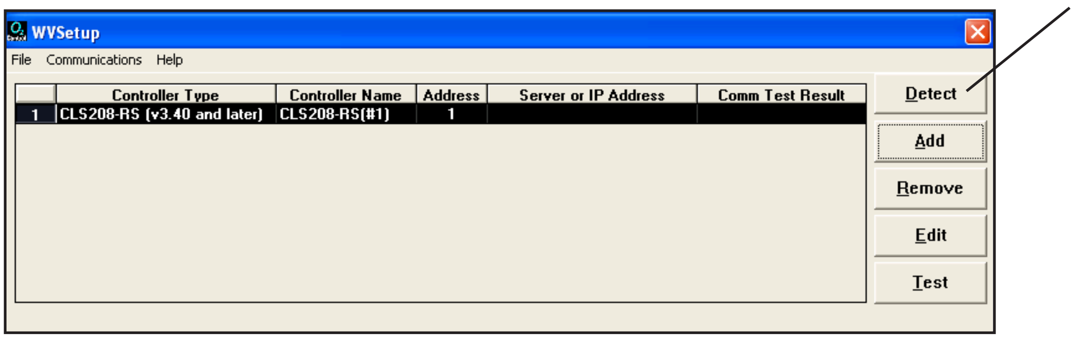
1. On the front panel of the new machine being added to the system, in sequence, push the three buttons one after the other: **enter**- **Alarm Ack**- **Chng SP**. Do not hold down any of the buttons.
2. The menu *SETUP GLOBAL PARAMETERS?* should appear. If not, press **NO** until the menu appears. If it does appear, select **YES.**
3. Select **NO** until the menu *CONTROLLER ADDRESS?* is reached. Select **YES.** If this selection has been passed, press **BACK** and progress through the menus again.
4. Press **YES** or **NO** to scroll up and down through numbers to assign the controller. When the desired number to address the controller with appears press **ENTER** to save the change. **BACK** will cancel the change.
5. Once the number has been assigned and saved select **BACK** twice to get out of the menus. The controller will automatically leave the menu after about 3 minutes of inactivity.
6. The controller must be powered down and restarted to recognize an address change.
7. After the controller is addressed and restarted the next controller in sequence can be assigned following the same procedure.

Watiview Software Installation

If your system was purchased with a computer, then the Watview software has been pre-installed at the factory. If your sysem was not purchased with a computer, or if the controller loses communication with the software then use the following procedure to properly setup the Watview software.

1. Click on the **WVSetup** icon on the desktop to open the **WVSetup** setup screen. If you do not have the Wativew icon saved onto the desktop then the program can be located by accessing the **Start** menu from your computer.

2. The *WVSetup* window will open, displaying your controller inside of the window. Click on **Detect** to open the *Auto Communicator* window.



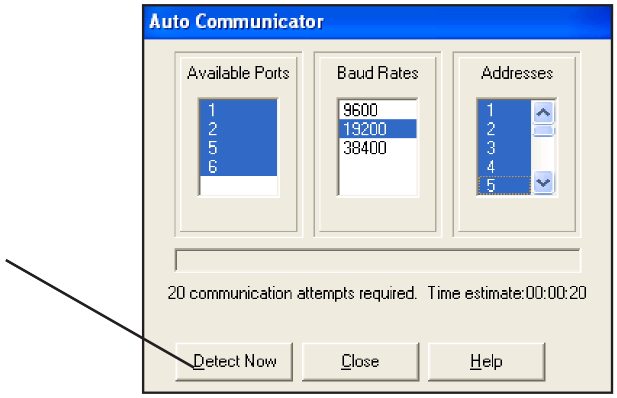
The *Auto Communicatior* window lists *Available Ports*, *Baud Rates* and *Addresses*. The *Baud Rate* will always be **19200** for every system, however the *Port* and the *Address* that the controller is communicating to the software on will not be the same for every system. By performing the following steps within the *Auto Communicator* window you will be able to determine which *Port* and which *Address* your software will be using in order to allow communication between the software and the controller.

3. When the *Auto Communicator* window opens you will need to select **ALL** ports under the *Available Ports* column. To do this, hold down the **Ctrl** key and click on every available port. **NOTE:** In many instances there will be missing ports. In the following example, ports 3 and 4 are not listed in the column. This all depends on system configuration and has no affect on communication.

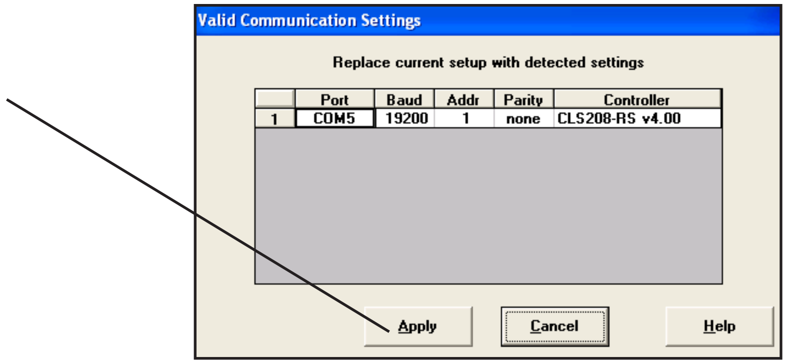
4. Select **19200** under the *Baud Rates* column.

5. Select addresses **1-11** under the *Addresses* column. To do this, hold down the **Ctrl** key and click on each address up until address **11**.

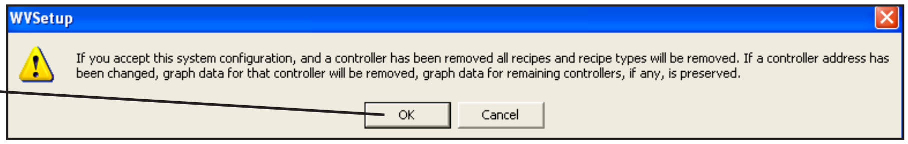
6. Once all items have been highlighted, select **Detect Now**. The computer will begin several attempts to locate the port and address that you need in order for communication to take place between the controller and the software.



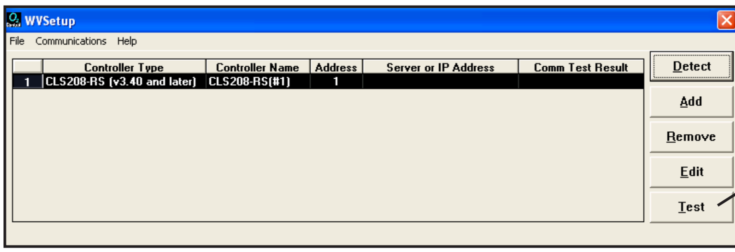
7. Once the appropriate port and address have been detected, the *Valid Communication Settings* window will open displaying where the communication is taking place.
In the following example, the *Port* was found on **COM5** and the *Address* was found on **1**.
Now, click **Apply**.



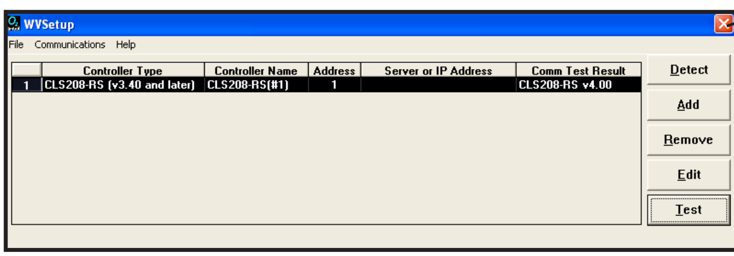
8. The *WVSetup* caution window will open. Click **OK**.



9. The *WVSetup* window will now display the controller that was detected. Select **Test**.



10. Once the controller/test result appear in the *Comm Test Result* column the setup is complete. To exit the *WVSetup* window click on the **red X** in the upper right corner.



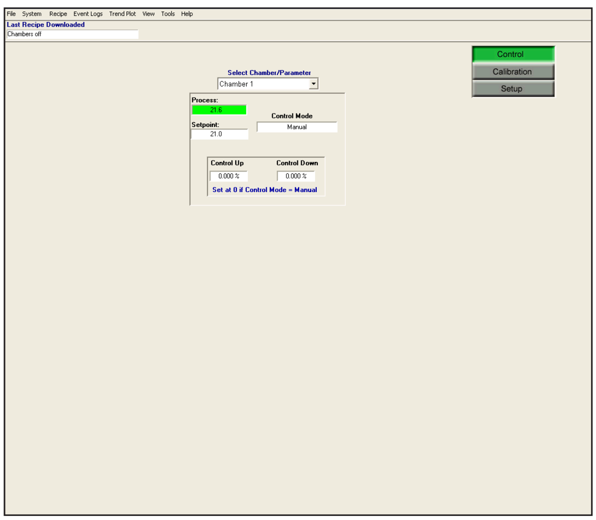
8 Control Screen, Calibration Screen

The operator interface consists of a series of custom overview screens that reflect the configuration of the system. These custom screens are designed to consolidate basic system controls in order to make system operation as simple as possible.

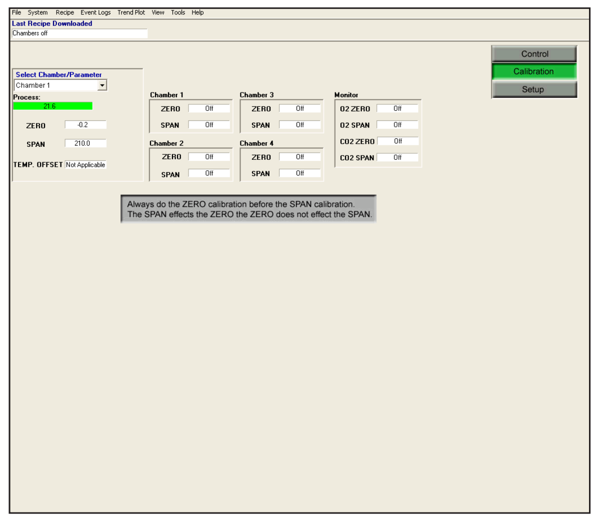
Basic system operation consists of process control functions and sensor calibration. There are two types of operation screens: *Control* screens and *Calibration* screens. *Control* screens allow users to manipulate the process control parameters available for each chamber. *Calibration* screens allow users to initiate calibration procedures for each chamber sensor.

Select Chamber/Parameter selection allows users to choose chambers. Each chamber and parameter is named and numbered for selection. So basic chamber operation consists of selecting the chamber and then selecting the desired function, *Control* or *Calibration*.

A large number of additional screens are also available including the *Trend Plot Graph* screen, *Data Logging* screens and *System Parameter* screens. These screens are accessible to various degrees depending on user status and are usually not required for standard system operations. Detailed screen interface information, system control and system calibration procedures are described later in this manual.



Control Screen



Calibration Screen

All custom control screens have been developed by BioSpherix, Ltd. *Control* screen descriptions are detailed in the following sections. The specific configuration of control screens may differ slightly depending on the features and functions included on individual systems.

The *Calibration* screens & *Control* screens can be accessed by selecting the items in the **View** dropdown.

Control Interface

The following buttons and features are common on all of the main *Control/Calibration* screens:

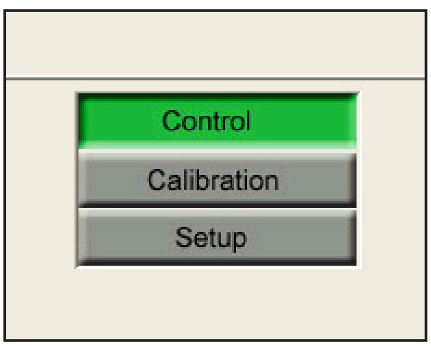
Control – Opens the control interface used to set all control functions

Calibration – Opens the calibration interface used to calibrate sensors.

Back – Returns to the previous screen.

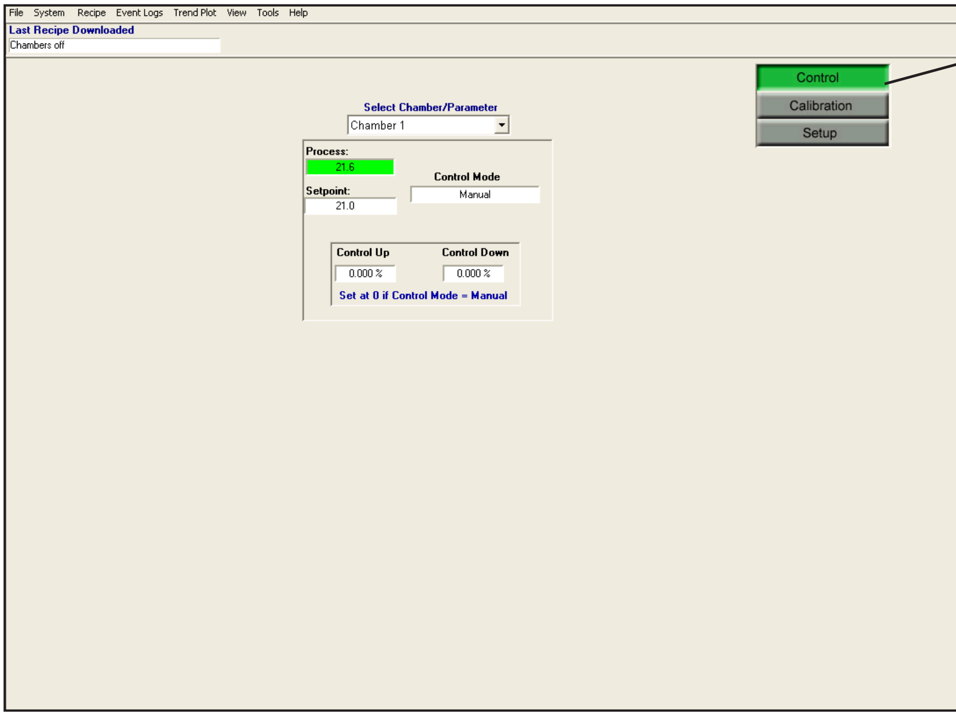
Alarm – If an alarm occurs, click this button to open a detailed description of the alarm.

Green buttons and green fields designate control modes that are currently selected or fields that cannot be manually changed.



Control Screen

The *Control* screen is used to control gas, temperature and RH parameters for each chamber. This screen is also used to turn on/off the sample stream pumps. To access the *Control* screen, click the **Control** button.



Select Chamber/Parameter – This drop down menu allows the operator to select the individual chamber/parameter to control.

Process – This is the real-time process reading of the chamber/parameter that is currently selected in the *Select Chamber/Parameter* field.

Setpoint – This is the desired process level that is currently set for the chamber/parameter that is selected in the *Select Chamber/Parameter* field.

Control Mode – Double click the **Control Mode** field to open the **Control Status** field. *Control Status* (pop-up window) – Select **Auto** or **Manual**:

- Auto – Used the majority of the time; the mode used whenever a parameter is controlled.
- Manual – Used to turn off gas control and used during calibration to zero the *Control UP* and/or *Control Down* fields.
- Tune – Used for system tuning.
- Send (button) – Sends or enters the current selection to the controller.
- Cancel (button) – Closes the *Control Status* field.
- Help (button) – Opens the *Help* file.

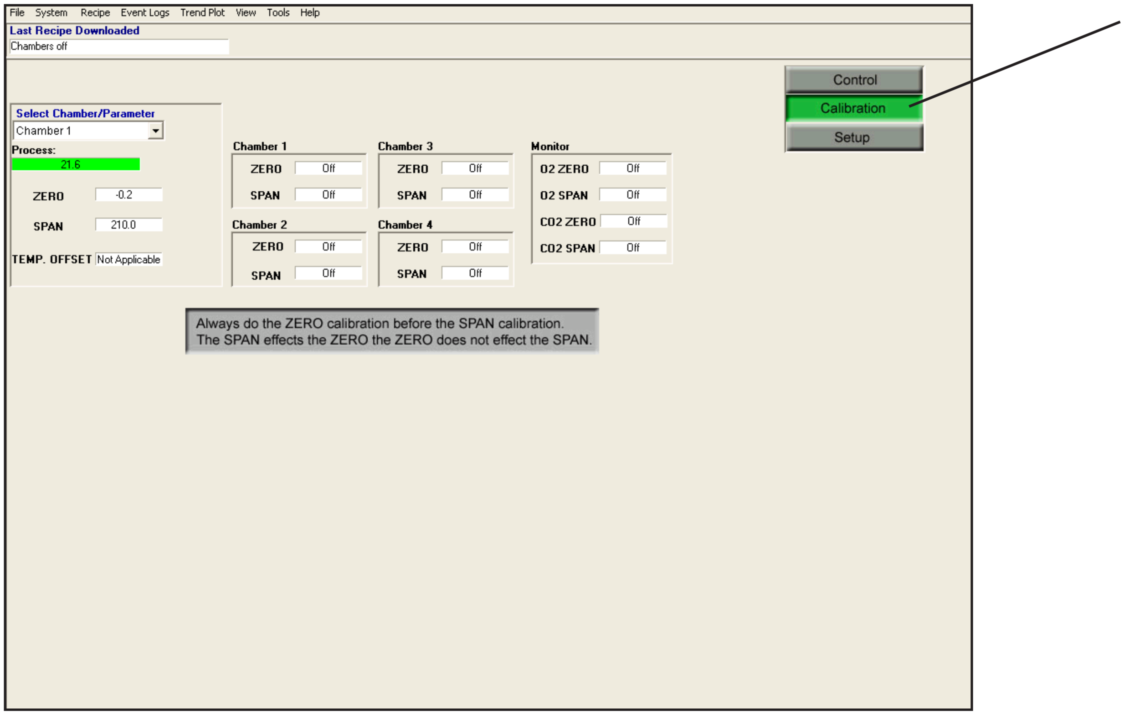
Control UP, Control Down: Used to turn off gas control and used during calibration. After the *Control Mode* is set to *Manual*, these fields are zeroed out by double clicking and entering zero. These fields are automatically updated while the *Control Mode* is set to *Auto*.

NOTE

If Control mode is set to Manual and Off, be sure to set Control Up and Control Down to 0.00%

Calibration Screen

The *Calibration* screen is used during the calibration of each of the sensors. This screen is also used to turn on/off the sample stream pumps. To access the *Calibration* screen, click the **Calibration** button.



Select Chamber/Parameter – This drop down menu allows the operator to select the individual chamber/parameter for calibration.

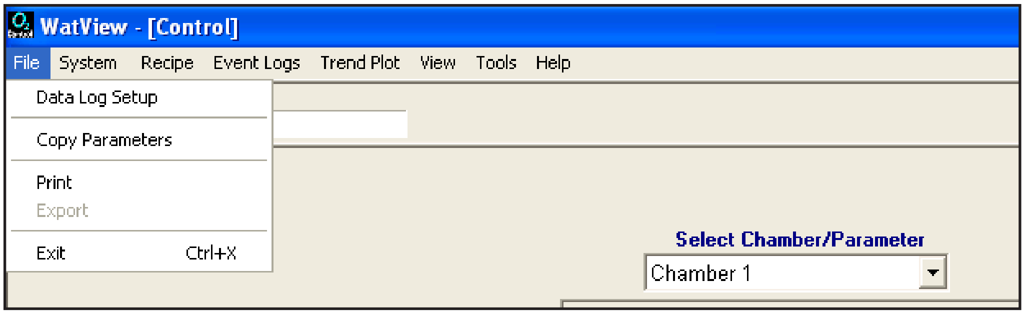
Process – This is the real-time process reading of the Incubation chamber/parameter that is currently selected in the *Select Chamber/Parameter* field.

ZERO – During zero calibration, this field is used to adjust the *Process* reading to *0.0.*
SPAN – During span calibration, this field is used to adjust the *Process* reading to match the known gas level of the SPAN gas.

Chamber # ZERO – On or Off – Turns on/off the zero calibration function for the chosen chamber.
Chamber # SPAN - On or Off – Turns on/off the span calibration function for the chosen chamber.

Monitor O2 ZERO – On or Off – Turns on/off the O2 zero calibration function for the monitor pod.
Monitor O2 SPAN – On or Off – Turns on/off the O2 span calibration function for the monitor pod.
Monitor CO2 ZERO – On or Off – Turns on/off the CO2 zero calibration function for the monitor pod.
Monitor CO2 SPAN – On or Off – Turns on/off the CO2 span calibration function for the monitor pod.

Menu Items



File

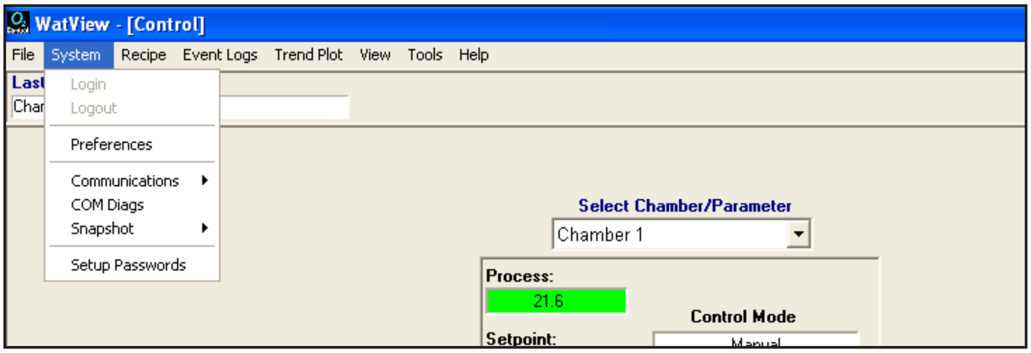
- **Data Log Setup**
  Launch the *Data Logger* window. Use this dialog box to set up, operate and monitor data logging.

- **Copy Parameters**
  Launch the *Copy Parameters* window. Use this dialog box to copy parameter settings from one controller to one or more other controllers or from one index to one or more other indexes.
  The *Copy Parameters* window can also be opened from the *Spreadsheet Overview* screen. To do this, right-click on the row in the *Spreadsheet Overview* screen that contains the settings you want to copy and then select **Copy Parameters.**

- **Print**
  Use this button to launch an interface to print the current screen.

- **Export**
  Use this button to export an image.

- **Exit**
  Exit the WatView application.



System

- **Login**
  Log In to the system

- **Logout**
  Log Out of the system

- **Preferences**
  Launch the *Preferences* window.

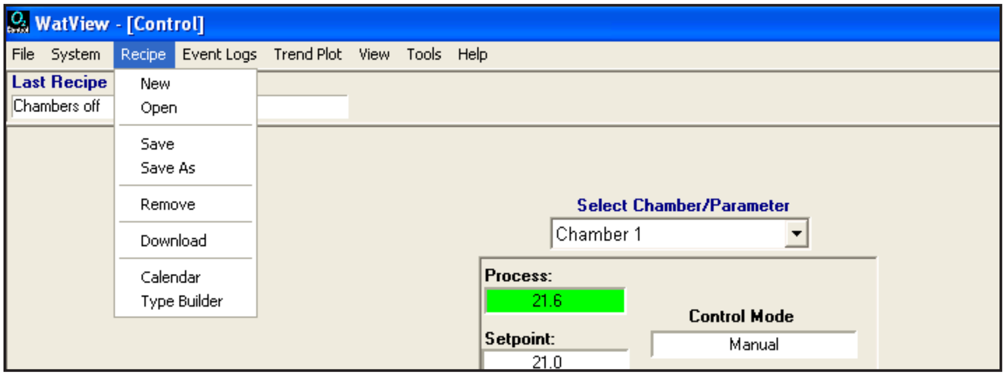
- **Communications, Disable, Enable**
  Select **Disable** to temporarily stop WatView from attempting to communicate with one or more controllers.

  Select **Enable** to have WatView start communicating with controllers with which communications have been disabled.

- **COM Diags**
  Opens the *Communication Diagnostics* screen to determine whether WatView is communicating with the controllers.

- **Snapshot, Save, Restore, Remove**
  A snapshot is a record of a controller's settings stored on the control PC. A snapshot includes the parameters required to set up a controller. A snapshot can be used to restore a controller's setup. A snapshot can also be used to copy the setup of one controller to an identically equipped controller. Snapshots are initially created at the factory after a system has been set up, adjusted to run, and thoroughly tested. A new snapshot should be made for each controller after any additional changes are made.

- **Setup Passwords**
  Opens the password setup dialog. Only the supervisor level password can access the password setup dialog.



Recipe

Recipes provide extensive options to automate system functions and tie in individual controllers.

- **New**
  Creates a new recipe. If more than one recipe type exists, the *New* command opens the *Choose Recipe Type* dialog box. After you choose a recipe type the *Recipe Editor* screen opens.

- **Open**
  Choose this command to select an existing recipe from the *Select Recipe* dialog box and open that recipe on the *Recipe Editor* screen.

- **Save**
  Saves changes to the open recipe when the *Recipe Editor* screen is visible. Otherwise, selecting *Save* opens the *Select Recipe* dialog box and saves the parameters currently in the controller in a new recipe.

> **NOTE**
>
> Saving a recipe does not download parameters to the controller, instead it saves the recipe to the hard drive. Choose **Download** from the **Recipe** menu to download a recipe to the controller.

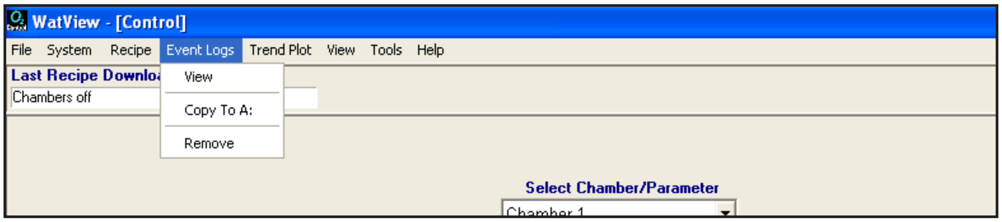
- **Save As**
  Opens the *Save Recipe* dialog box.

- **Remove**
  Choose this command to delete a recipe from the computer's disk. Choosing **Remove** opens the *Select Recipe* dialog box.

- **Download**
  Choose this command to send a recipe to the controller(s). Choosing **Download** opens the *Select Recipe* dialog box.

- **Calendar**
  Opens the *Calendar Events* screen. Use the *Calendar Events* screen to schedule automatic downloads of recipes.

- **Type Builder**
  Opens the *Recipe Type Builder* screen. Use the *Recipe Type Builder* screen to select which parameters are stored and downloaded as part of recipes.



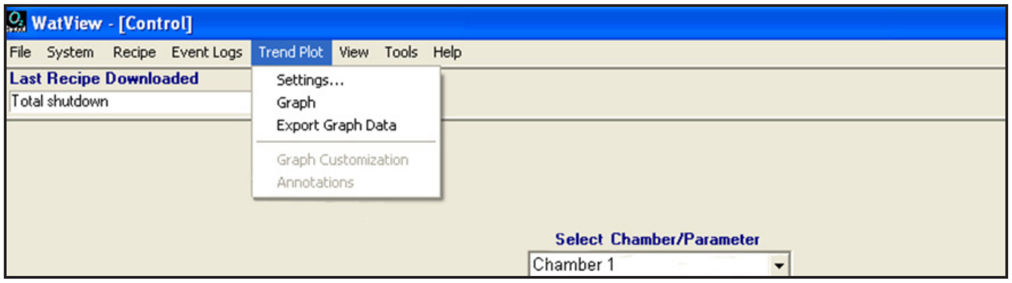
Event Logs

Event logs track system users that log into the system, as well as every action that is performed. Each system user will have a password and each time they log in and use the system, all activities will be recorded.

- **View**
  Opens the *Event Log* screen on which you can select a log to view.

- **Copy to A:**
  Choose this command to copy one or more log files to a flash drive. Selecting **Copy to A:** opens the *Select Items From List* dialog box from which you may select one or more log files to copy to the A: drive. The program will save the selected log files to the flash drive.

- **Remove**
  Choose this command to remove one or more log files from your hard drive. Selecting **Remove** opens the *Select Items* from *List* dialog box from which you may select one or more log files to delete. The program deletes the selected log files from the hard drive.



Trend Plot

- **Settings**
  Opens the *Plot Settings* dialog box. Use this dialog box to specify what data will appear on the trend plot graph.

- **Graph**
  Opens the trend plot graph. Use the *Trend Plot* screen to graph process data.

- **Export Graph Data**
  Opens the *Export Settings* dialog box. Use this dialog box to export data accumulated for trend plotting to a comma-delimited text file.

NOTE

Prior to beginning any experiments with your system(s) it is important that you review the "Data Logging" and "Trend Plotting" sections. These sections will provide detailed descriptions of each feature as well as procedures on how to store and backup your data.

NOTE

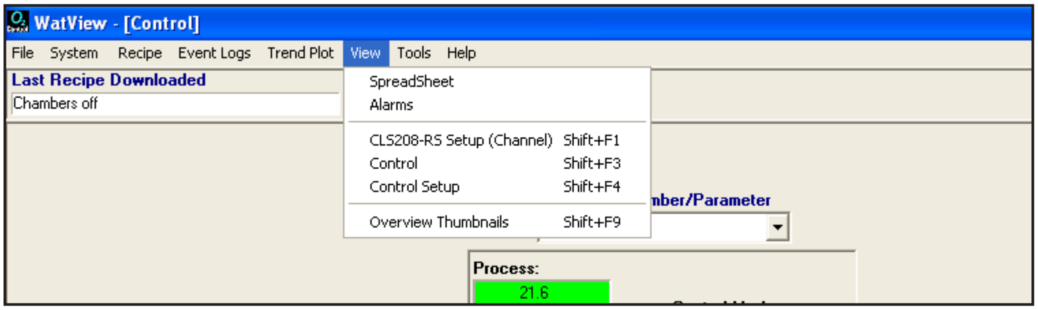
Data logging is not setup to log your data automatically - this feature must be enabled by the user. **If the appropriate settings are not set prior to beginning an experiment, then there will be potential for data loss.**

NOTE

By default, the trend plot graph will only store your data for 30 days and any data that is older than 30 days will be deleted automatically, unless these settings are manually changed.

- **Graph Customization**
  Opens a dialog in which you can adjust the settings that determine how the graph appears (colors, fonts etc.).

- **Annotations**
  Opens the *Edit Graph Annotation* dialog box. Use this dialog box to create an annotation on the graph or edit an existing annotation.



View

- **SpreadSheet**
  Opens the *Spreadsheet Overview* screen. Use this screen to monitor and modify controller parameters. Use the tabs and the buttons to view and edit the parameter values on the various spreadsheets.

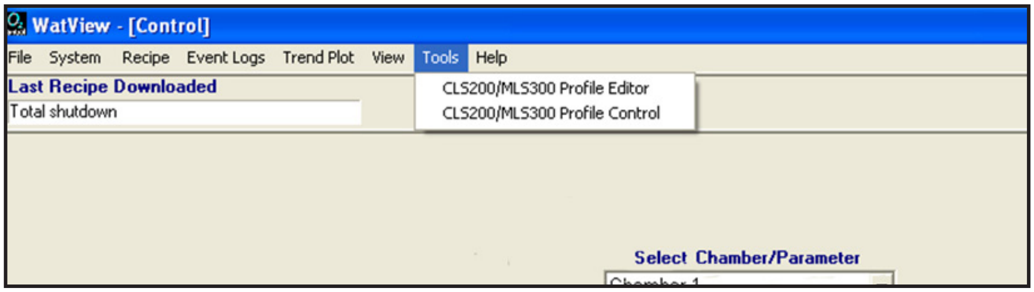
- **Alarms**
  Opens the *Alarm* screen. Use the *Alarm* screen to monitor and manage alarms. If *Auto Alarm View* is selected on the *Alarms* tab on the *Preferences* screen then the *Alarm* screen will display automatically whenever an alarm occurs.

- **CLS208-RS Setup (Channel) Shift +F1**
  Opens the control interface, high level.

- **Control Shift +F3**
  Opens the standard control interface.

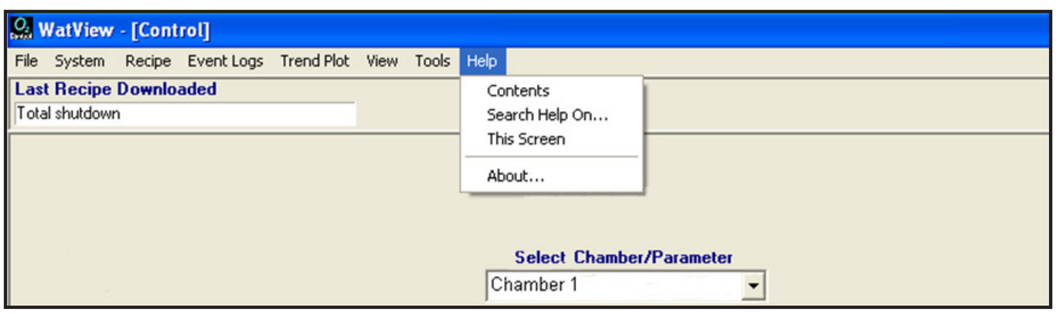
- **Control Setup Shift +F4**
  Opens the standard control interface.

- **Overview Thumbnails Shift +F9**
  Opens the *Overview Thumbnails* dialog box. Use this dialog box to select a custom overview to display. Use the scroll bar to bring additional thumbnails into view. To open a custom overview screen, click the associated thumbnail.



Tools

The *Tools* menu contains tools specific to the installed controllers. See the tool specific help for help on each tool. The *Tools* menu appears only if there are controller's with tools installed. The Tools drop down menu is used to launch the *Profile Editor* and the *Profile Control* for any controller that has this functionality.



Help

A comprehensive set of explanations, definitions, procedures and reference material is offered in this online help system. By familiarizing yourself with its organization you should be able to quickly locate the information you need, when you need it.

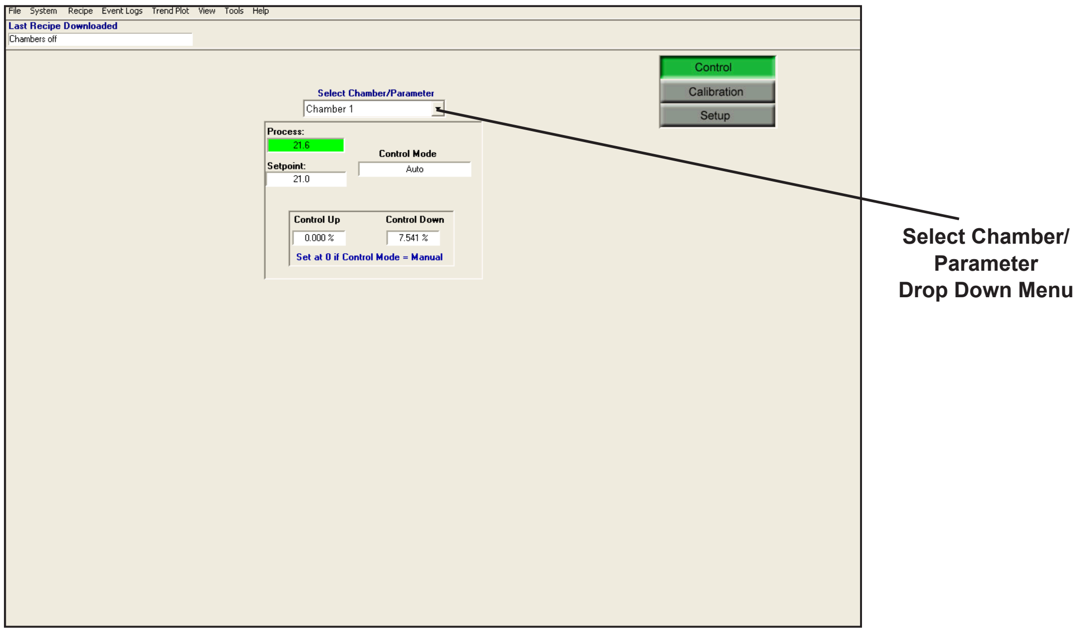
9 Manual Mode, Auto Mode

Manual Mode

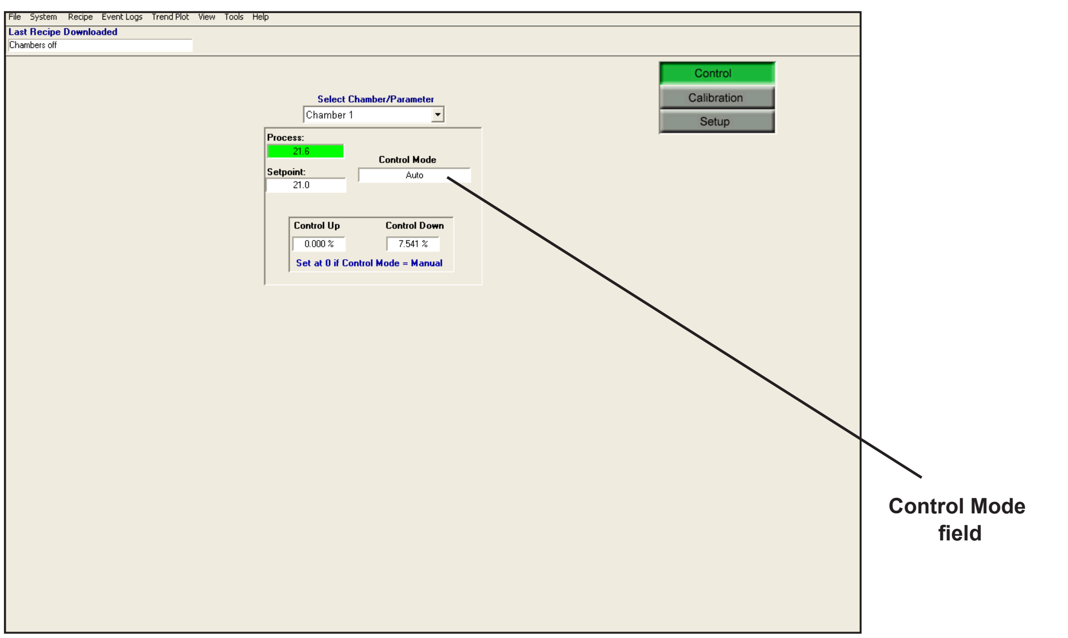
Manual Mode is the default control mode at System Startup. *Manual Mode* is used to turn off a control function (oxygen, carbon dioxide, etc.) by manually setting the *Control UP* and *Control Down* fields to **zero**.

Putting a Control Function in Manual Mode:

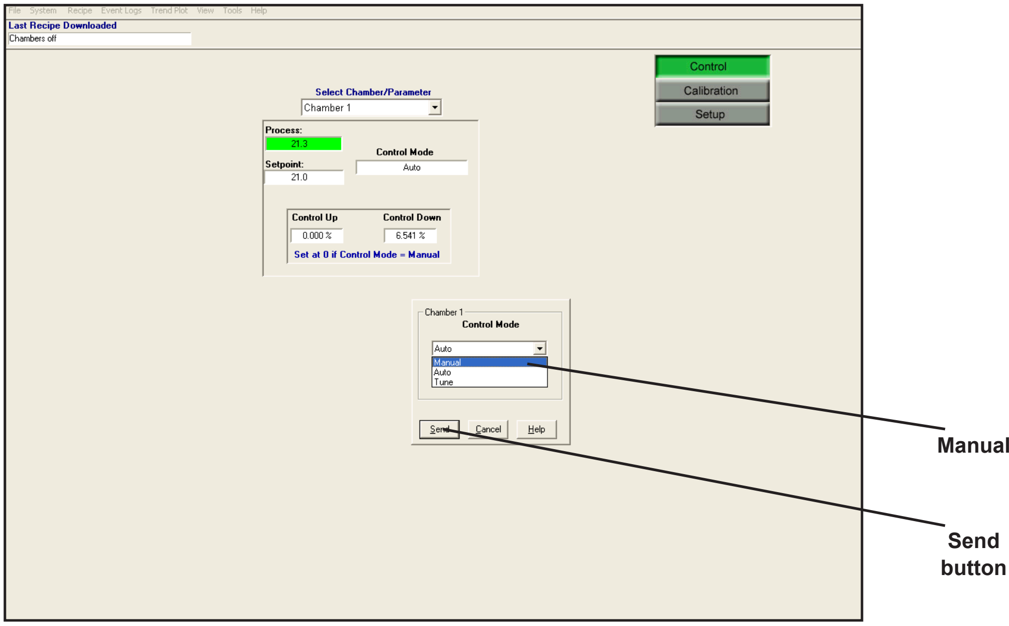
1. *Manual Mode* is set by first selecting the **Chamber/Parameter** from the *Select Chamber/ Parameter* drop down menu.



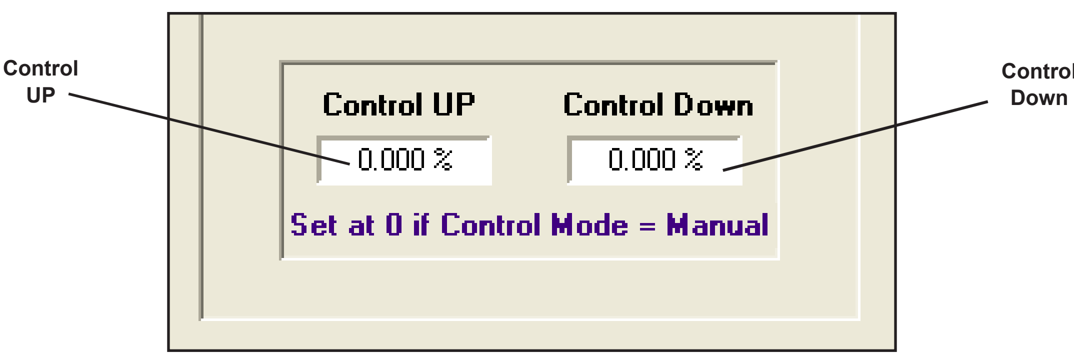
2. Next, double click the **Control Mode** field to open the *Control Mode* drop down menu.



3. The *Control Mode* drop down menu displays the *Manual, Auto, or Tune* options. Select the **Manual** option from the *Control Status* drop down menu and press the **Send** button. The control function is now in *Manual Mode*. The *Control Mode* field will display *Manual.*



4. To turn off gas control, make sure that *Control UP* and *Control Down* fields both read *0.000%*. If either field does not read *0.000%* then double click the number field, adjust to **0** and then click the **Send** button.



Set **Control UP** and **Control Down** to **0.000%**

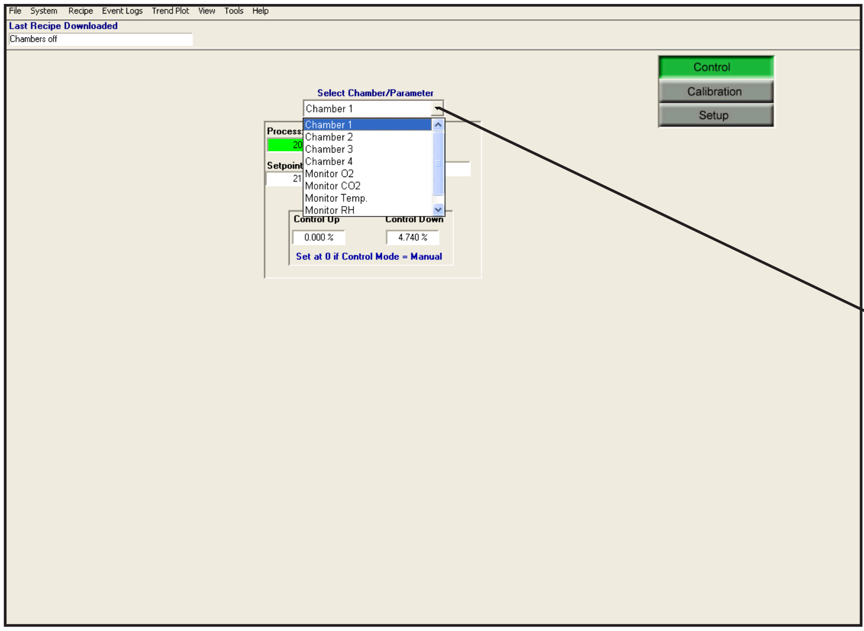
In general, the *Control UP* field controls the process variable input (O2, CO2, etc.) and the *Control Down* field controls the nitrogen input, in order to bring the process level down. Setting the *Control UP* field to **100%** will turn on that function **100%** of the time, **50%** will turn on that function **50%** of the time. Setting the *Control Down* field to **100%** will turn on nitrogen infusion **100%** of the time, **50%** will turn on nitrogen infusion **50%** of the time. Generally, *Manual Mode* is not used to control any process functions.

Auto Mode

Auto Mode is used for all static control functions. When a control function (oxygen, carbon dioxide, etc.) is placed in *Auto Mode* and the desired *Setpoint* is entered, the system will control that function to the entered *Setpoint* until the *Setpoint* is changed or the control function is placed in *Manual Mode.*

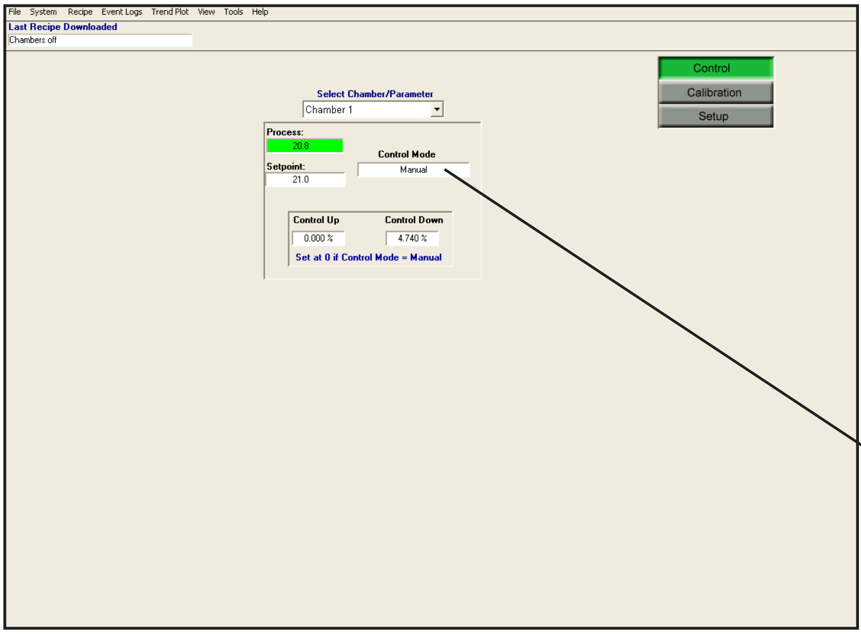
Putting a Control Function in Auto Mode:

1. *Auto Mode* is set by first selecting the **Chamber/Parameter** from the *Select Chamber/ Parameter* drop down menu.



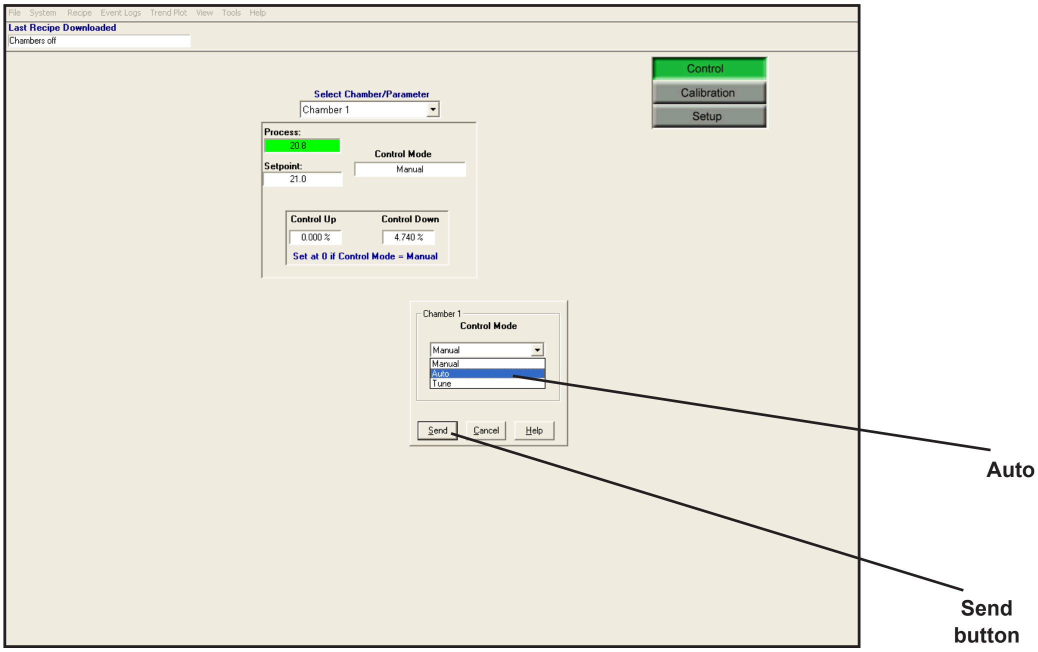
Select Chamber/ Parameter Drop Down Menu

2. Next, double click the **Control Mode** field to open the *Control Status* drop down menu.

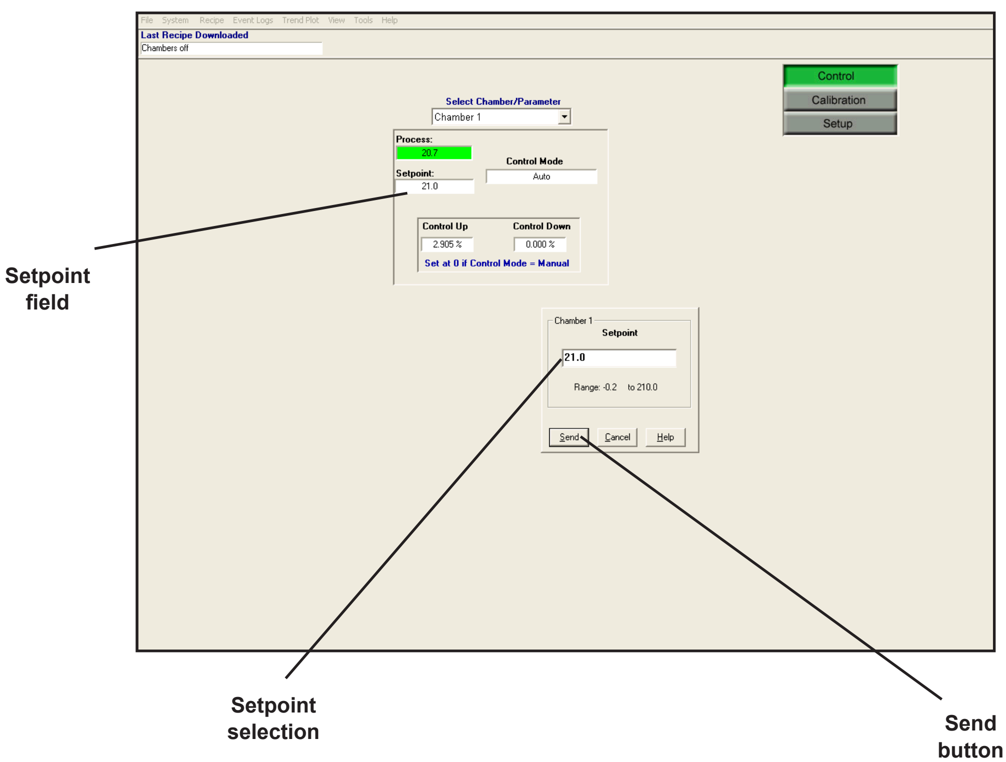


Control Mode field

3. The *Control Status* drop down menu displays the *Manual*, *Auto*, or *Tune* options. Select the **Auto** option from the *Control Status* drop down menu and press the **Send** button. The control function is now in Auto *Mode*; the *Control Mode* field will display *Auto.*



4. With the control function in *Auto Mode*, a setpoint can be entered by double clicking the **Setpoint** field, entering the desired setpoint and then clicking the **Send** button.



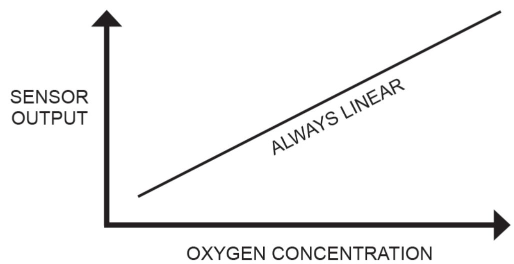
10 Sensor Calibration

Calibration of the sensors is mandatory for the continual operation of the OxyCycler model A84 unit. Calibration should be performed:

- Upon System Startup
- Before and after every production run or experiment
- On a periodic basis, at least once a week

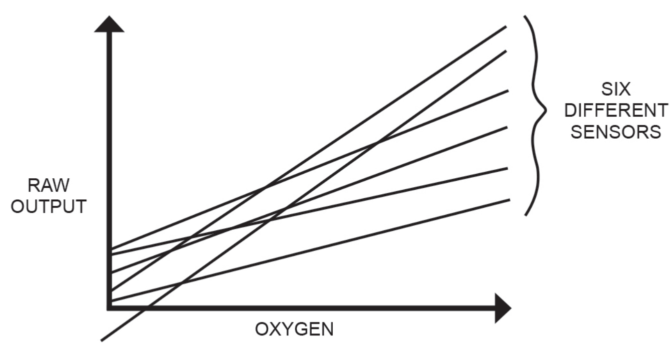
Calibration Overview Tutorial

If a sensor is not calibrated, it will not be accurate. Since the sensor provides the feedback for control, if the sensor is not accurate then control will not be accurate either.

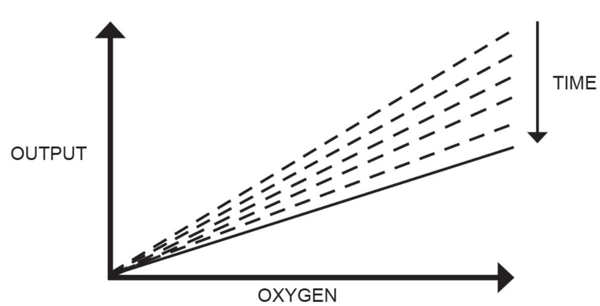


Sensors generate an electrical signal (output) which is linear and directly proportional with the gas concentration.

Sensors are not identical. Although always linear and directly proportional, raw output can be quite different for each sensor.

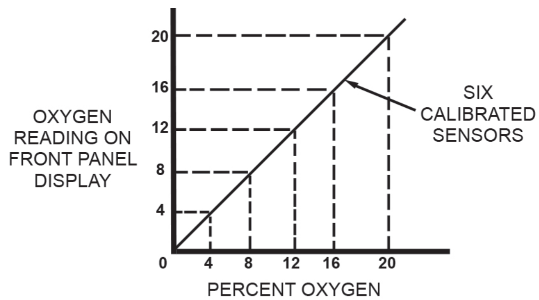


Sensor output changes over time (drift), generally but not always in a slow, downward direction. Sensors remain linear but gradually lose power. Some sensors drift more than others.

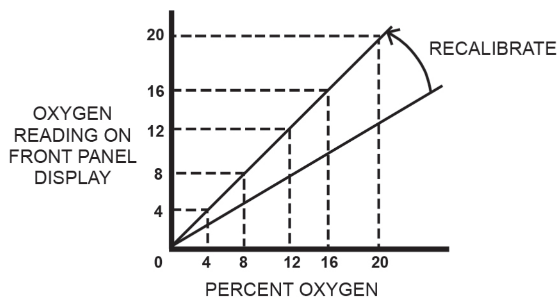


Calibration electronically corrects for the difference among sensors. Regardless of each sensor's raw output, it makes all of them read the same. It makes them read what they should read. It makes them accurate.

Calibration also compensates for drift. Drift can be monitored with periodic calibration checks. If sensors drift away from accuracy, they will not read what they should read. Simply re-calibrate.



Check calibration as frequently as necessary to have confidence in accuracy. Weekly checks are usually sufficient. Check before and after each experiment.



Calibration Standards

Sensors are calibrated to a known standard, either pure gas or a mixture with known gas concentrations. Since sensor outputs are linear, calibrating at two known points makes all other points accurate as well.

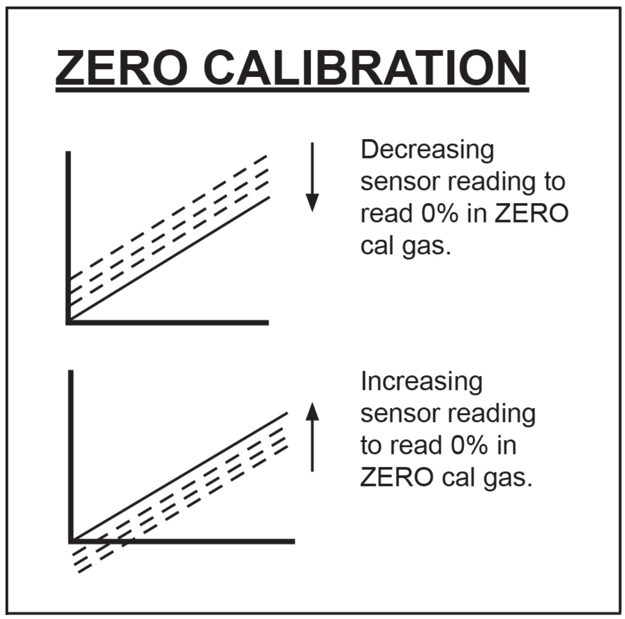
Oxygen sensor and carbon dioxide sensor (in monitor pod) are calibrated to nitrogen for the 0% standard (called ZERO CAL GAS), a certified 1%-99% mix of carbon dioxide/oxygen (respectively) for the span standard (called SPAN CAL GAS). Calibration is accomplished through the sample draw stream within the unit. A sample of the gas is pushed past all of the sensors that are inside of the actuator pod. This way you can make them read what you know they should read, depending on which gas you are sending through the sample draw stream. Make sure to calibrate both the ZERO and the SPAN. Also, make sure that you calibrate the ZERO first and then calibrate the SPAN for an accurate reading.

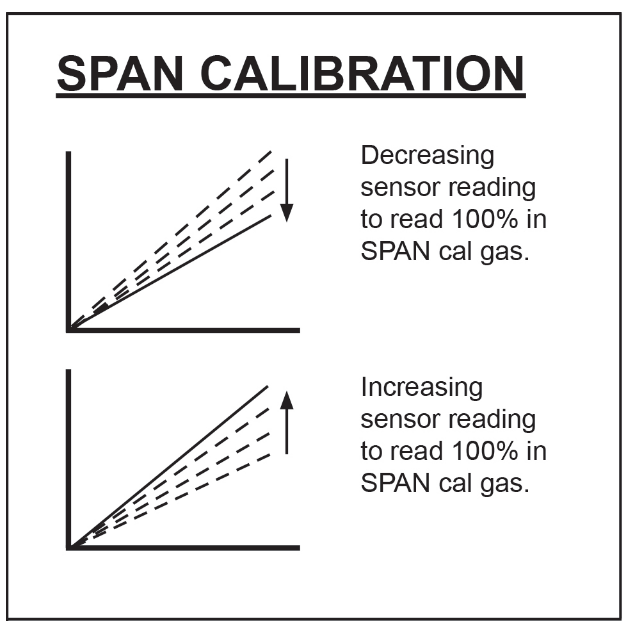
Calibration Checks

Once sensors are calibrated at ZERO and SPAN, you have to check the SPAN calibration periodically to detect and correct for drift. Usually the ZERO point will not change over the life of the sensor, but the SPAN will. Drift is usually minimal for 90% of a sensors active life. You may not have to re-calibrate for a long time, but the only way to know is to check.
Check calibration as frequently as necessary to have confidence in accuracy.

Manual Calibration

It's also possible to manually calibrate sensors. A calibration chamber with 1/8" ID tubing is included for this purpose. The large smooth-bore hole in the calibration chamber fits over the tip of the oxygen sensor. The tubing extends to and fits over the hose barb of the bleed valve outlets on the front panel of the OxyCycler model A84. Opening that bleed valve immerses the oxygen sensor in that gas.
Manual calibrations may never be needed. It's an option for troubleshooting or if there's a malfunction.





Preparation for Calibration

This section will describe how to properly calibrate the oxygen sensors in the actuator pods.

Preparing for Calibration:

1. Next, open the regulator on the compressed nitrogen gas supply to 0-40 PSIG. **Never exceed 40 PSIG, doing so could damage the equipment.**
2. Now, open the regulator on the compressed carbon dioxide/oxygen mix gas supply to 0-40 PSIG. **Never exceed 40 PSIG, doing so could damage the equipment.**
3. Then, check to make sure that the compressed nitrogen gas supply is connected properly. Open the bleed valve labeled **NITROGEN** on the front panel; if gas is heard expelling from the bleed barb, then the gas is connected properly. Once it has been confirmed that the nitrogen is connected properly, close the bleed valve.
4. Next, check to make sure that the compressed carbon dioxide/oxygen mix is connected properly. Open the bleed valve labeled **MIX** on the front panel; if gas is heard expelling from the bleed barb, then the gas is connected properly. Once it has been confirmed that the carbon dioxide/oxygen mix is connected properly, close the bleed valve.

NOTE

Do not continue with the "Calibrations" section of this manual until you have fully read the Communications section and properly install the software and hardware for the OxyCycler model A41 unit.

How to Access the OxyCycler WatView Software:

1. Turn on the computer.
2. Double-click the **OxyCycler/WatView** icon, which is located on the desktop.
3. Once the program has loaded, begin calibration.

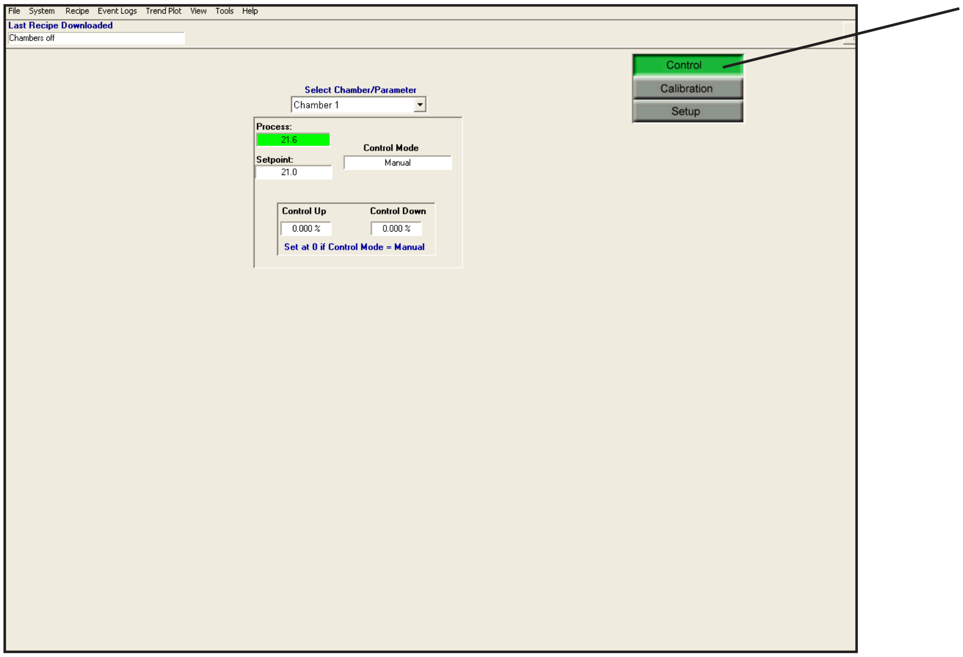
Calibration of Actuator Pods

This section will describe how to properly calibrate an actuator pod. Use this process to calibrate all of the actuator pods. All of this will be done on the computer.

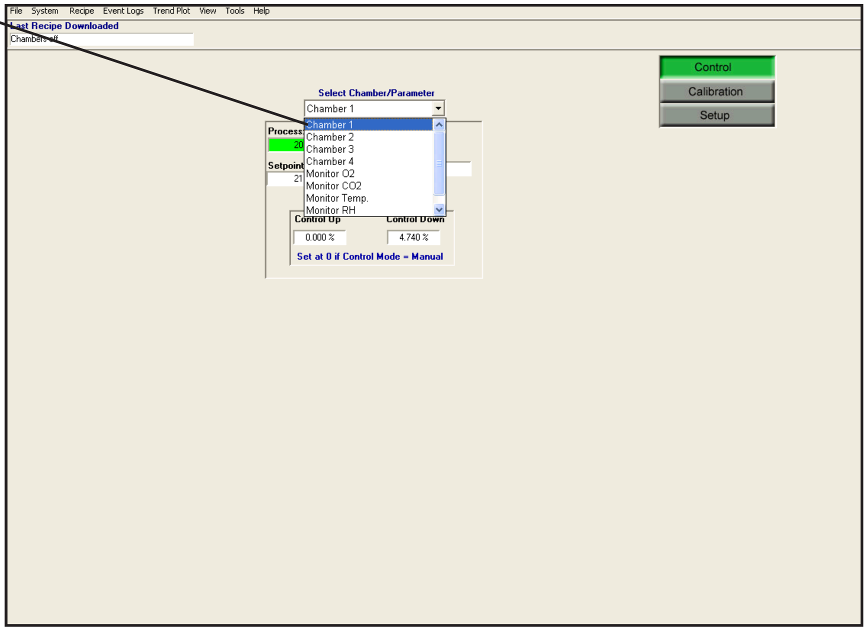
Shutting Off Gas Control:

1. Before calibrating, shut off all gas control.

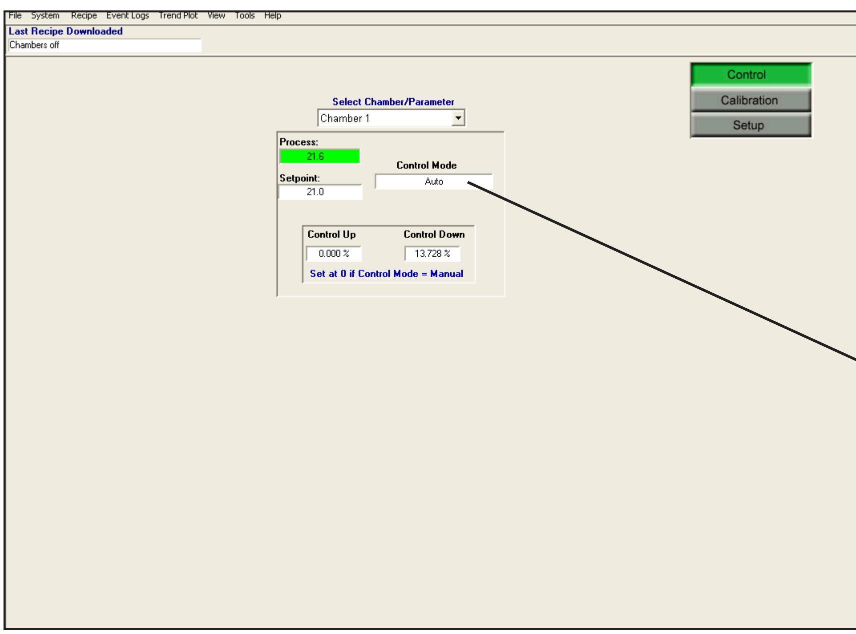
2. Click the **Control** button.



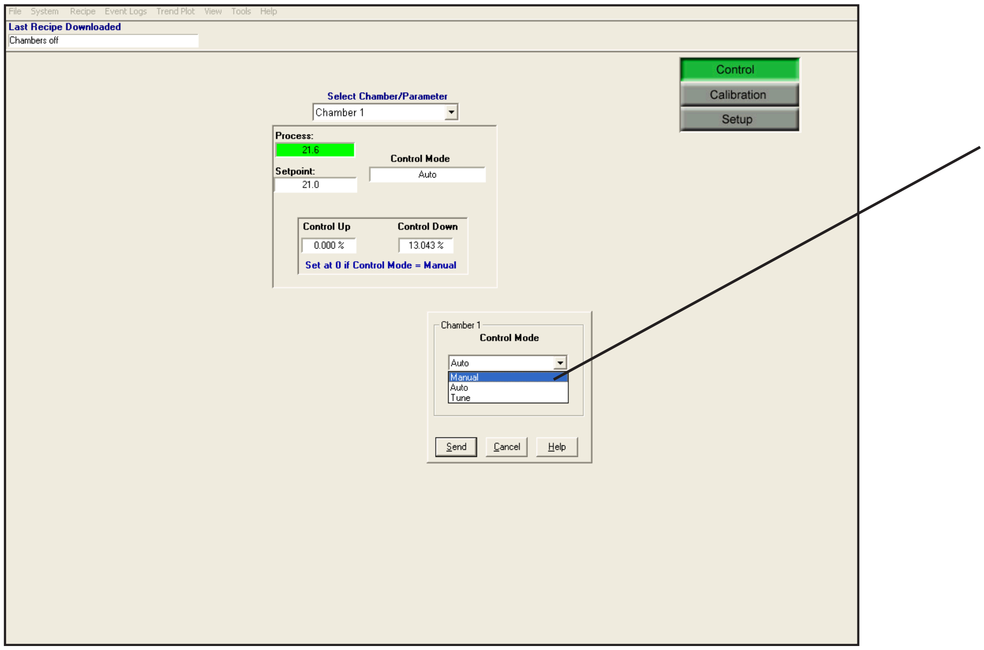
3. Under the *Select Chamber/Parameter* heading, select **Chamber 1** in the pull down menu.



4. Double click the reading underneath **Control Mode** to open the *Chamber 1 Control Mode* window.

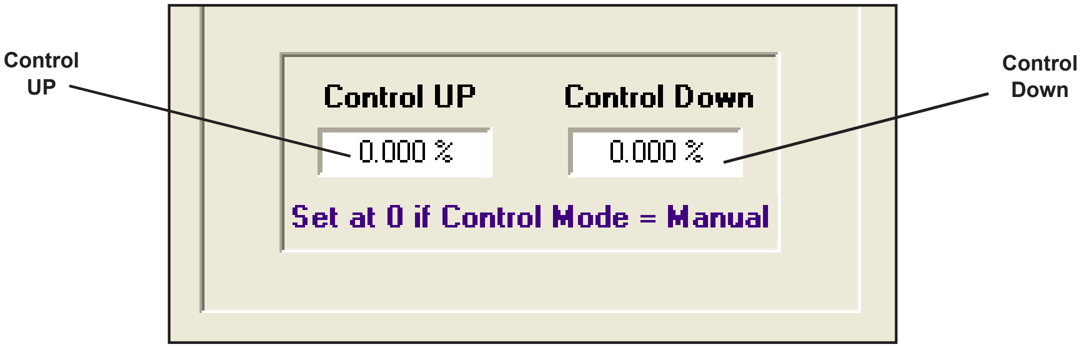


5. Change the *Chamber 1 Control Mode* to **Manual** in the pull down menu and click **Send.**



6. Make sure that the *Control Up* and the *Control Down* are both reading *0.000%.*

7. If either one or both don't read *0.000%* then double click the number in either column to bring up the popup window, adjust the number to **0** and click **Send.**

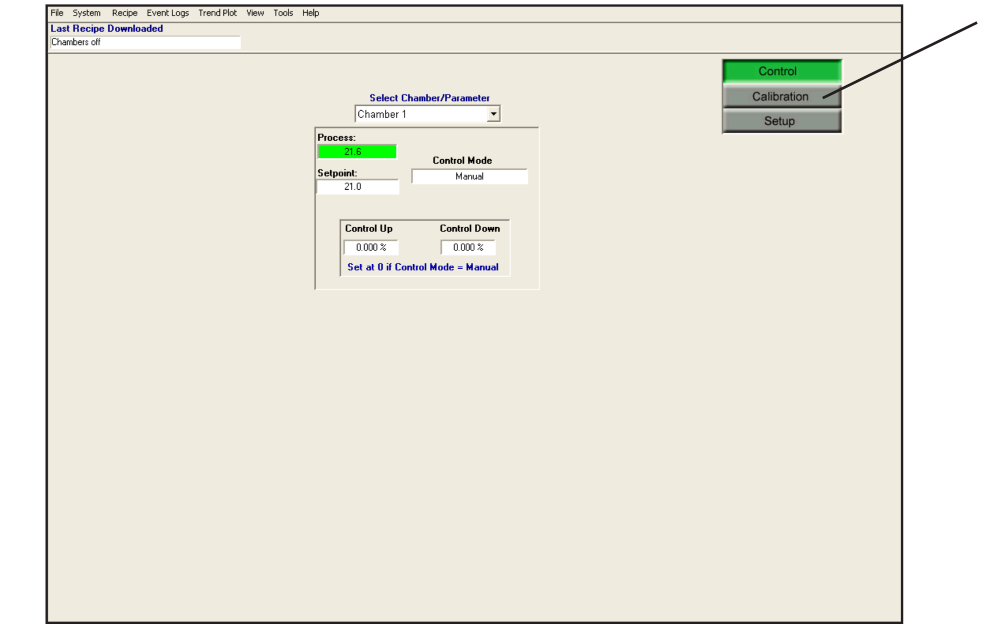


Set **Control UP** and **Control Down** to **0.000%**

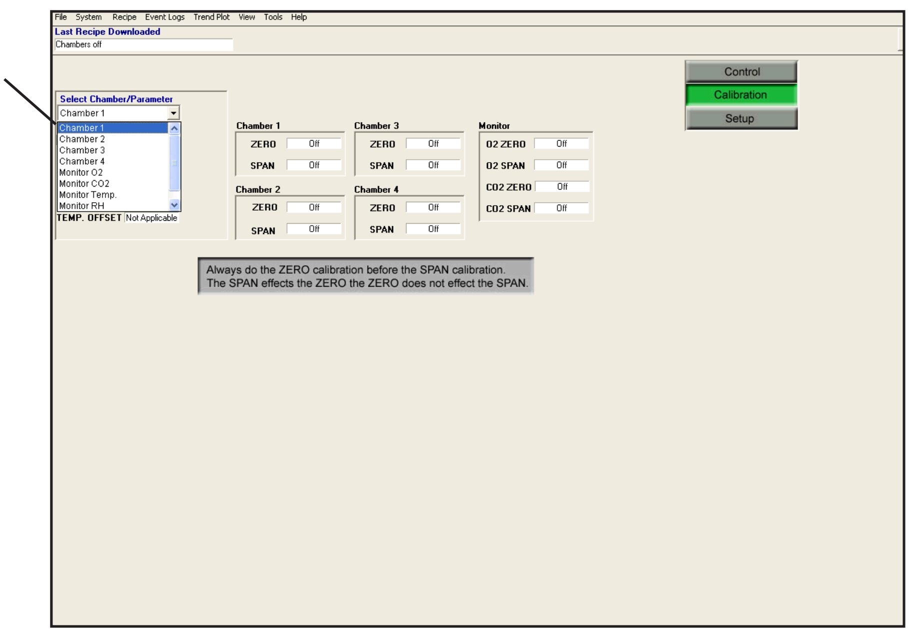
8. Repeat this process for all the other chambers.

ZERO Calibration:

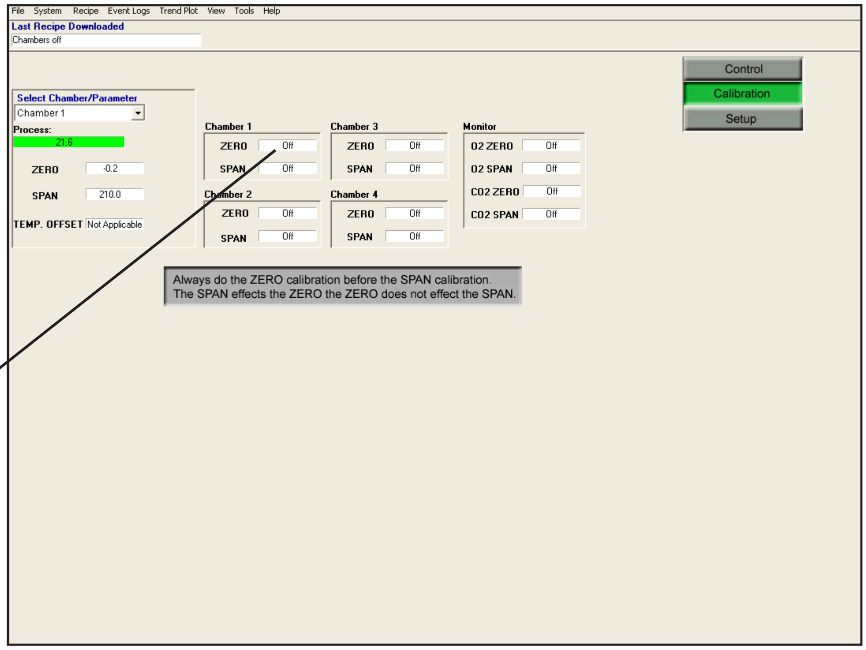
1. Click the **Calibration** button.



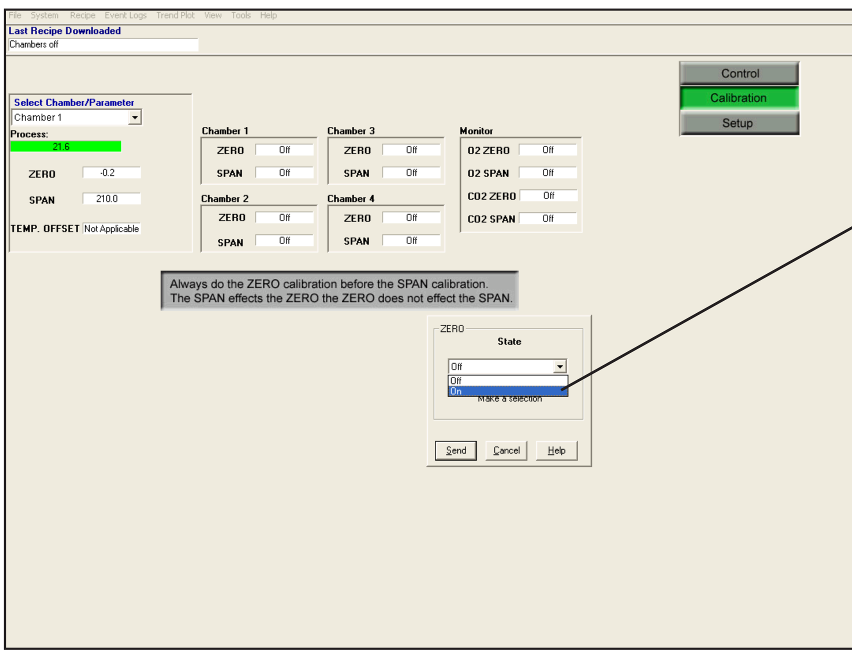
2. Under the *Select Chamber/Parameter* pull down heading, select a chamber to calibrate. In this example we will select **Chamber 1.**



3. Under the *Chamber 1* heading, double click the reading next *to* **ZERO.**



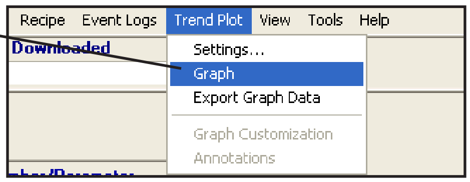
4. Change the *ZERO State* to **On** and click **Send.** This will turn on the zero calibration function.

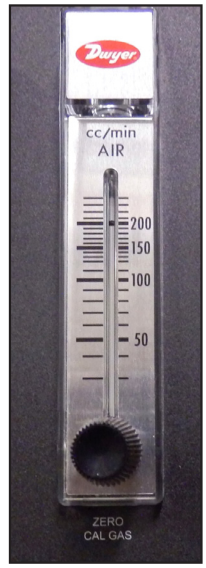


5. Adjust the *ZERO CAL GAS* flowmeter on the front panel of the unit to read **200cc.**

6. Go back to the computer, wait for the *Process* reading to level off (1-2 minutes). You can tell the sensor is reading only the zero calibration gas when the *Process* reading on the *Calibration* screen becomes stable and the reading levels out.

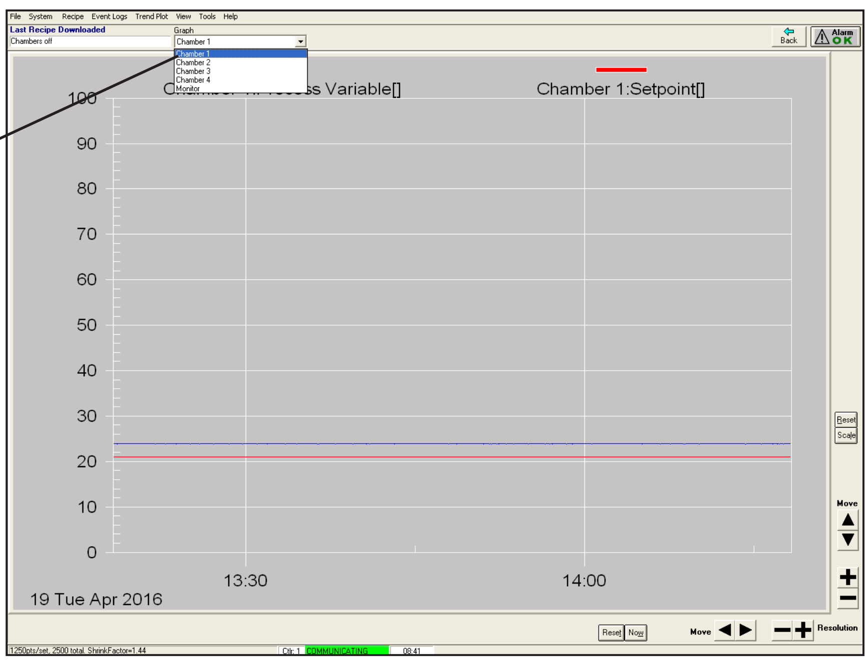
7. Another way to watch the *Process* reading, is to use the *Trend Plot* window. To open the *Trend Plot* window, click on the **Trend Plot** tab in the toolbar and select **Graph.**





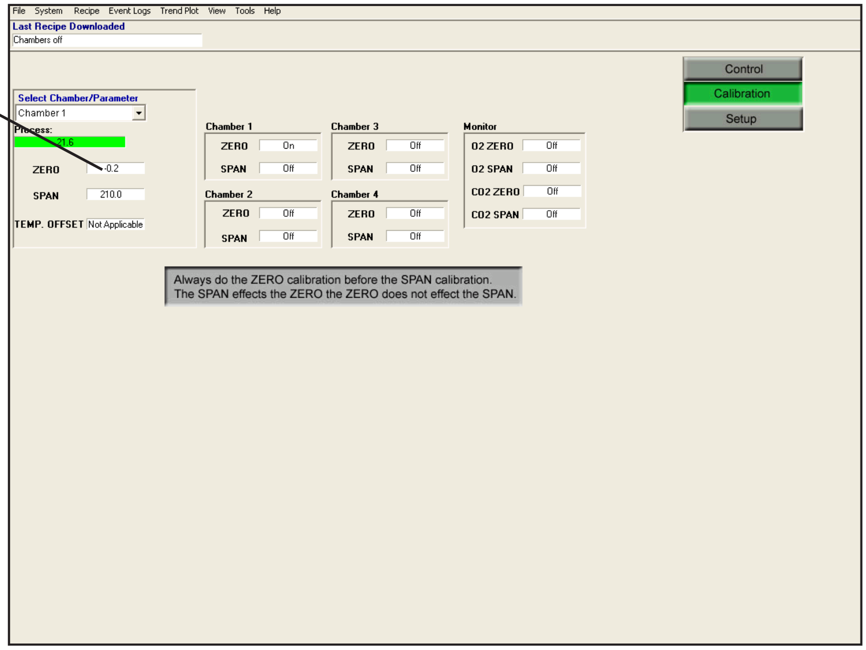
Zero Calibration Flow Meter

8. The *Trend Plot* window will display the *Process* reading with a graph. From the pull down menu, on the *Trend Plot* window, select **Chamber 1.** (Window may vary slightly from picture below.)



9. Once the graph levels off, go back to the *OxyCycler* window, by clicking the **Back** button.

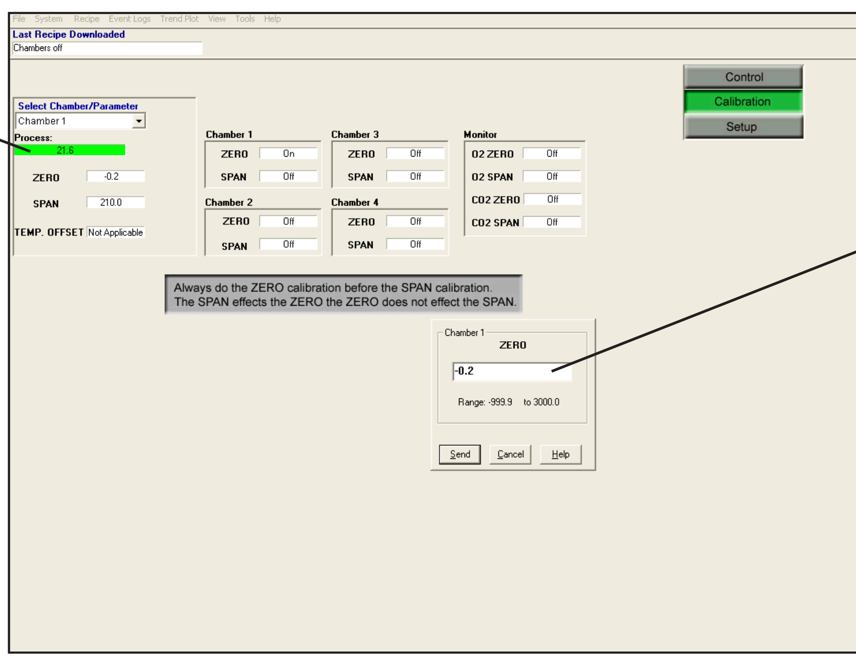
10. Double click the reading next to **ZERO** to open the *Chamber 1 Zero* popup window.



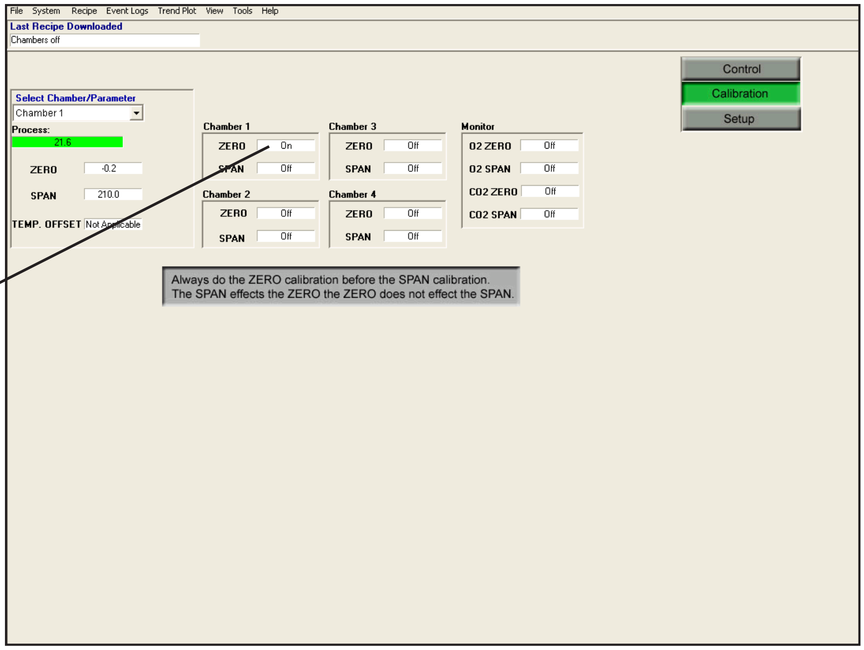
11. In the *Chamber 1 Zero* popup window, adjust the **ZERO** reading up or down so that the *Process* reads **0.0** and then click **Send.** The *ZERO* function corresponds with the *Process* reading. The amount the *ZERO* function is changed, is the amount the *Process* will change.

Example: If the *Process* field shows 0.1 and the *ZERO* field shows 0.3, changing the *ZERO* field to 0.2 will bring the *Process* field down to 0.0.

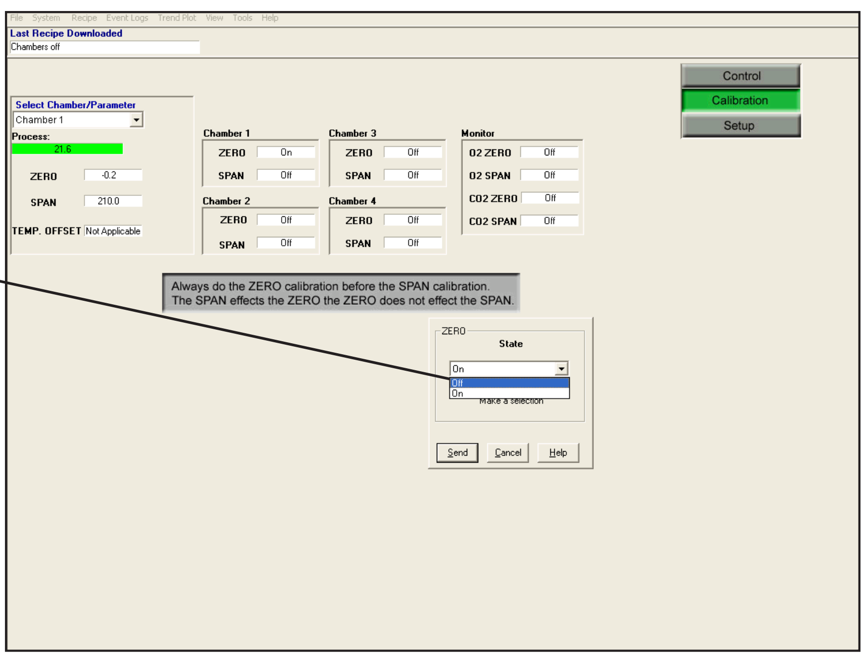
Process



12. Once the *ZERO* function has been calibrated it must be shut off. To do this double click the reading next to **ZERO** underneath the *Chamber 1* heading.



13. Once the popup window opens, change the *ZERO State* to **Off** and click **Send.**

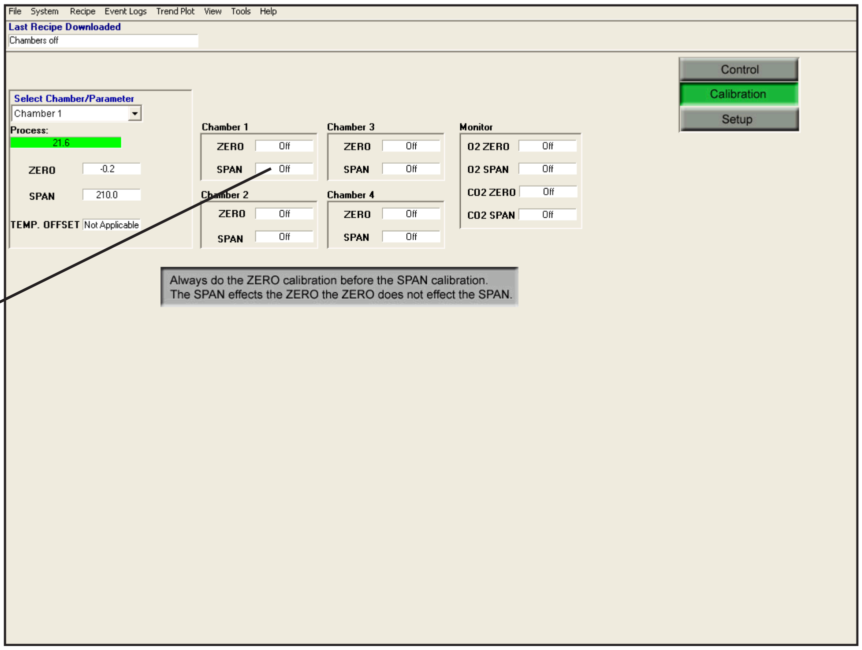


SPAN Calibration:

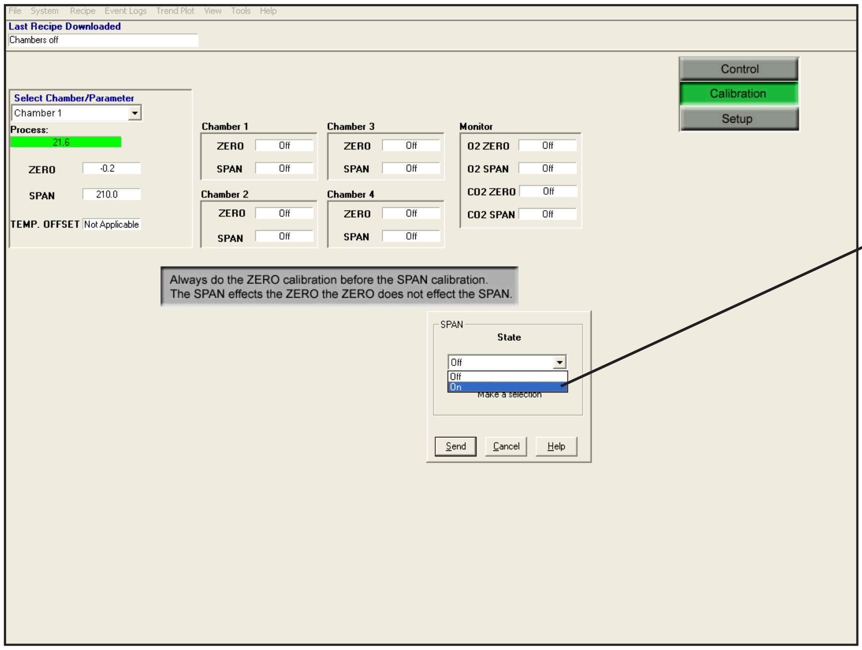
1. Wait approximately 3-4 minutes between the calibration of the ZERO and the calibration of the SPAN. While calibrating Chamber 1, either wait 3-4 minutes, or go through and calibrate all other chambers. Use the same process for all sensors as was used for *Chamber 1.*

2. After 3-4 minutes (or after calibrating the sensors to ZERO on all other chambers) begin *SPAN* calibration for *Chamber 1.*

3. Double click the reading next to **SPAN** underneath the *Chamber 1* heading.



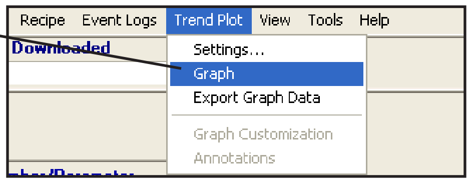
4. Once the popup window opens, change the *SPAN State* to **On** and click **Send.** This will turn on the span function.



5. Adjust the *SPAN CAL GAS* flowmeter on the front panel to read **200cc.**

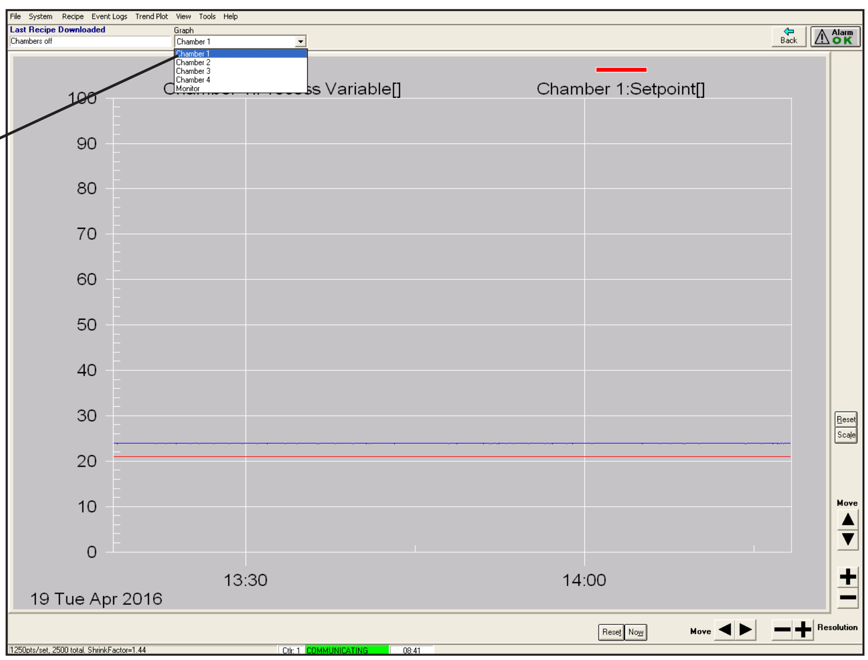
6. Go back to the computer, wait for the *Process* reading to level off (1-2 minutes). You can tell the sensor is reading only the span calibration gas when the *Process* reading on the *Calibration* screen becomes stable and the reading levels out.

7. Another way to watch the *Process* reading, is to use the *Trend Plot* window. To open the *Trend Plot* window, click on the **Trend Plot** tab in the toolbar and select **Graph.**



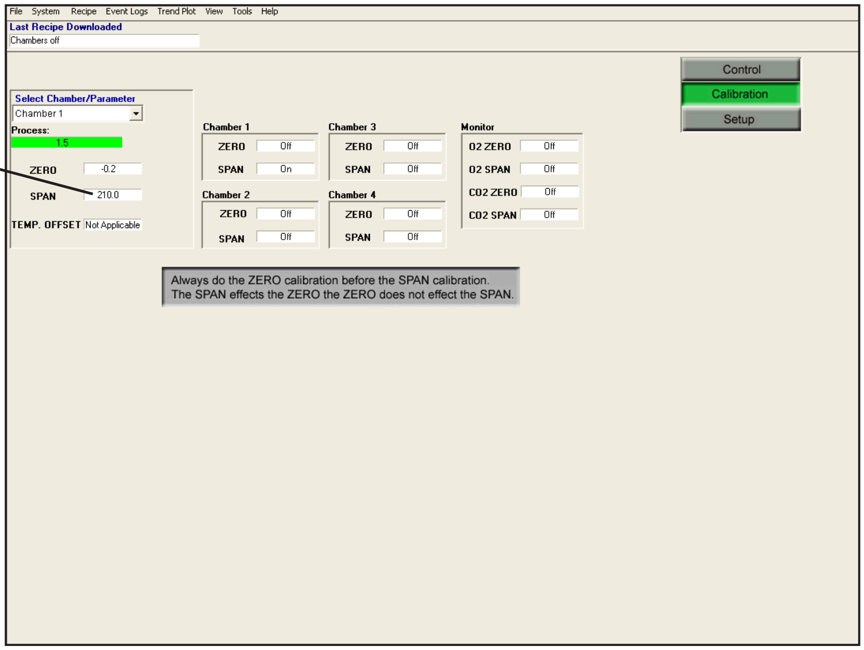
Span Calibration Flow Meter

8. The *Trend Plot* window will display the *Process* reading with a graph. From the pull down menu, on the *Trend Plot* window, select **Chamber 1.** (Window may vary slightly from picture below.)



9. Once the *Process* has leveled, go back to the *OxyCycler* window by clicking the **Back** button.

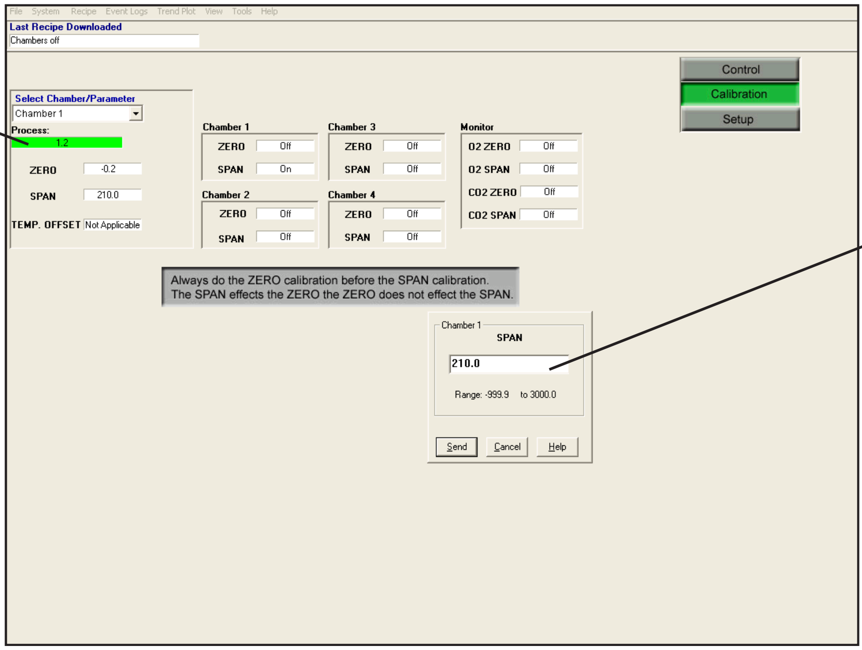
10. Double click the reading next to **SPAN** to open the *Chamber 1 SPAN* popup window.



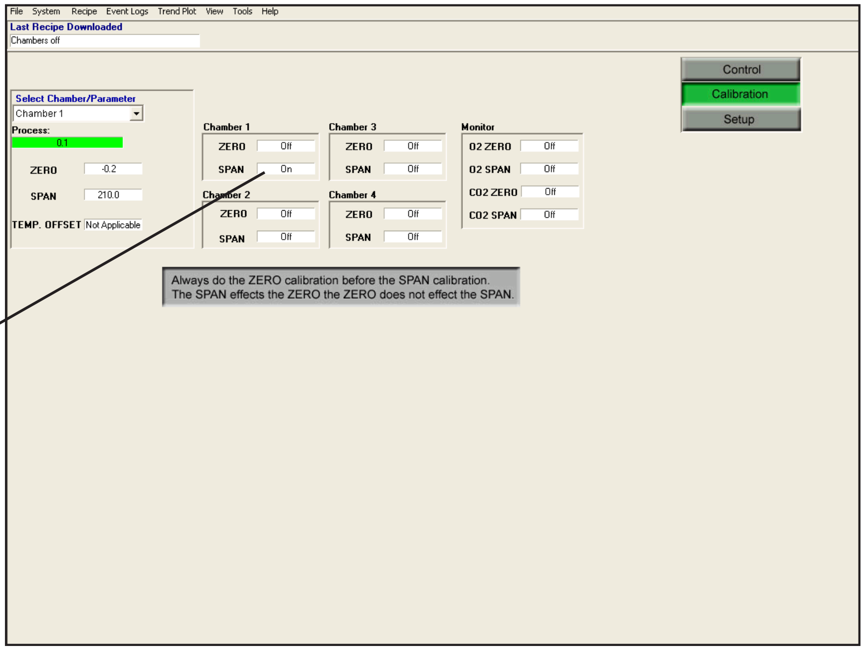
11. In the *Chamber 1 SPAN* popup window, adjust the **SPAN** reading up or down so that the *Process* reads the exact O2 percentage that is in the CO2/O2 mix (see the certificate on the compressed mix for the exact percentage of oxygen) and then click **Send.**

The *SPAN* corresponds with the *Process*, but not the same way as the *ZERO* does, it is a more coarse adjustment.

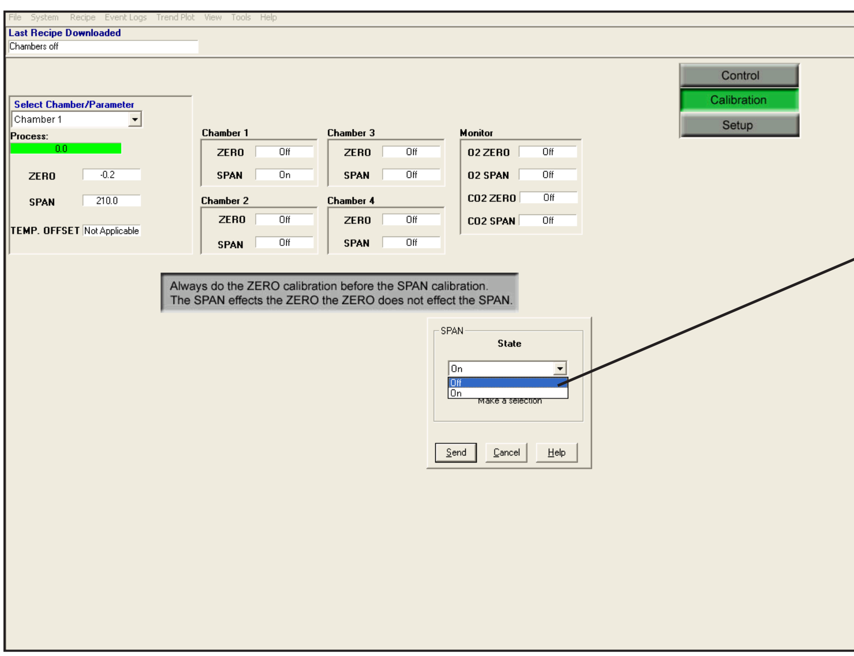
Process



12. Once the *SPAN* function has been calibrated it must be shut off. To do this double click the reading next to **SPAN** underneath the *Chamber 1* heading.

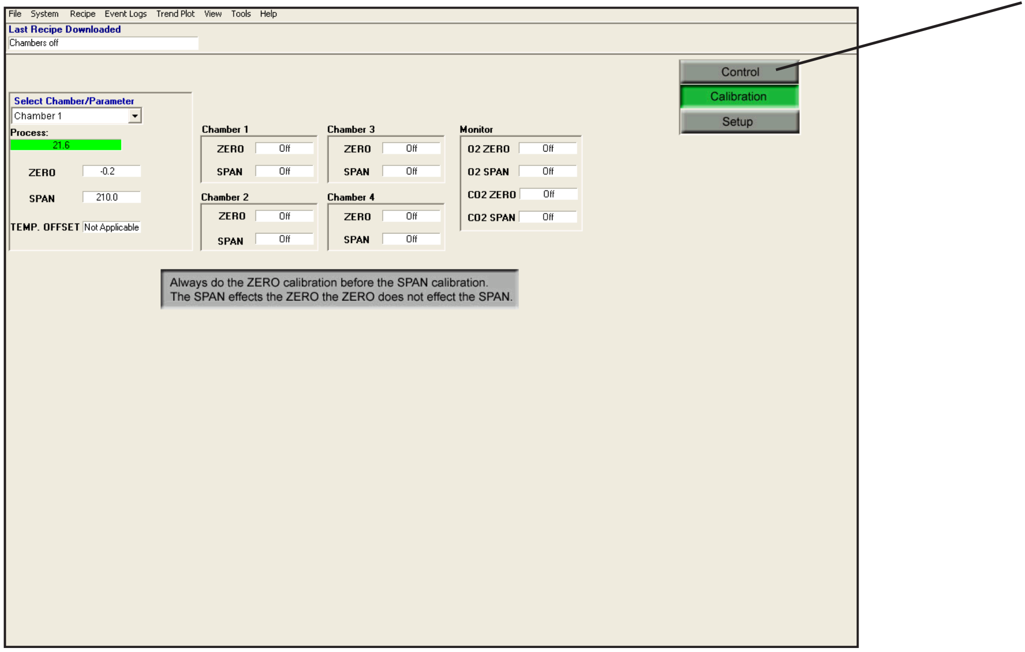


13. Once the popup window opens, change the *Span State* to **Off** and click **Send.**

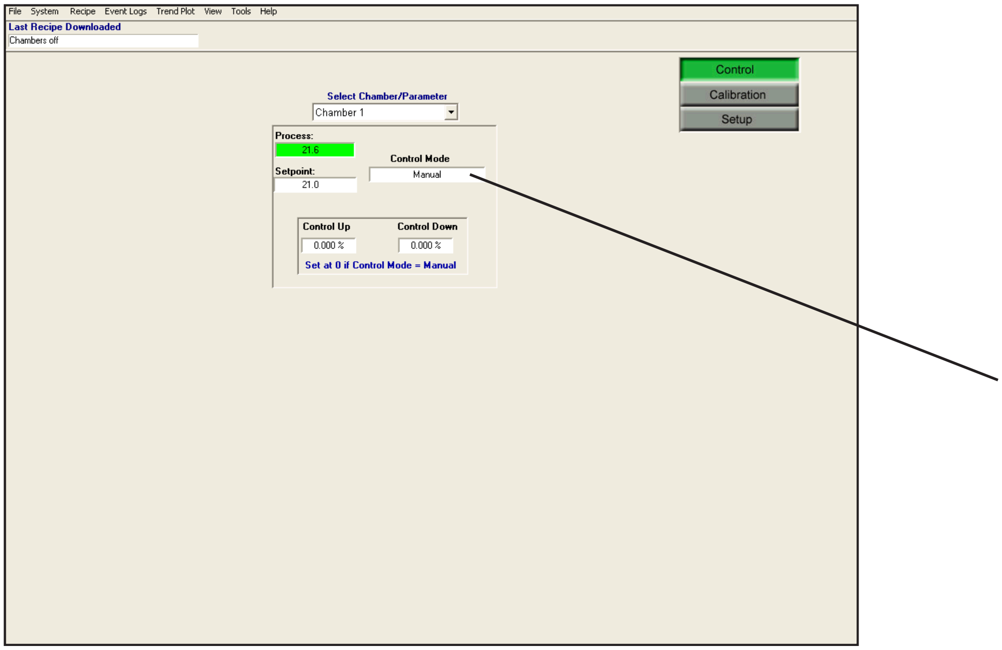


OxyCycler Model A84

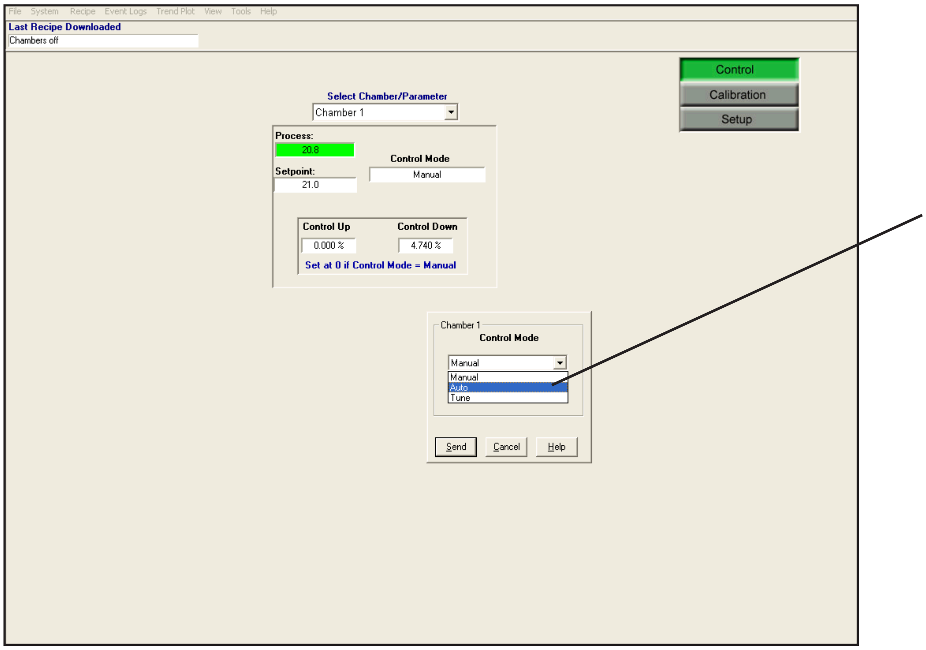
14. Turn the *Control* back on when finished with the actuator pod(s) calibration. Click the **Control** button.



15. Double click the reading underneath **Control Mode** to open the *Chamber 1 Control Mode* window.



16. Change the *Chamber 1 Control Mode* to **Auto** and click **Send**.



17. Repeat both the zero calibration and the span calibration procedures for all the chambers.

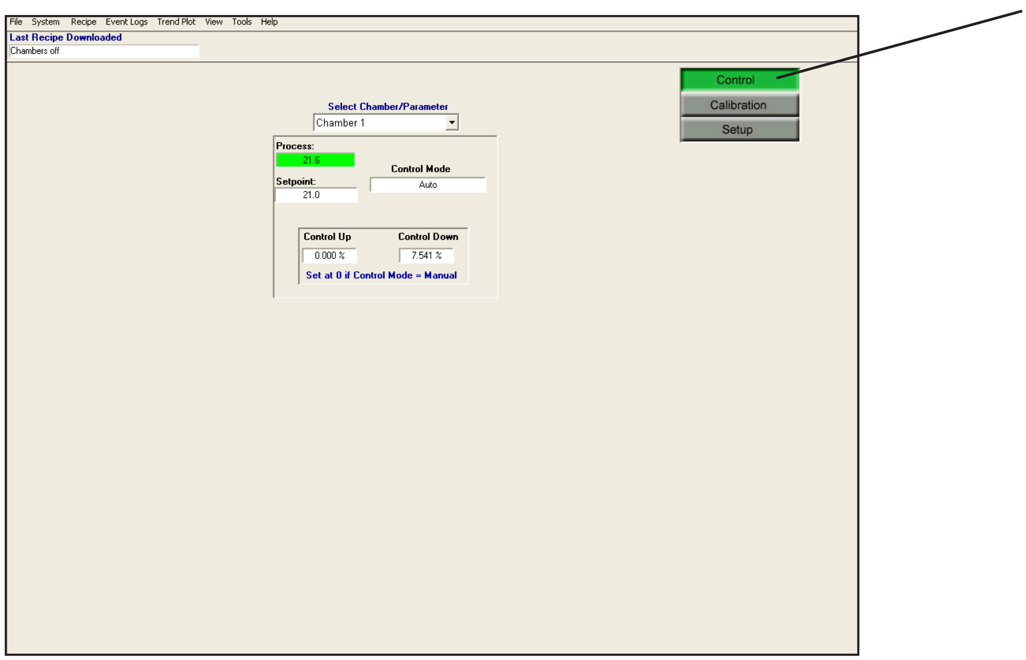
Calibration of Monitor Pod

Preparations for Calibration of Monitor Pod Oxygen Sensor:

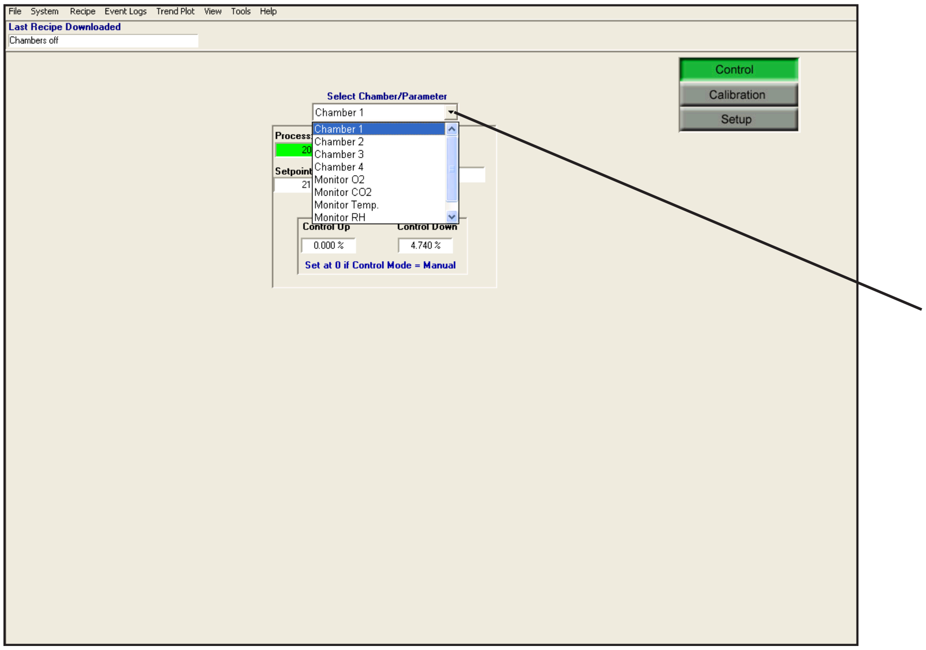
1. If you haven't done so already, connect the compressed nitrogen and the compressed carbon dioxide/oxygen mix gas supplies to the unit.
2. Open the regulators to 0-40 PSIG. Use the check valves on the front of the unit to check that the gas is connected properly. Make sure to close the bleed valves after confirmation.

> **WARNING**
>
> DO NOT exceed 40 PSIG or damage will occur to the unit.

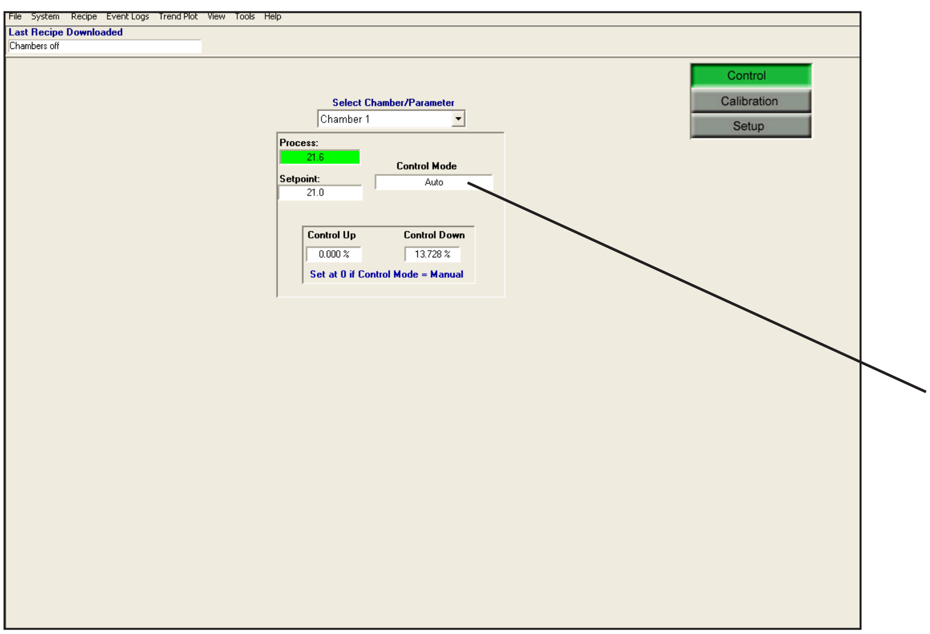
3. Stop controlling with the actuator pod that is attached to the same chamber as the monitor pod. To do this, click the **Control** button.



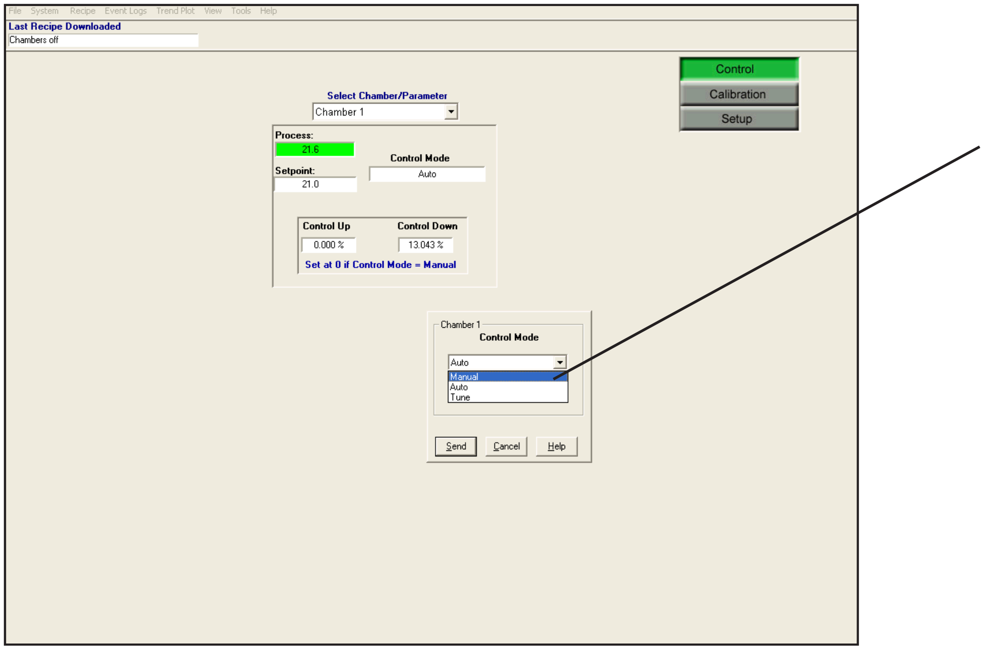
4. Select the proper chamber in the *Select Chamber/Parameter* pull down menu.



5. Double click the reading underneath **Control Mode** to open the *Chamber 1 Control Mode* window.

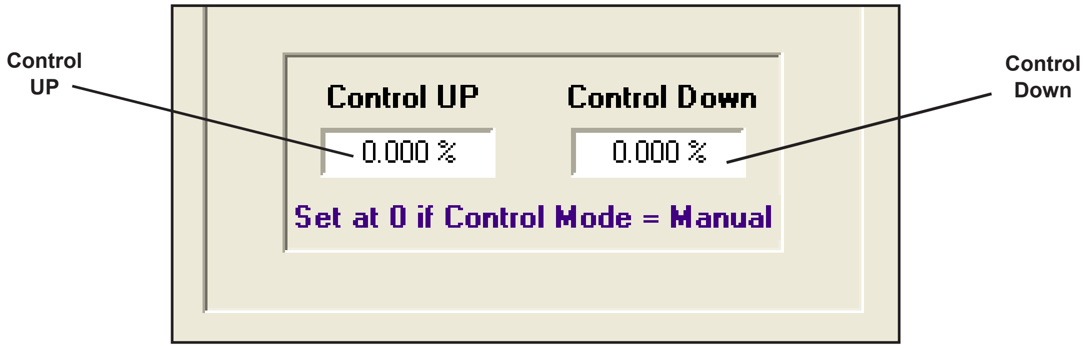


6. Change the *Chamber 1 Control Mode* to **Manual** in the pull down menu and click **Send.**



7. Make sure that the *Control Up* and the *Control Down* are both reading *0.000%.*

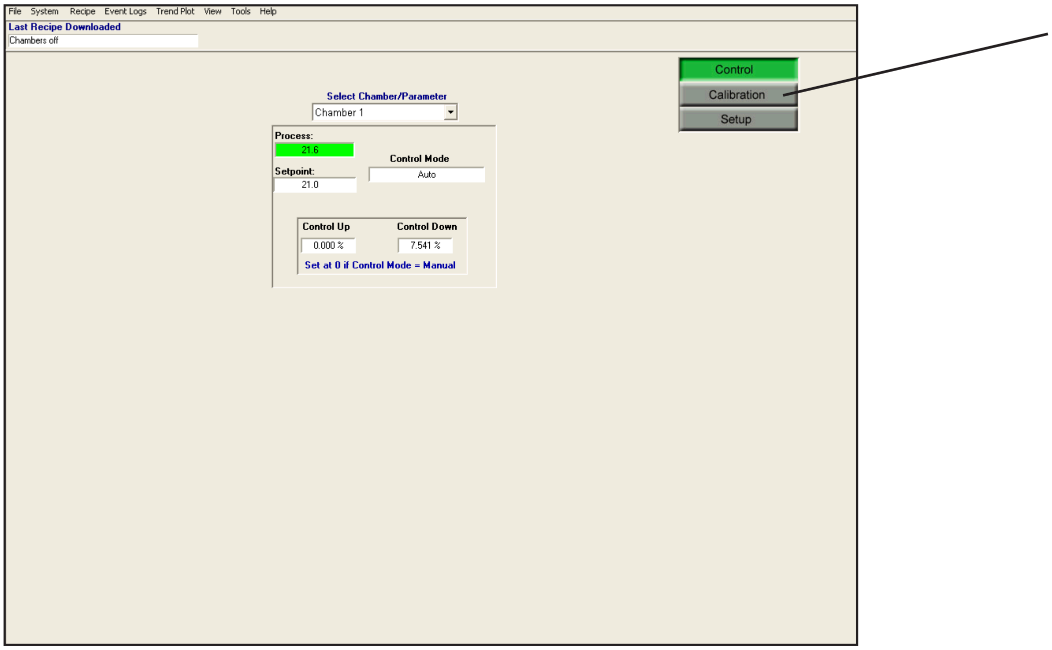
8. If either one or both don't read *0.000%,* then double click the number in either column to bring up the popup window, adjust the number to **0** and click **Send.**



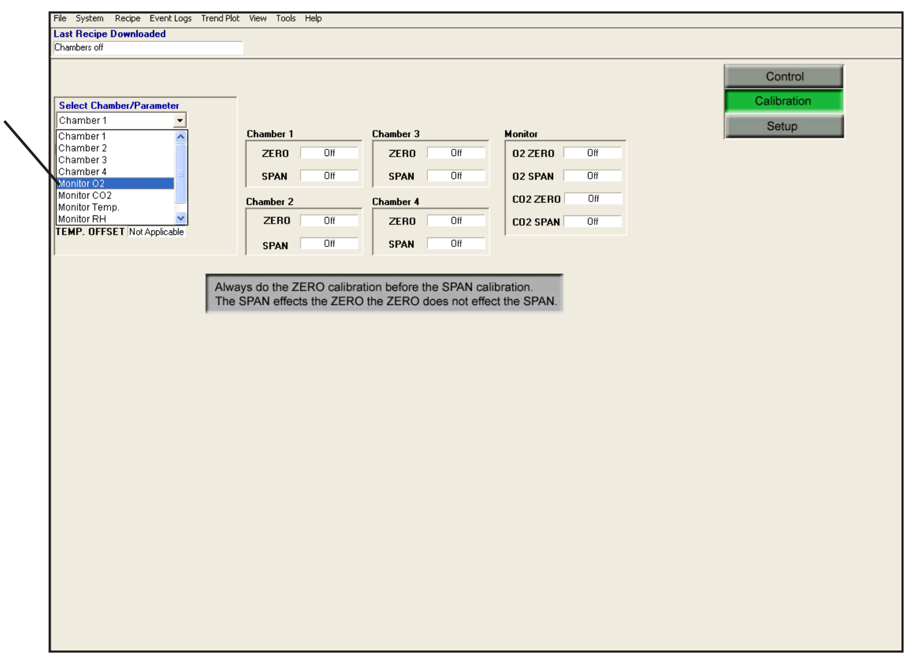
Set **Control UP** and **Control Down** to **0.000%**

ZERO Calibration of the Remote Oxygen Sensor:

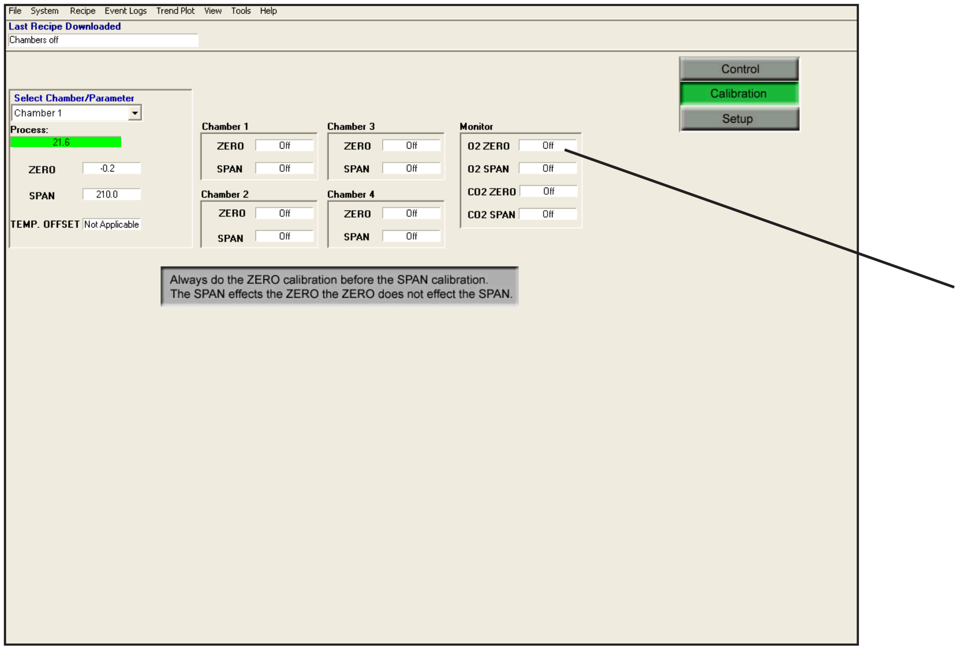
1. Click the **Calibration** button.



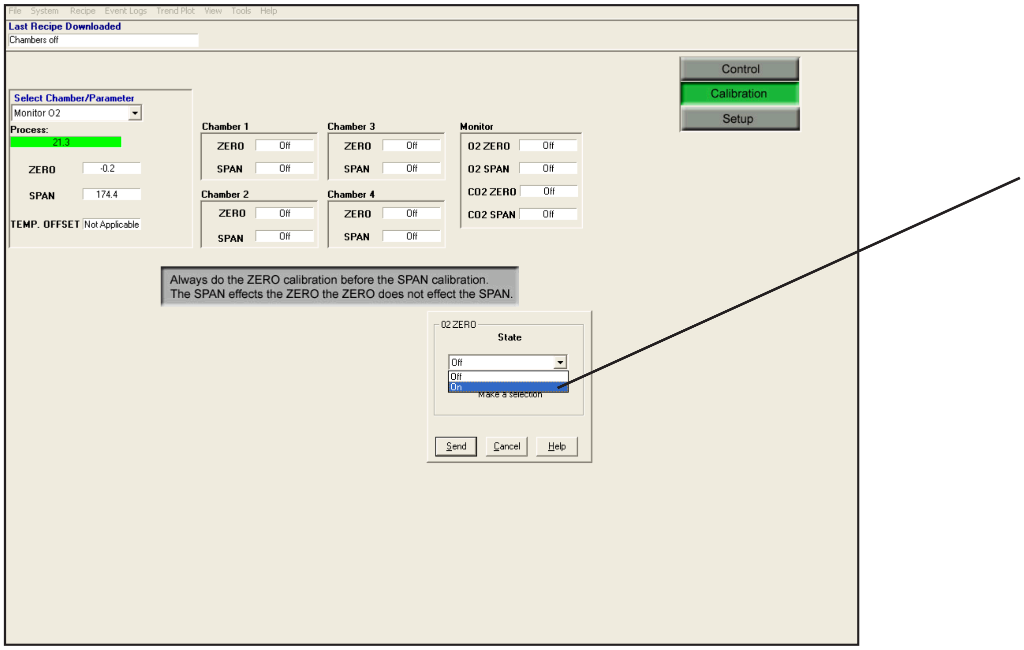
2. Under the *Select Chamber/Parameter* heading, click which sensor to calibrate. The following example will explain how to calibrate the **Monitor O2.**



3. Under the *Monitor* heading, double click the reading next to **O2 ZERO.**



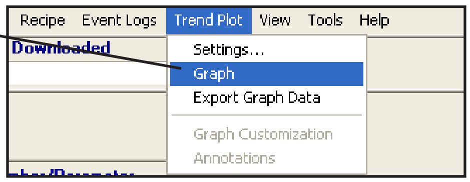
4. Change the *O2 ZERO State* to **On** and click **Send.** This will turn on the zero calibration function.

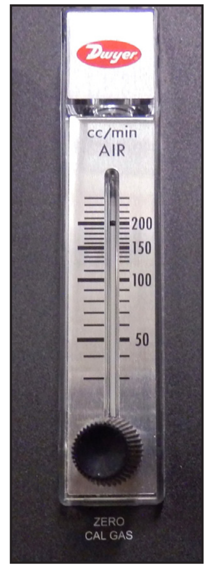


5. Adjust the *ZERO CAL GAS* flowmeter on the front panel of the unit to read **200cc.**

6. Go back to the computer, wait for the *Process* reading to level off (1-2 minutes). You can tell the sensor is reading only the zero calibration gas when the *Process* reading on the *Calibration* screen becomes stable and the reading levels out.

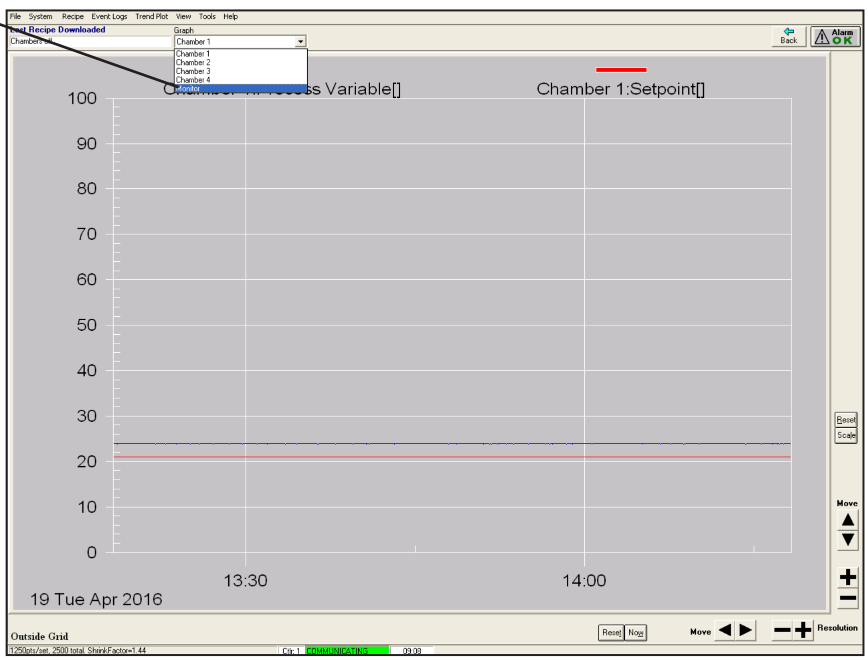
7. Another way to watch the *Process* reading, is to use the *Trend Plot* window. To open the *Trend Plot* window, click on the **Trend Plot** tab in the toolbar and select **Graph.**





Zero Calibration Flow Meter

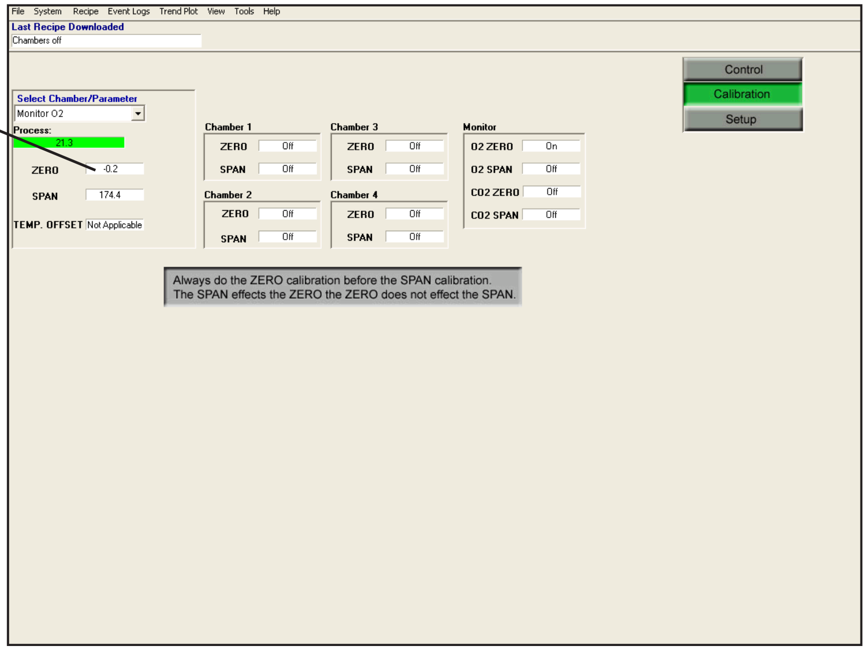
8. The *Trend Plot* window will show the *Process* reading with a graph. From the pull down menu, on the *Trend Plot* window, select **Monitor.** (Window may vary slightly from picture below.)



9. Once the graph levels off, go back to the *OxyCycler* window by clicking the **Back** button

> **NOTE**
>
> After closing the *Trend Plot* window the screen will revert back to *Chamber 1.*

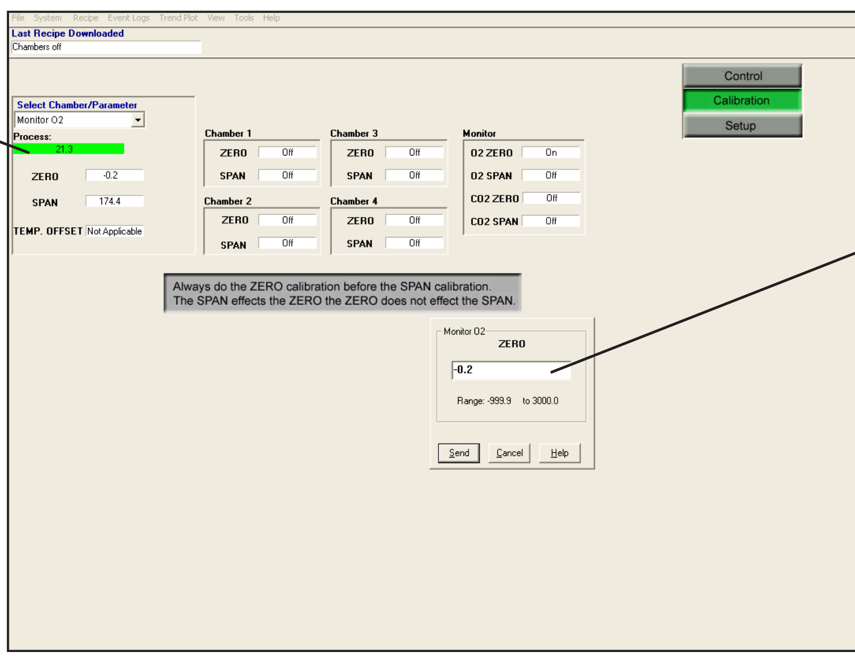
10. Double click the reading next to **ZERO** to open the *Monitor O2 Zero* popup window.



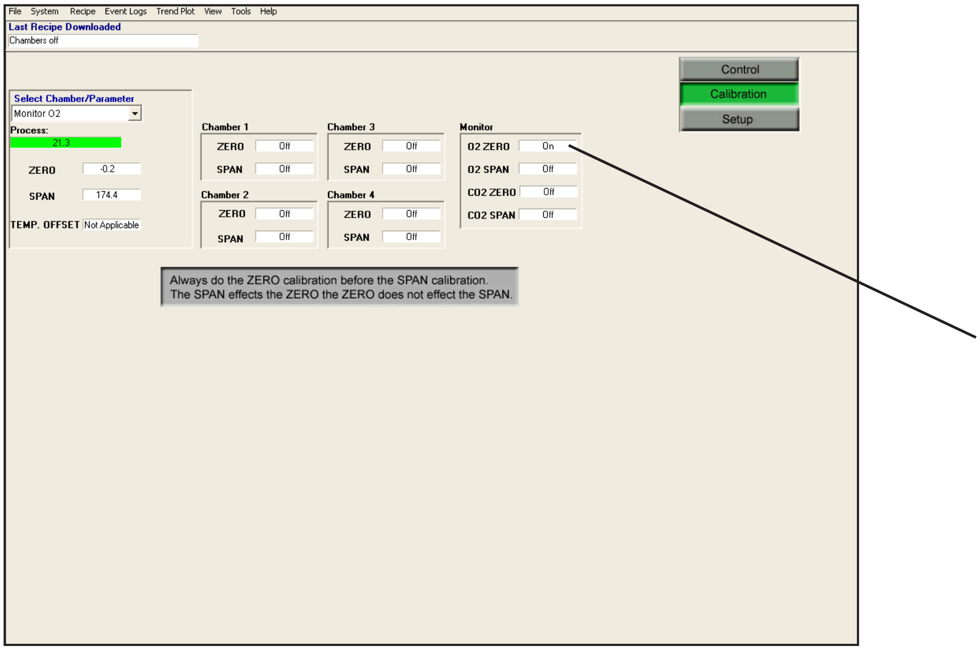
11. In the *Monitor O2 Zero* popup window adjust the **ZERO** reading up or down so that the *Process* reads **0.0** and then click **Send.** The *ZERO* function corresponds with the *Process* reading. The amount you change the *ZERO* function, is the amount the *Process* will change.

Example: If the *Process* field shows 0.1 and the *ZERO* field shows 0.3, changing the *ZERO* field to 0.2 will bring the *Process* field down to 0.0.

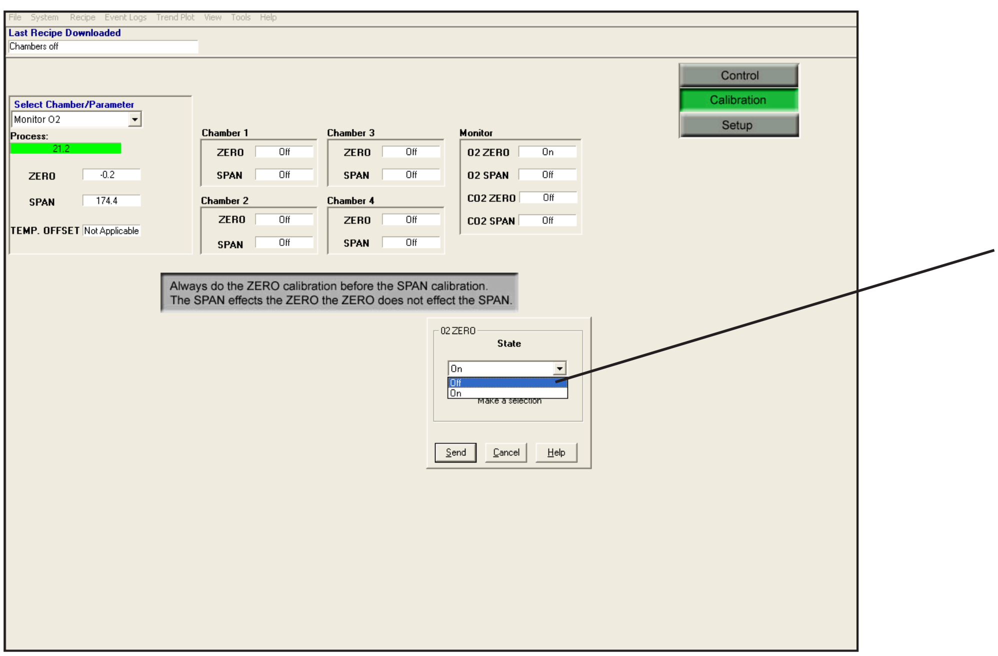
Process



12. Once the *ZERO* function has been calibrated, the *ZERO* function can be shut off. To do this, double click the reading next to **O2 ZERO** under the *Monitor* heading.



13. Once the popup opens, change the *Span State* to **Off** and click **Send.**



Calibration of Carbon Dioxide Sensor

Preparations for Calibration of Monitor Pod Oxygen Sensor:

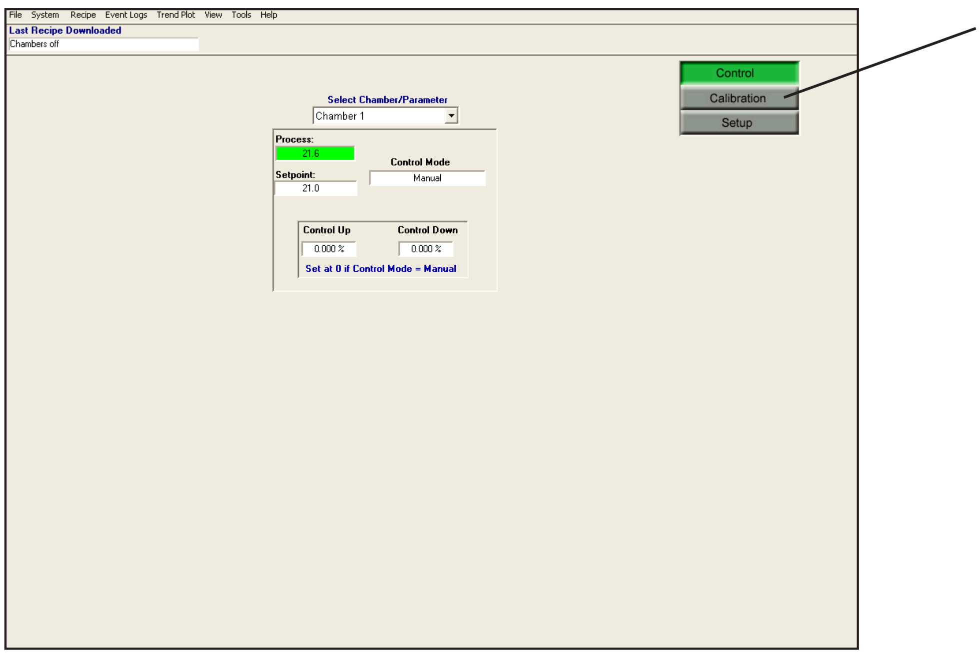
1. If you haven't done so already, connect the compressed nitrogen and the compressed carbon dioxide/oxygen mix gas supplies to the unit.

2. Open the regulators to 0-40 PSIG. Use the check valves on the front of the unit to check that the gas is connected properly. Make sure to close the bleed valves after confirmation.

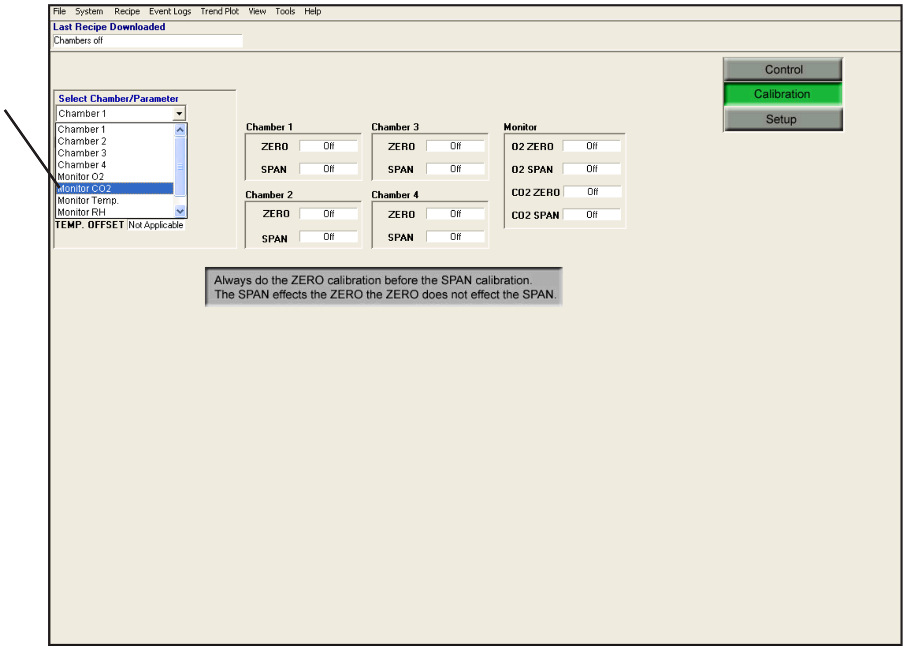
> **WARNING**
>
> DO NOT exceed 40 PSIG or damage will occur to the unit.

ZERO Calibration of Carbon Dioxide Sensor:

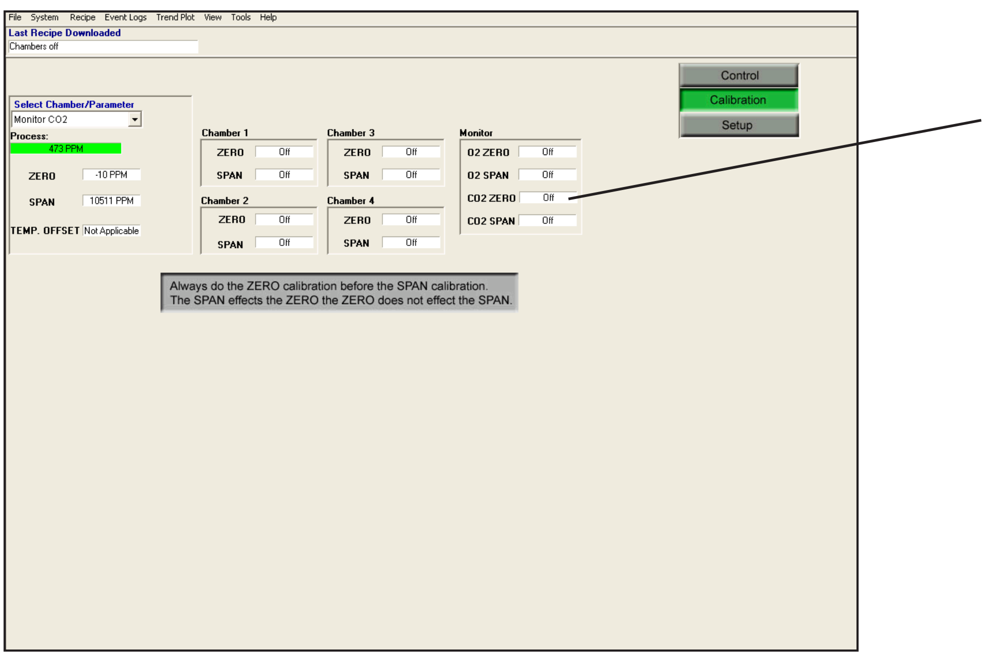
1. Click the **Calibration** button.



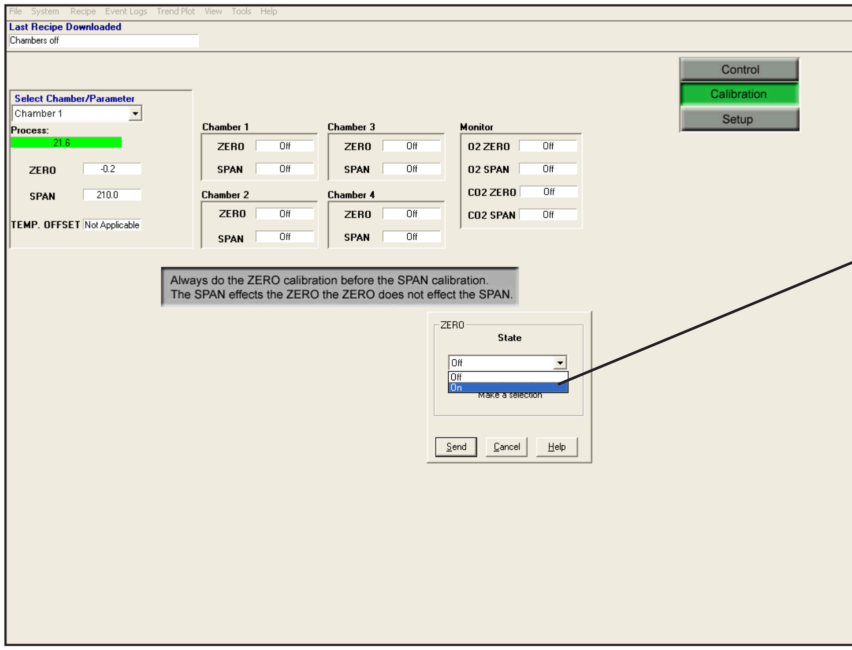
2. Under the *Select Chamber/Parameter* heading, click which sensor to calibrate. The following example will explain how to calibrate the **Monitor CO2.**



3. Under the *Monitor* heading, double click the reading next to **CO2 ZERO.**



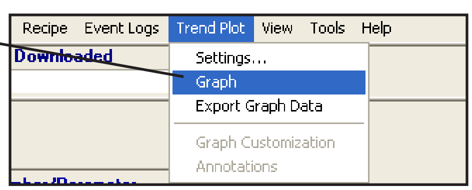
4. Change the *CO2 ZERO State* to **On** and click **Send.** This will turn on the zero calibration function.

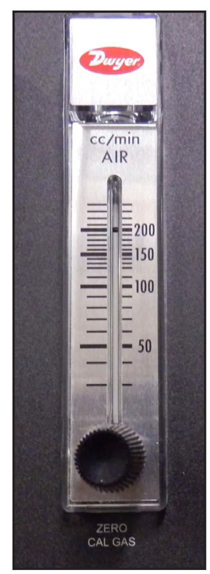


5. Adjust the *ZERO CAL GAS* flowmeter on the front panel of the unit to read **200cc.**

6. Go back to the computer, wait for the *Process* reading to level off (1-2 minutes). You can tell the sensor is reading only the zero calibration gas when the *Process* reading on the *Calibration* screen becomes stable and the reading levels out.

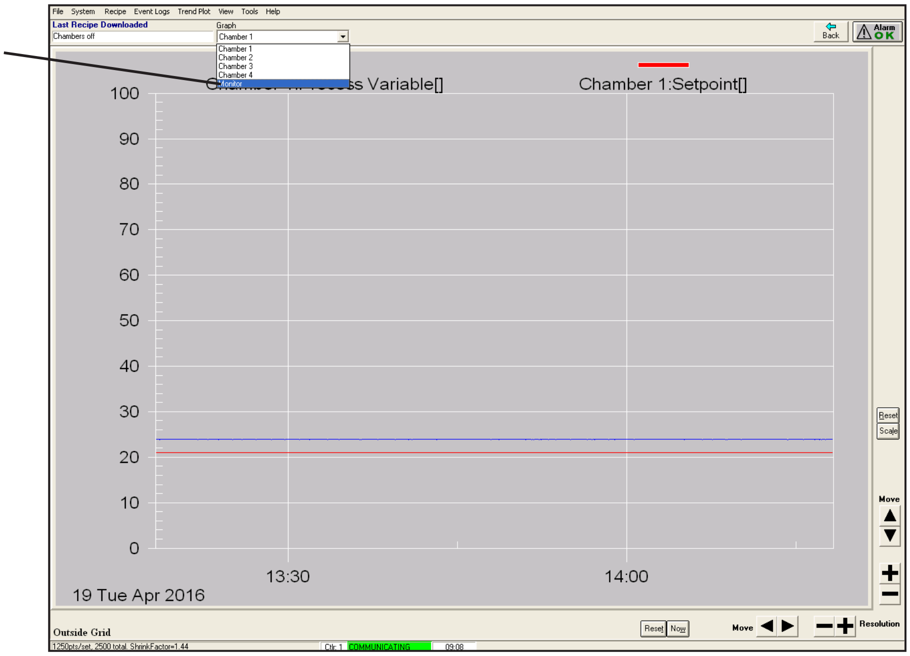
7. Another way to watch the *Process* reading, is to use the *Trend Plot* window. To open the *Trend Plot* window, click on the **Trend Plot** tab in the toolbar and select **Graph.**



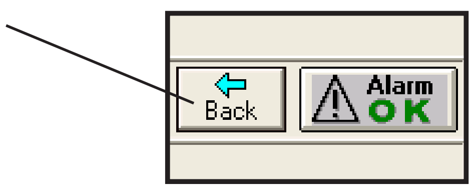


Zero Calibration Flow Meter

8. The *Trend Plot* window will show the *Process* reading with a graph. From the pull down menu, on the *Trend Plot* window, select **Monitor.** (Window may vary slightly from picture below.)



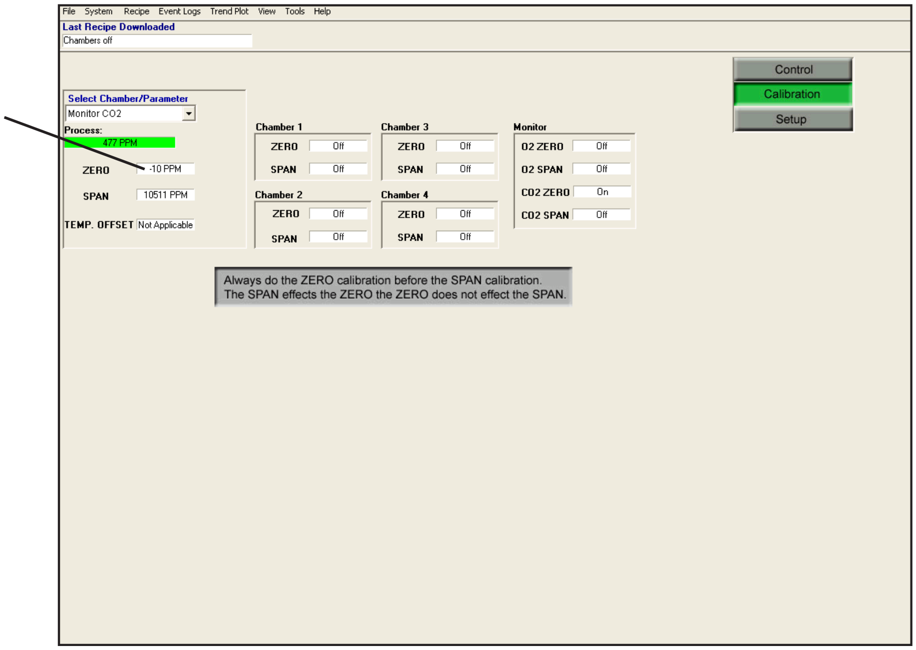
9. Once the graph levels off, go back to the *OxyCycler* window, by clicking the **Back** button.



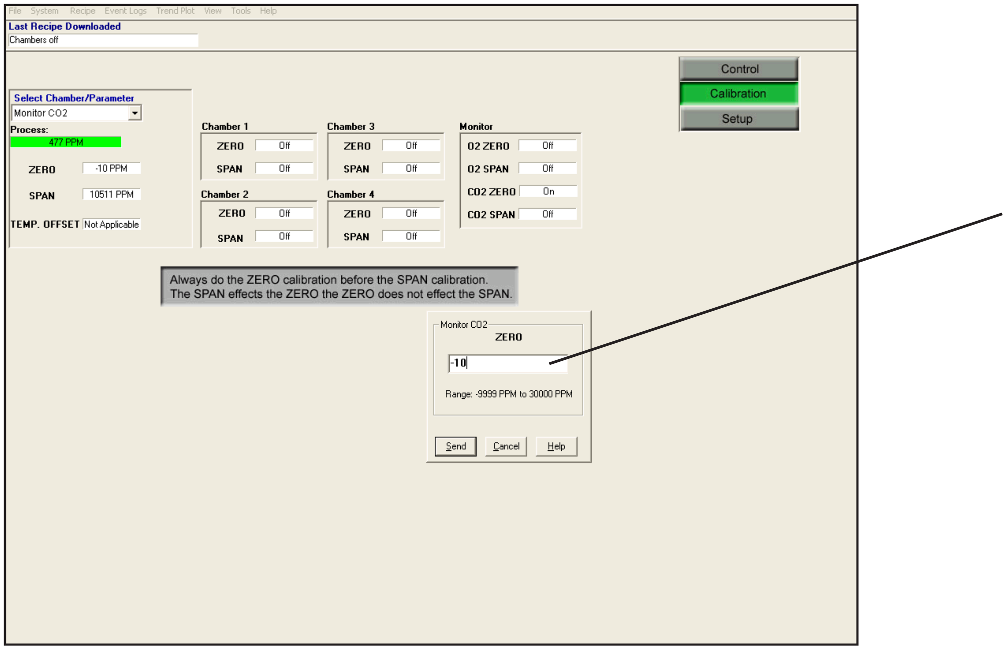
NOTE

After closing the *Trend Plot* window the screen will revert back to *Chamber 1.*

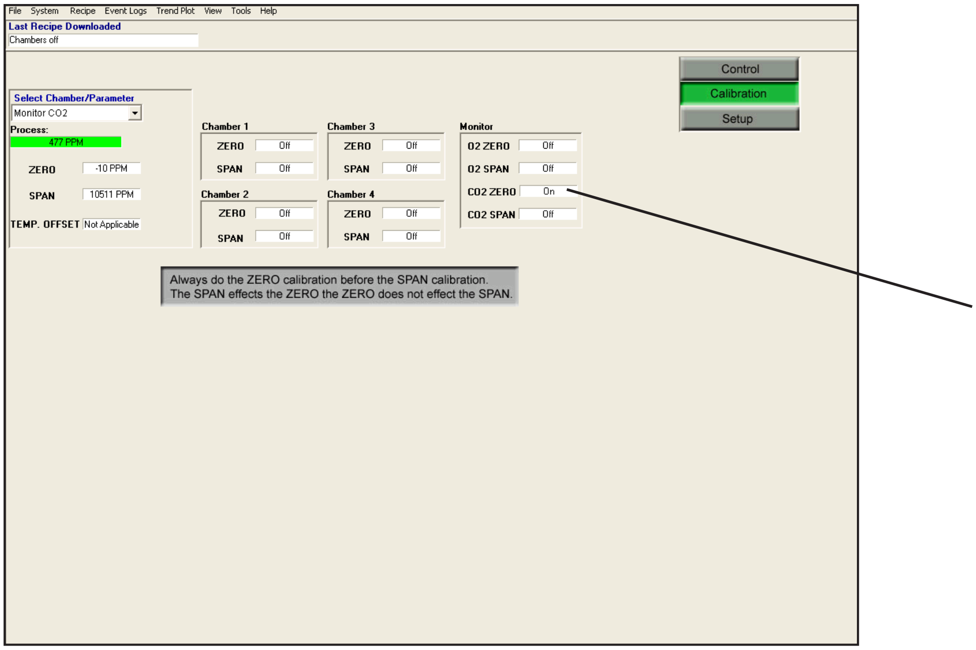
10. Double click the reading next to **ZERO** to open the *Monitor CO2 Zero* popup window.



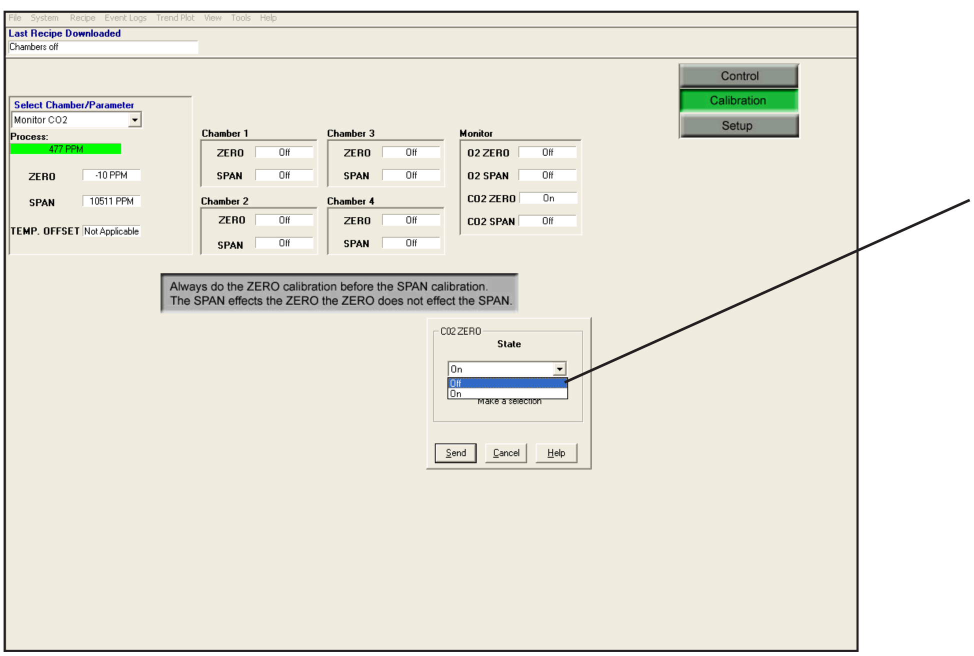
11. In the *Monitor CO2 Zero* popup window adjust the **ZERO** reading up or down so that the *Process* reads **0 ppm** (parts per million) and then click **Send.** The *ZERO* function corresponds with the *Process* reading. The amount the *ZERO* function is changed, is the amount the *Process* will change.



12. Once the *ZERO* function has been calibrated, the *ZERO* function can be shut off. To do this, double click the reading next to **CO2 ZERO** under the *Monitor* heading.

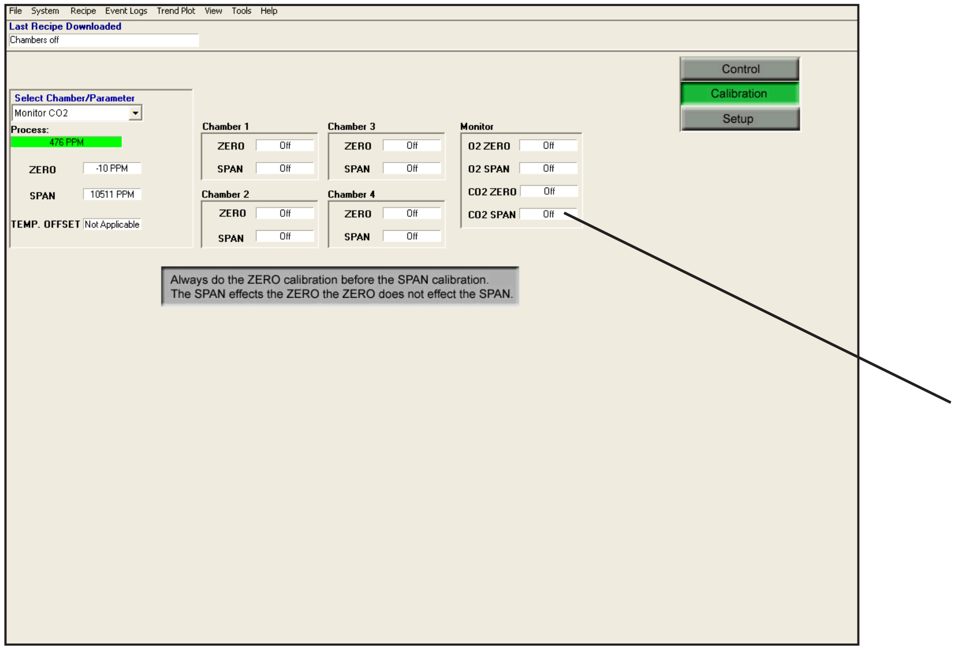


13. Once the *CO2 ZERO* popup opens, change the *CO2 ZERO State* to **Off** and click **Send.**

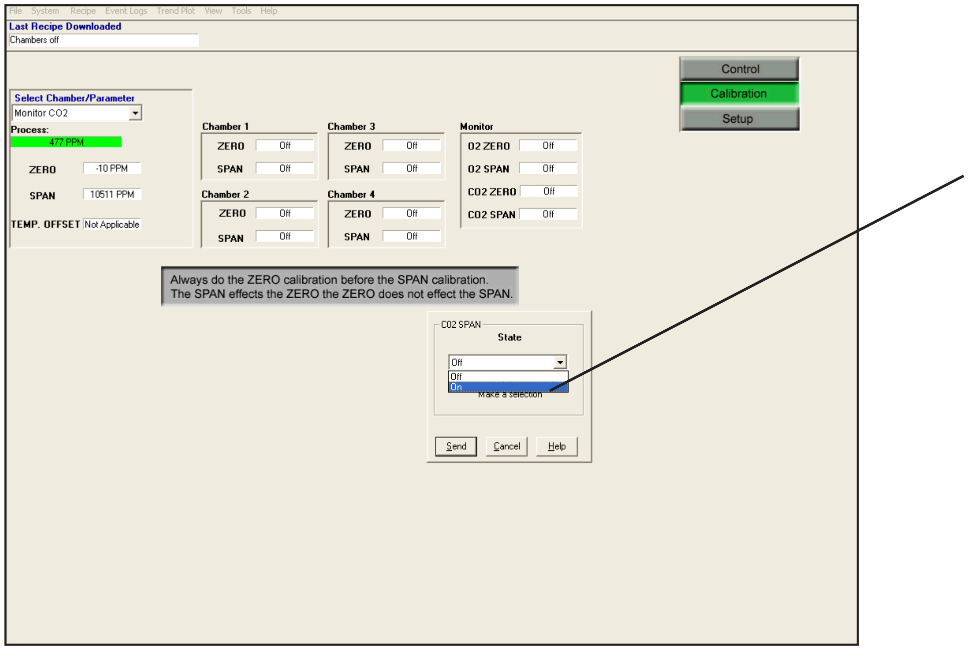


Span Calibration of Carbon Dioxide Sensor:

1. Double click the reading next to **CO2 SPAN** underneath the *Monitor* heading.



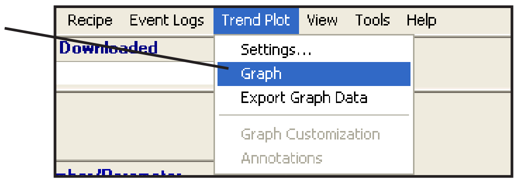
2. Once the *CO2 SPAN* popup window opens, change the *CO2 SPAN State* to **On** and click **Send.** This will turn on the span function.

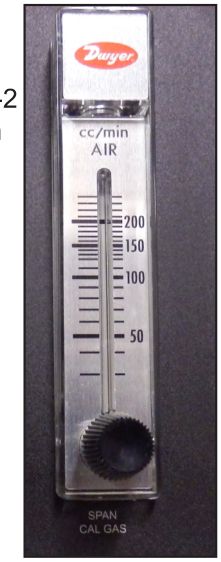


3. Adjust the *SPAN CAL GAS* flowmeter on the front panel to read **200cc.**

4. Go back to the computer, wait for the *Process* reading to level off (1-2 minutes). You can tell the sensor is reading only the span calibration gas when the *Process* reading on the *Calibration* screen becomes stable and the reading levels out.

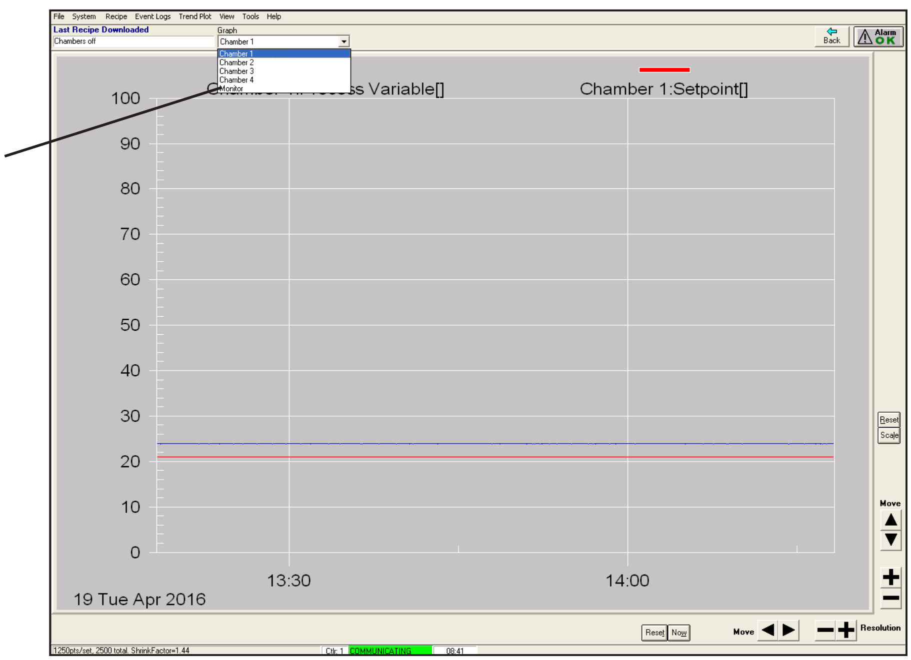
5. Another way to watch the *Process* reading, is to use the *Trend Plot* window. To open the *Trend Plot* window, click on the **Trend Plot** tab in the toolbar and select **Graph.**





Span Calibration Flow Meter

6. The *Trend Plot* window will display the *Process* reading with a graph. From the pull down menu, on the *Trend Plot* window, select **Monitor.** (Window may vary slightly from picture below.)

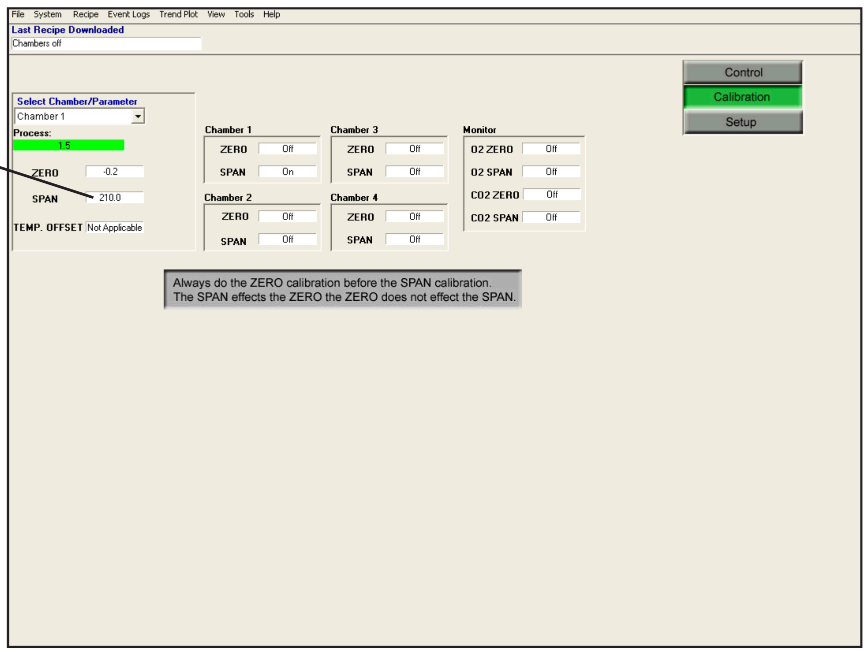


7. Once the *Process* has leveled off, go back to the *OxyCycler* window by click the **Back** button.

NOTE

After closing the *Trend Plot* window the screen will revert back to *Chamber 1.*

8. Double click the reading next to **SPAN** to open the *Monitor CO2 SPAN* popup window.

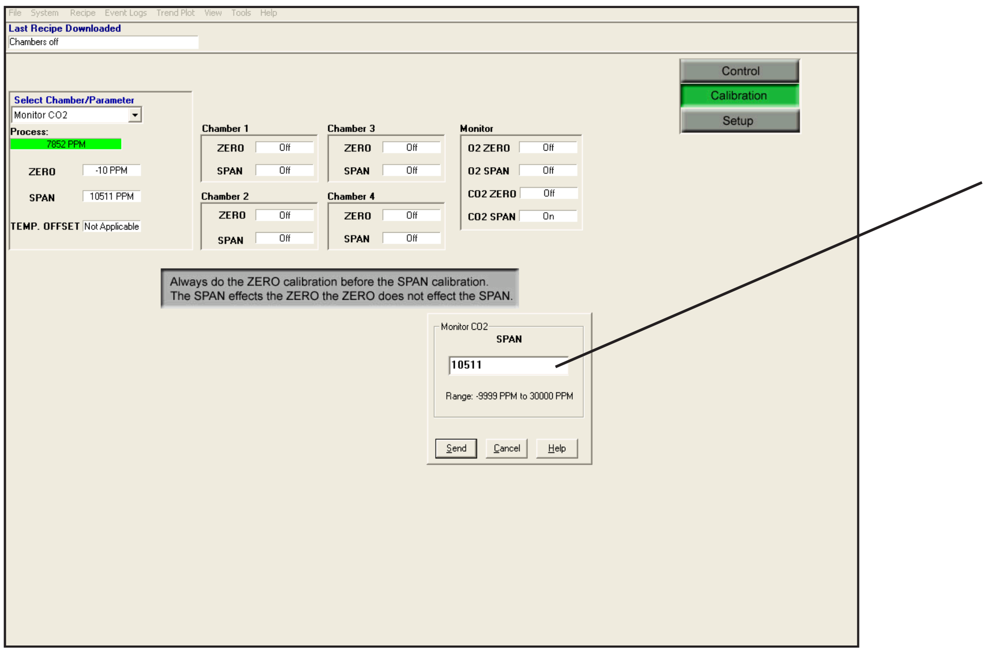


9. In the *Monitor CO2 SPAN* popup window, adjust the **SPAN** reading up or down so that the *Process* reads the exact CO2 percentage that is in the CO2/O2 mix (see the certificate on the compressed mix for the exact percentage of oxygen) and then click **Send.**

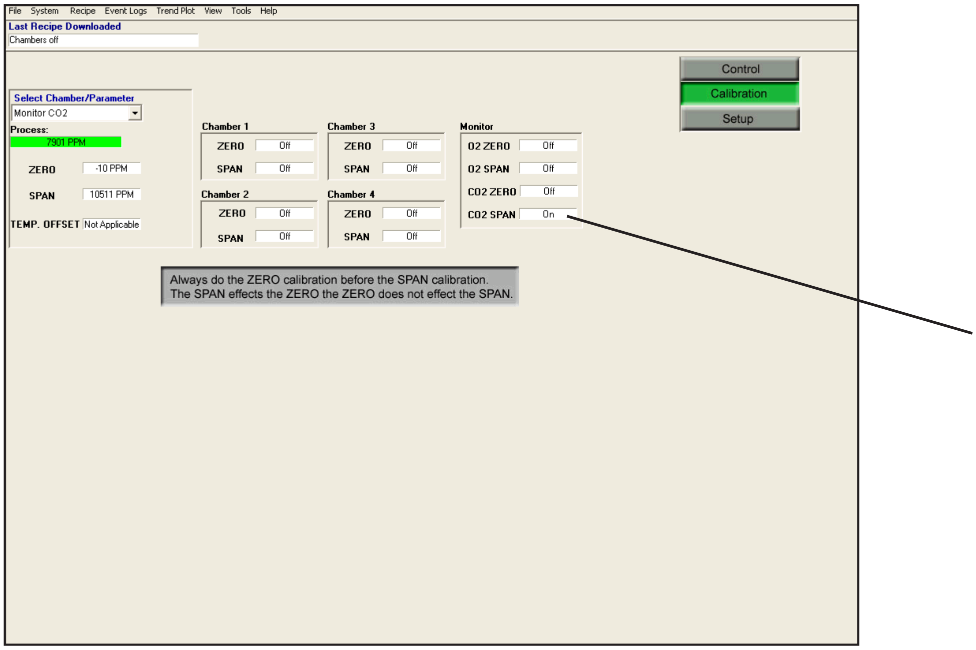
The *SPAN* corresponds with the *Process*, but not the same way as the *ZERO* does, it is a more coarse adjustment.

NOTE

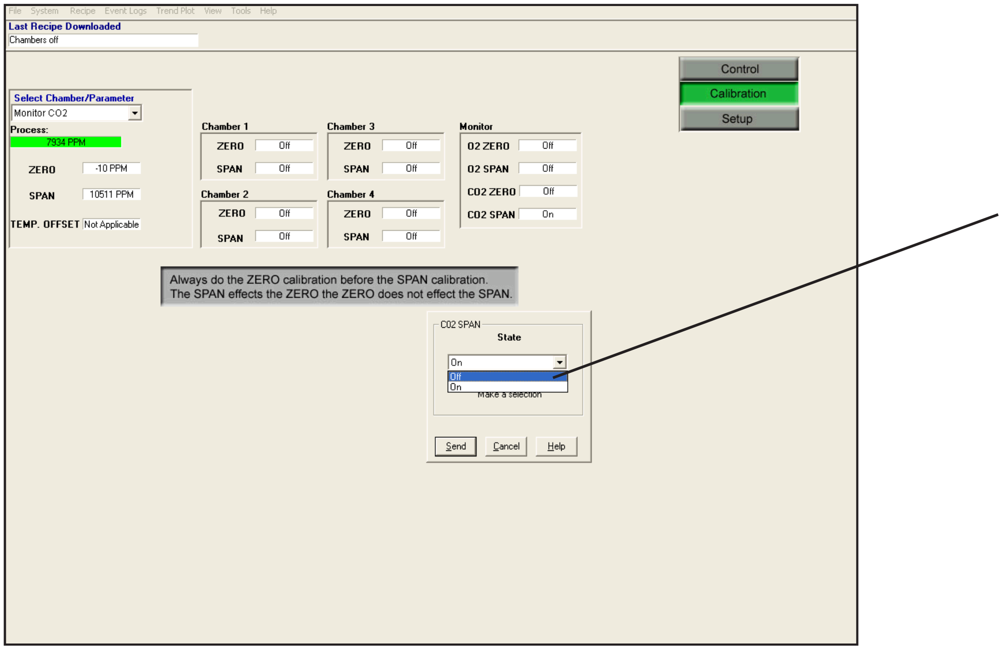
The reading on the computer is in PPM (Parts Per Million) and the number on the certificate is a percentage. 1%=10,000ppm.



10. Once the *SPAN* has been calibrated it must be shut off. To do this, double click the reading next to **CO2 SPAN** underneath the *Monitor* heading.



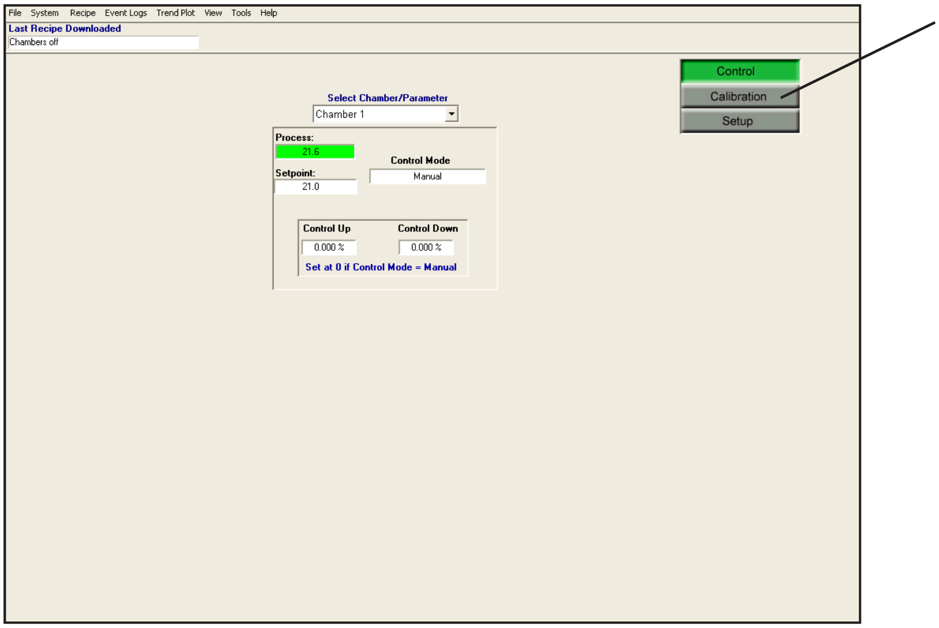
11. Once the *CO2 SPAN* popup window opens, change the *CO2 SPAN State* to **Off** and click **Send.**



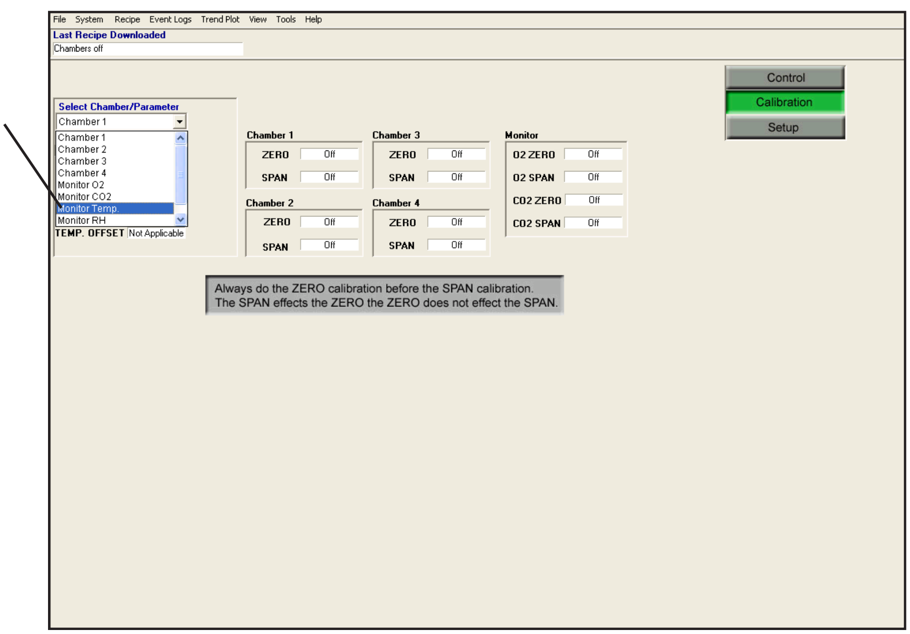
Calibration of Temperature Sensor

1. First, place an accurate thermometer into the chamber that the monitor pod is attached to.

2. Click the **Calibration** button.

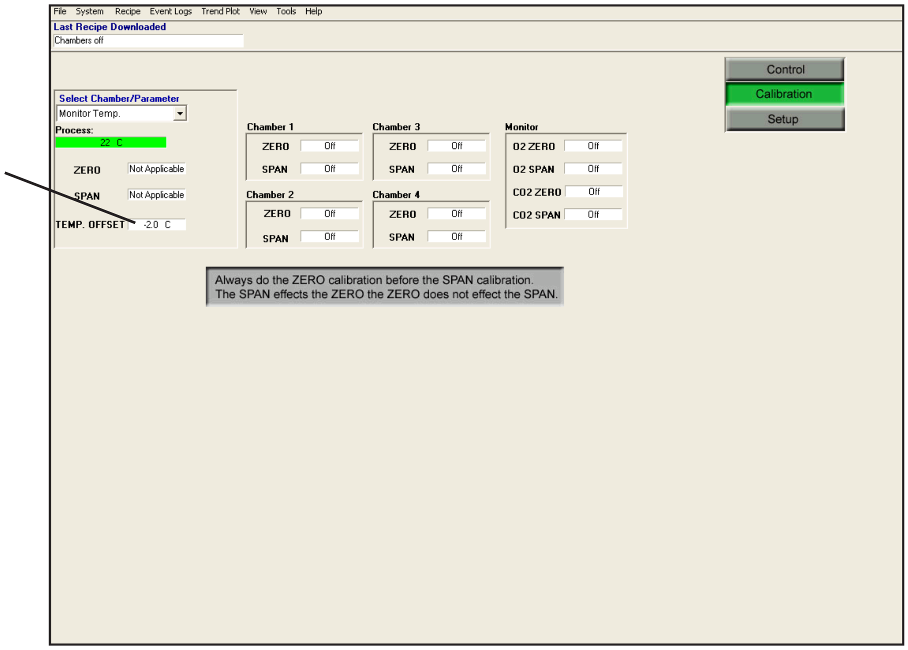


3. Under the *Select Chamber/Parameter* heading, select **Monitor Temp.**



4. Observe the difference between the *Process* reading and the reading of the thermometer that is within the chamber.

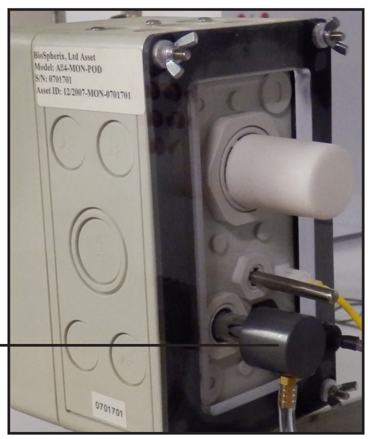
5. Change the *TEMP. OFFSET* so that the *Process* reads the same as the thermometer. To do this, double click in the field next to **TEMP. OFFSET** and enter the reading on the thermometer.



Calibration of Relative Humidity Sensor

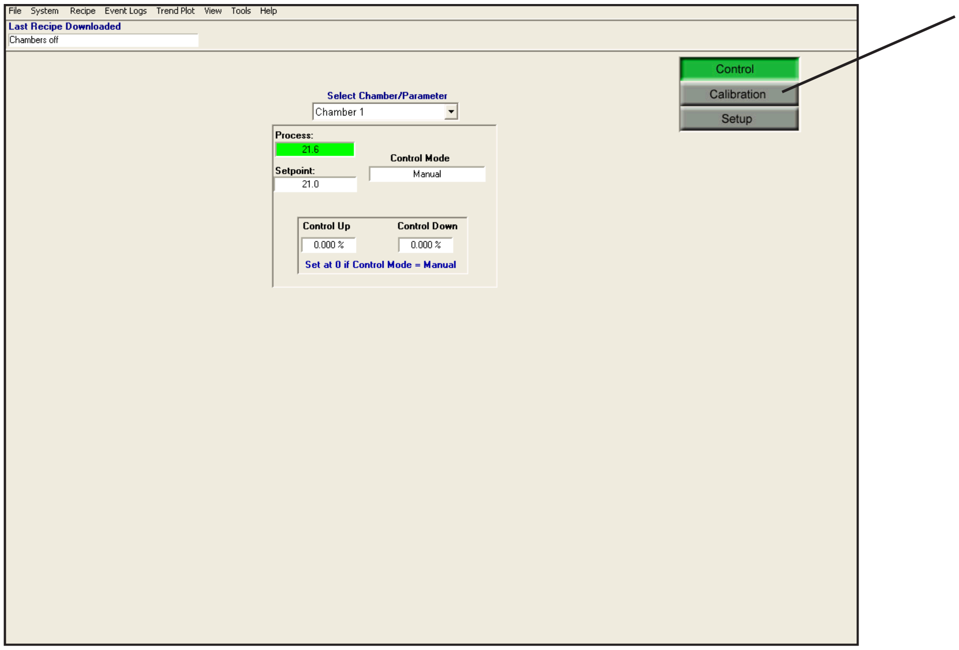
1. Attach the calibration tubing to the bleed barb on the front of the unit, labeled **NITROGEN**.

2. Attach the calibration chamber (which is attached to the calibration tubing) to the humidity sensor on the monitor pod.

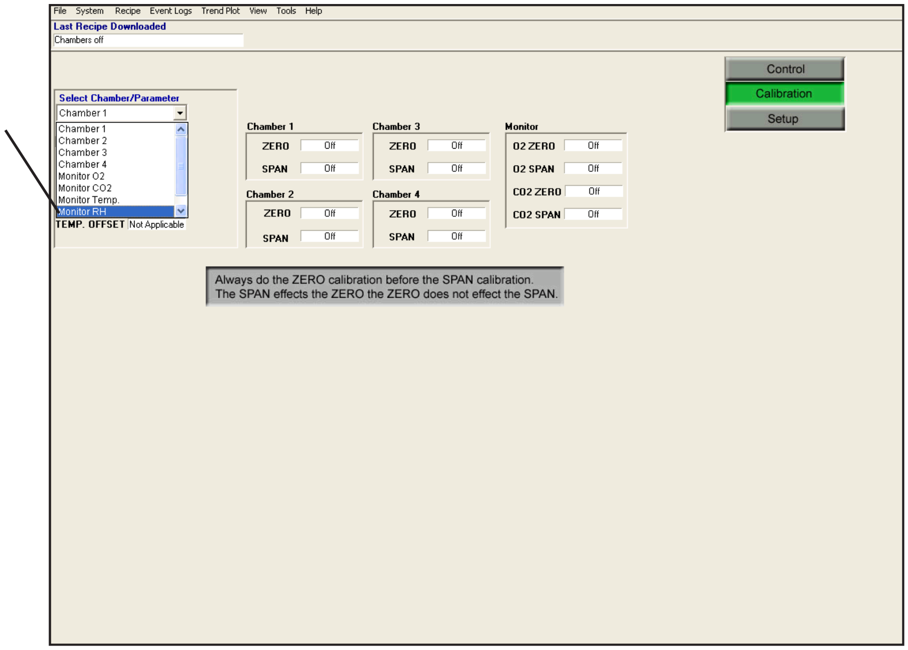


3. Open the bleed valve slightly, just until gas is heard expelling from the calibration chamber. This will flood the humidity sensor with dry gas.

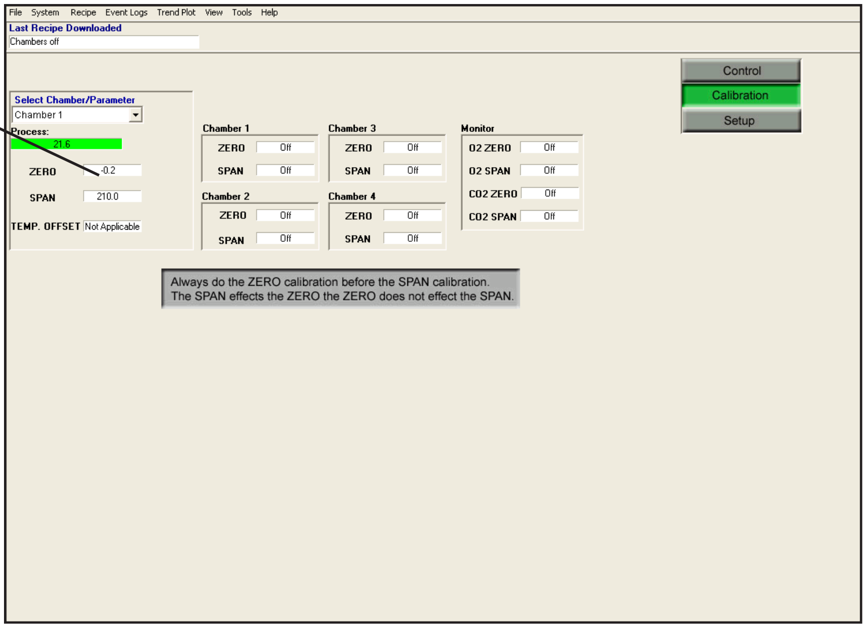
4. Now, on the computer, select the **Calibration** button.



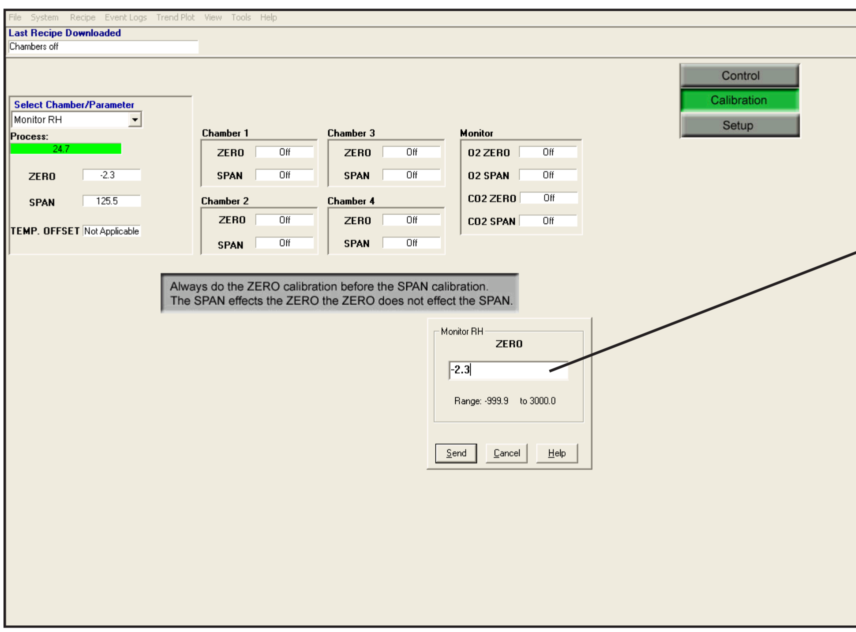
5. Under the *Select Chamber/Parameter* pull down menu, select **Monitor RH.**



6. Double click the reading next to **ZERO** to open the *Monitor RH ZERO* popup window.



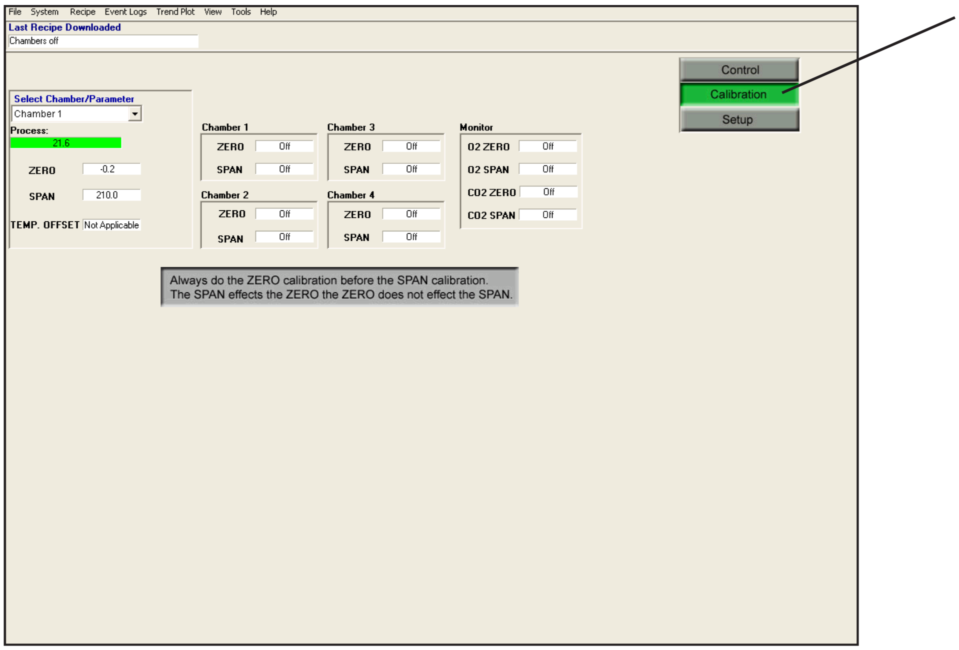
7. In the *Monitor RH ZERO* popup window adjust the number so that the *Process* reads **0** and then click **Send.**



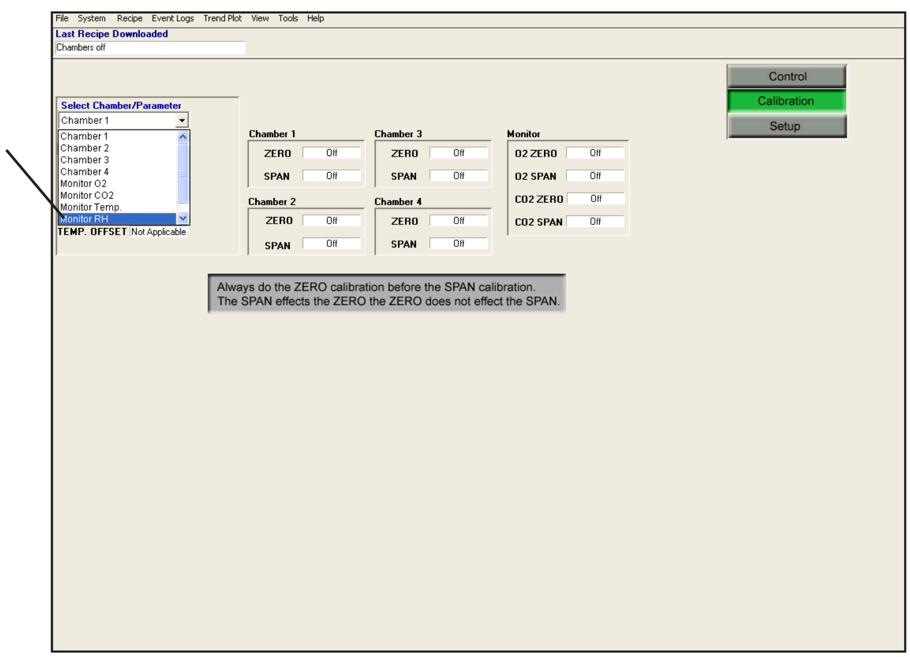
8. Close the **NITROGEN** bleed valve, remove the calibration tubing and the calibration chamber.

SPAN Calibration of Relative Humidty Sensor:

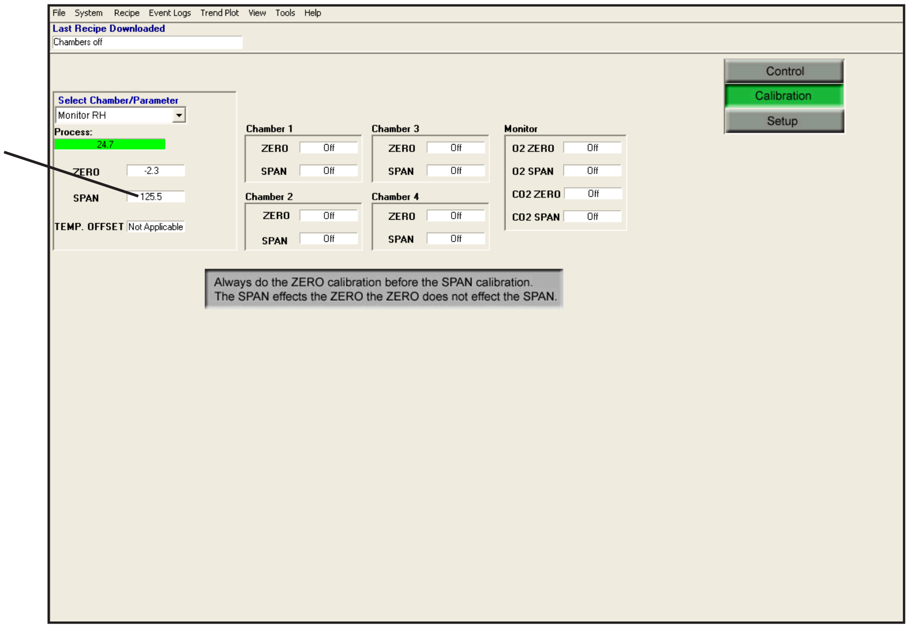
1. Wrap a damp paper towel around the humidity sensor. Make sure that the paper towel isn't dripping wet. Ring all of the excess water out before placing it over the sensor.
2. Allow time for the *Process* reading to level off.
3. Click the **Calibration** button.



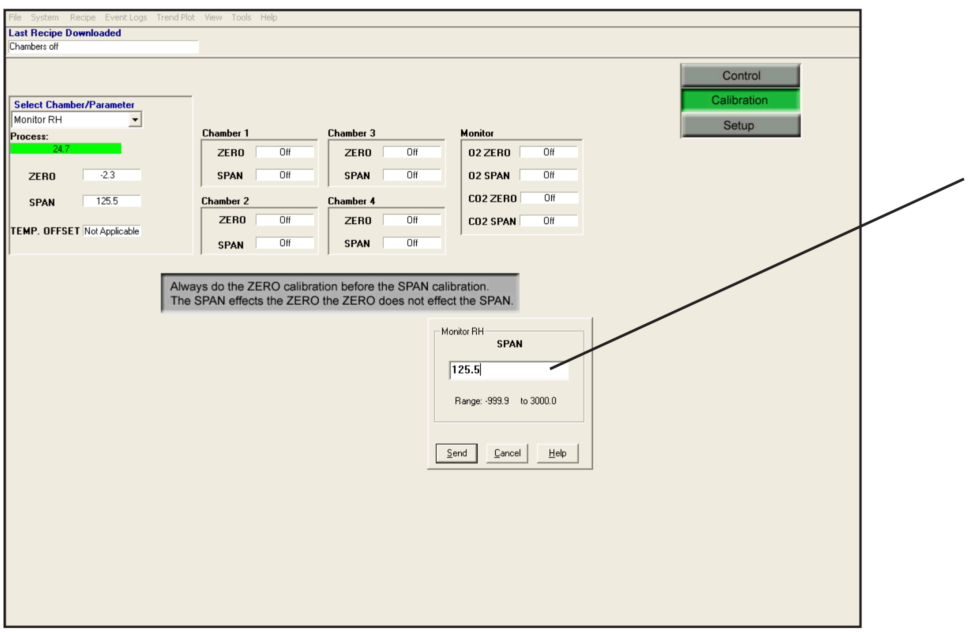
4. Under the *Select Chamber/Parameter* pull down menu, select the **Monitor RH.**



5. Double click the reading next to **SPAN** to open the *Monitor RH SPAN* popup window.



6. In the *Monitor RH SPAN* popup window adjust the number so that the *Process* reads **100** and then click **Send.**



7. Once the *SPAN* reading has been calibrated, remove the damp paper towel.

11 System Operations

> **NOTE**
>
> *Prior to beginning any experiments with your system(s) it is important that you review the "Data Logging" and "Trend Plotting" sections.* These sections will provide detailed descriptions of each feature as well as procedures on how to store and backup your data.

> **NOTE**
>
> Data logging is not setup to log your data automatically - this feature must be enabled by the user. **If the appropriate settings are not set prior to beginning an experiment, then there will be potential for data loss.**

> **NOTE**
>
> By default, the trend plot graph will only store your data for 30 days and any data that is older than 30 days will be deleted automatically, unless these settings are manually changed.

Control Methods:

Static Control

Static control of critical cell variables allows users to program a single, specific setpoint that will remain constant until the setpoint is changed or control is turned off. This is the standard control method for variables that require constant, long term stability throughout an experiment.

Dynamic Control

Dynamic control of critical cell variables allows users to program variable setpoints over time, throughout an experiment. Dynamic control is achieved through profiling. A profile allows users to dynamically control one or more critical cell variable, while the remaining variables are held constant. *Detailed procedures on how to write profiles can be found in the "Writing Profiles" section of this manual*.

Why Dynamic Control?

- To adapt to the needs of cells as requirements change.
- To simulate pathological conditions such as an acute transient exposure to specific levels caused by a wound or a clot.

Conventional cell culture equipment offers only static control, but cells are not static, cells are dynamic; cells change and environmental requirements change over time. This is one reason why dynamic control of the cell environment is so important; the ability to match critical cell variables with the constantly changing requirements of the cells.

Another reason for dynamic control is to simulate physiologic conditions in the body under various circumstances. Many experiments require precisely timed changes in critical cell variables. Other common physiologic conditions can be simulated as well, such as an ischemic or hypoxic exposure created by a pathologic event in the body such as a wound or a clot. Dynamic environmental control of critical cell variables provides the means to simulate and manipulate these and countless other physiological conditions.

Developing Profiles

Profiles are software programs and there are limitations to what a profile can do. Profile limitations are most often associated with the time lag that occurs between various changes in setpoints, this is the amount of time it takes to change a variable. The speed at which a variable reaches each new setpoint is limited due to the gas infusion rate, gas supply concentrations and the size of the culture chamber. There is generally no limit on how slowly a variable can be changed.

Dynamic control of a variable also has the potential to affect other, static variables. During static control, a single tune set will sufficiently control all of the variables, but the same tune set may not be sufficient when there are dynamic changes overlaid.

For a detailed description of Tuning, see the “Tuning” appendix provided with this manual.

Therefore, during testing it is important to check the success of the dynamic variable(s) that are addressed in the profile, as well as the static variables that are not addressed in the profile. Dynamic control of variable #1 might work fine, but it might also change static variable #2. In this case you may have to re-tune that control loop to compensate for this disturbance.

A common strategy in writing a profile is to program a repetitive control pattern, something that is done over and over again. A good example of this is simulating intermittent hypoxia. Profiles are limited to 20 control segments, so a repetitive control pattern of over 20 segments cannot be programmed into one profile. However, a single profile can be repeated multiple times, or the profile can be setup to run continuously. Very often the most efficient way to run a profile is to program a single cycle and then simply repeat it multiple times.

After a profile is written, it should be tested, debugged and saved under a descriptive name so that it can be easily repeated or reviewed.

Dynamic Control Examples

Keeping up with proliferating cell populations:
For a normal cell population that starts out small, at low density, with low oxygen consumption, the initial controlled oxygen concentration might be optimal.

However, as the cell population doubles and doubles again and continues growing, the oxygen consumption increases proportionately, and the initial static gas phase above the media may not be sufficient to supply the cells with the increased demand for oxygen. So one of the most widely used techniques of dynamic control is to simply raise the oxygen level in the gas phase over time to prevent the depletion of oxygen caused by the exponentially increasing cell population.

Testing a New Profile

In order to develop an assay with a dynamic hypoxia exposure that will induce apoptosis but not necrosis, you write a concept profile. For example a hypoxic level of 2% oxygen for 1 hour; run it and see how it works. If this new profile induces necrosis, it indicates too much hypoxia, too deep or for too long.

So you write new a profile where the hypoxia only goes down to 3% and another that goes down to 4%. If you determine that either of these profiles help, then you can save it. If you determine that each of these levels continues to induce necrosis, then the problem may be a timing function.

So again, you write a new profile to test the time duration function. Starting with your initial concept profile, instead of having 2% oxygen for one hour, try it for 30 minutes, then for 15 minutes. Run the profiles, compare results and deliberately write the profile that will do the job that you want it to do.

The basic profile methodology is to start with a concept, modify it, compare results and systematically reach the level where a profile will do the job that you want it to do.

Single Setpoint Control

This section will describe how to use Single Setpoint Control in Chamber 1. Repeat the following procedure for all of the other Chambers.

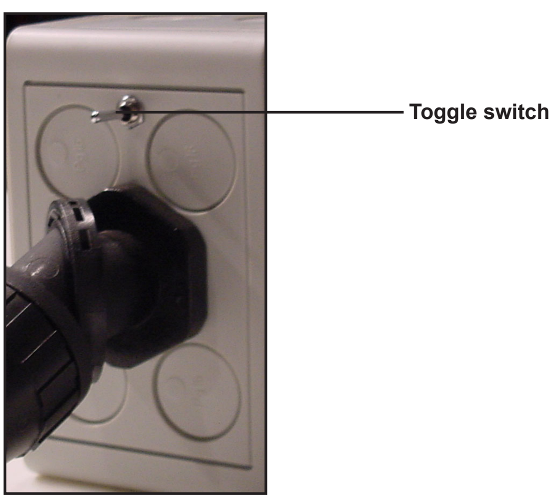
> **NOTE**
>
> Do not continue with the "Single Setpoint Control" section of this manual until you have read the "Communications" section and have properly installed the software and hardware for the OxyCycler model A84 unit.

Preparation for Operation:

1. Make sure that the compressed nitrogen and oxygen sources are connected to their corresponding hose barbs on the back panel of the OxyCycler model A84 unit.
2. Open the regulators on the two compressed gas sources to 0-40 PSIG.

> **WARNING**
>
> DO NOT exceed 40 PSIG or damage will occur to the unit.

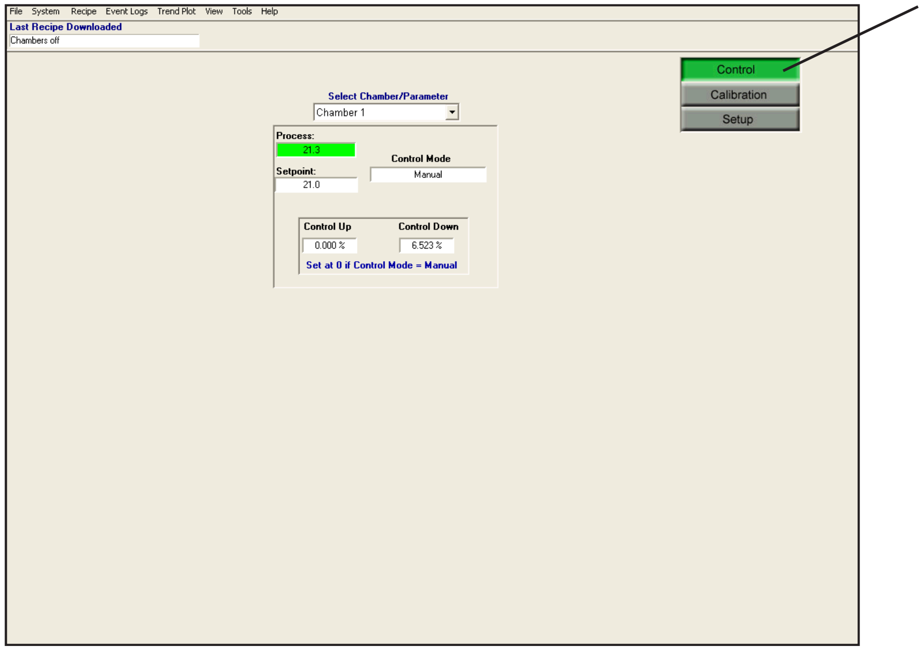
3. Check to make sure that the gases are connected properly by using the bleed barbs on the front panel of the unit. Open the bleed valve labeled **NITROGEN** on the front panel; if gas is heard expelling out of the bleed barb, then the gas is connected properly. Once it is confirmed that the gas is connected properly, then close the bleed valve. Repeat this process for both control gases.
4. Make sure that all of the fans on the pods are running. If they are not running, then flip the toggle switch on the side of the pod and the fan will begin to run.



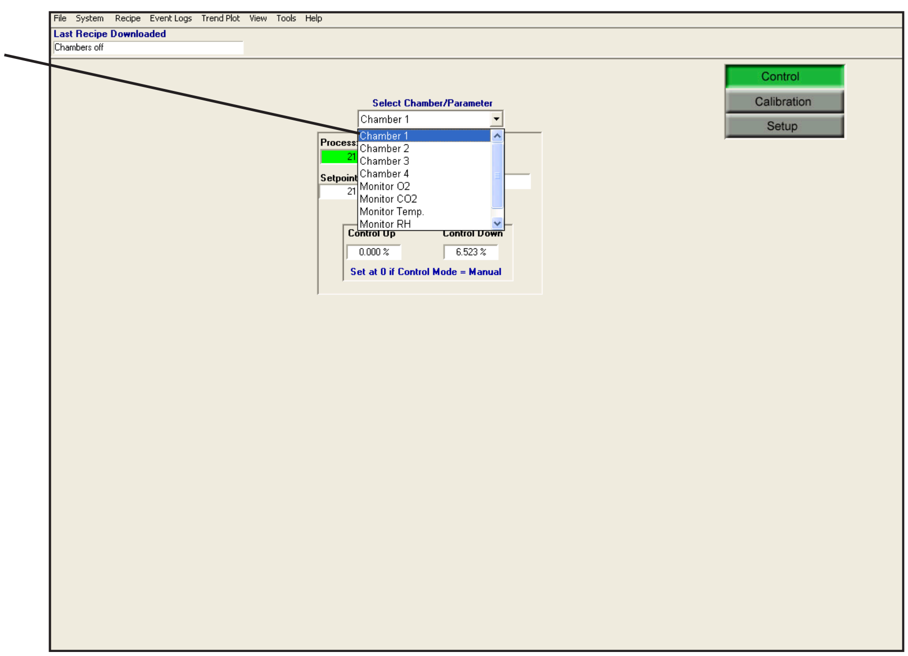
Single Setpoint Control:

1. Turn on the computer and open the *OxyCycler* program. In the following example we show how to set the Setpoint of *Chamber 1.*

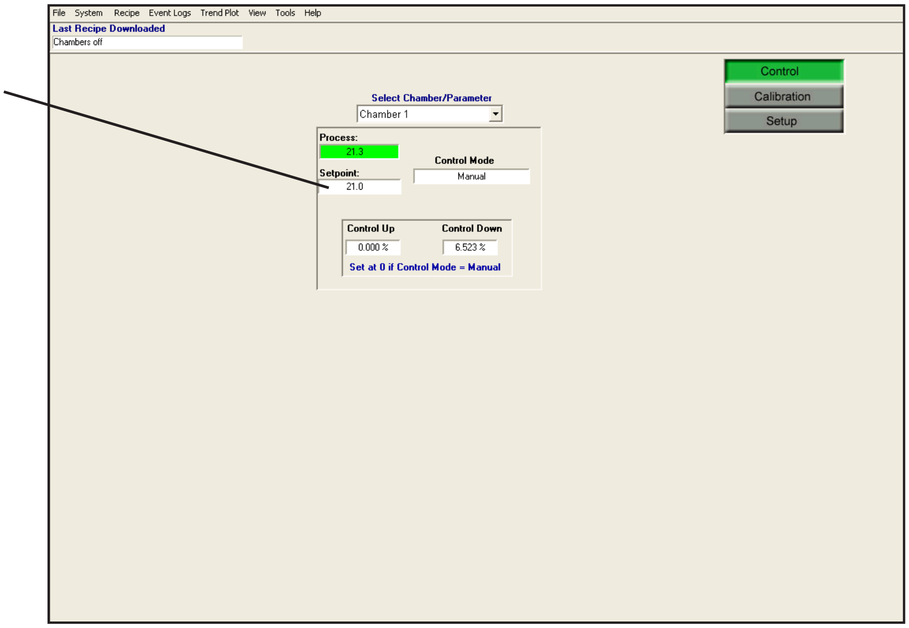
2. Click the **Control** button.



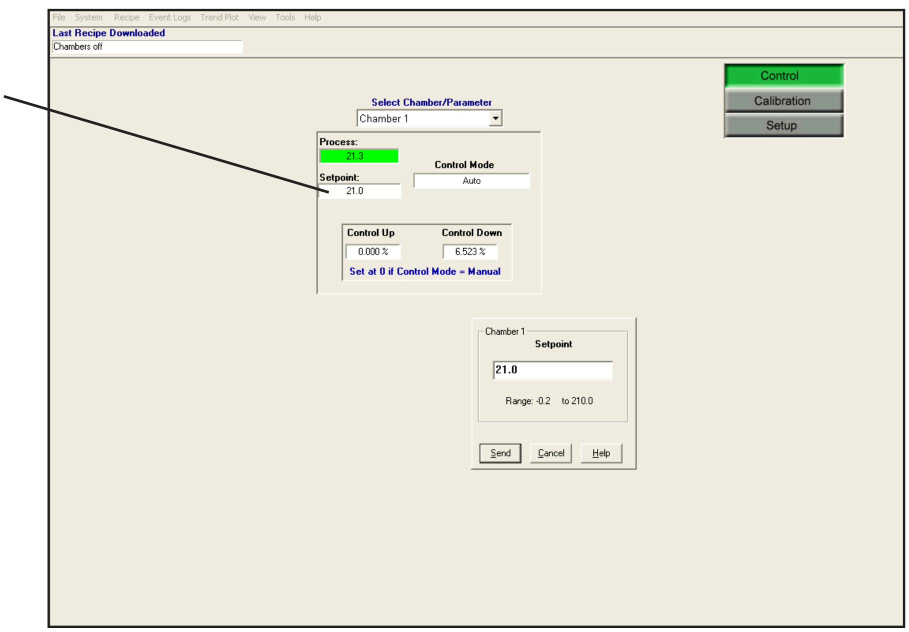
3. Under the *Select Chamber/Parameter* pull down menu, select the **Chamber 1.**



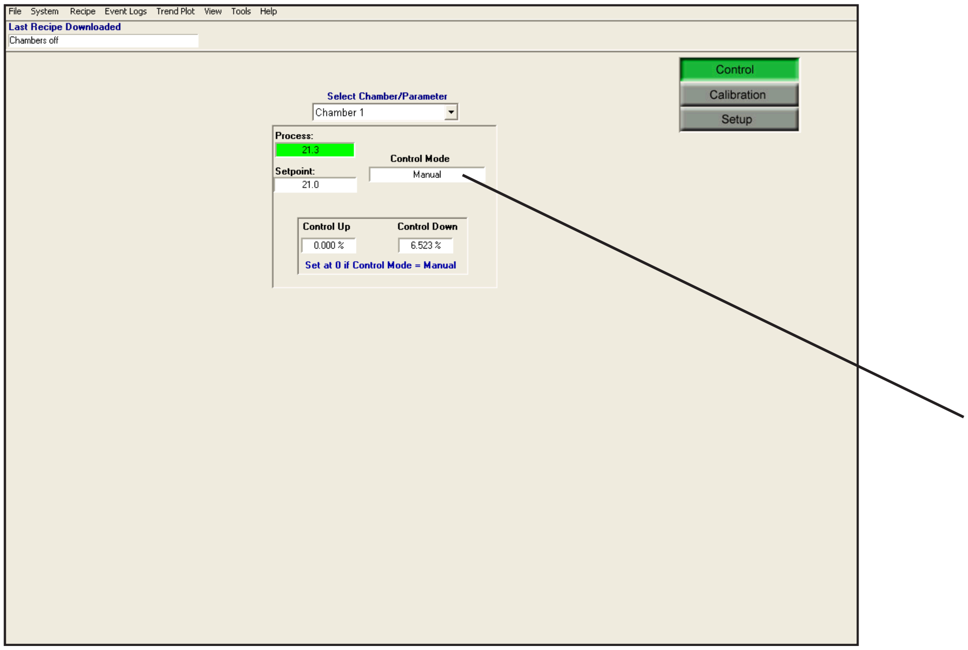
4. Double click in the **Setpoint** field to open the *Chamber 1 Setpoint* popup window.



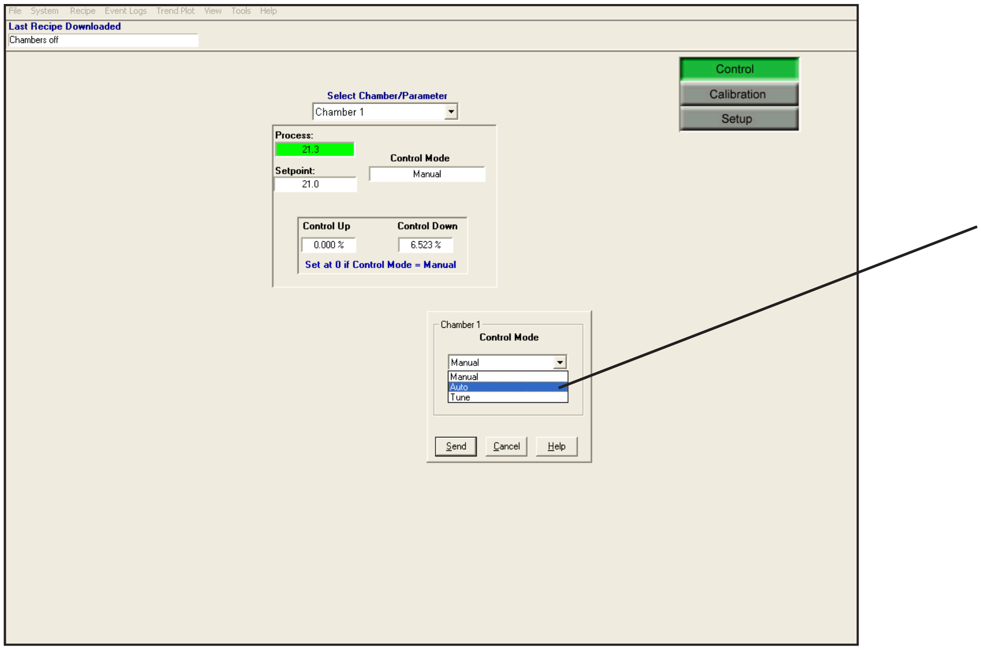
5. In the *Chamber 1 Setpoint* popup window, change the **Setpoint** to the desired setpoint of oxygen percentage in the *Chamber 1*. *The range for the *Setpoint* is *1-99.*



6. Double click the reading underneath **Control Mode** to open the *Chamber 1 Control Mode* window.

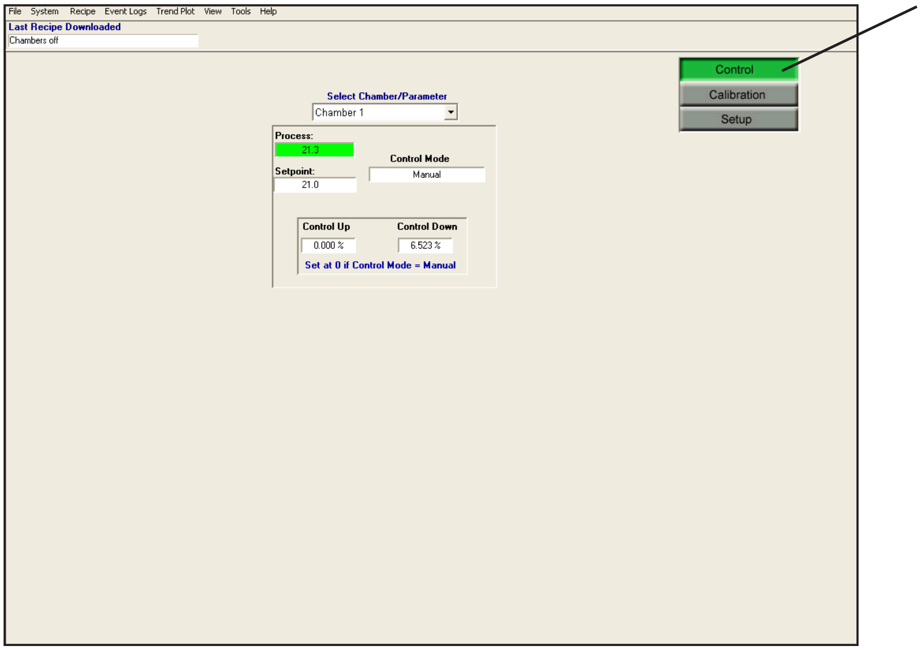


7. Change the *Chamber 1 Control Mode* to **Auto** in the pull down menu and click **Send.**

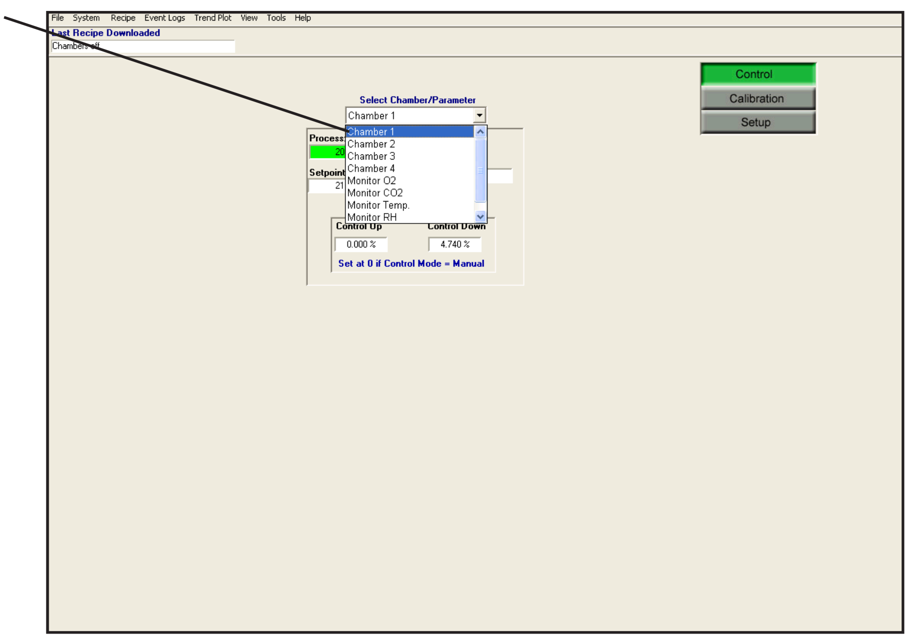


Shutting Off Gas Control:

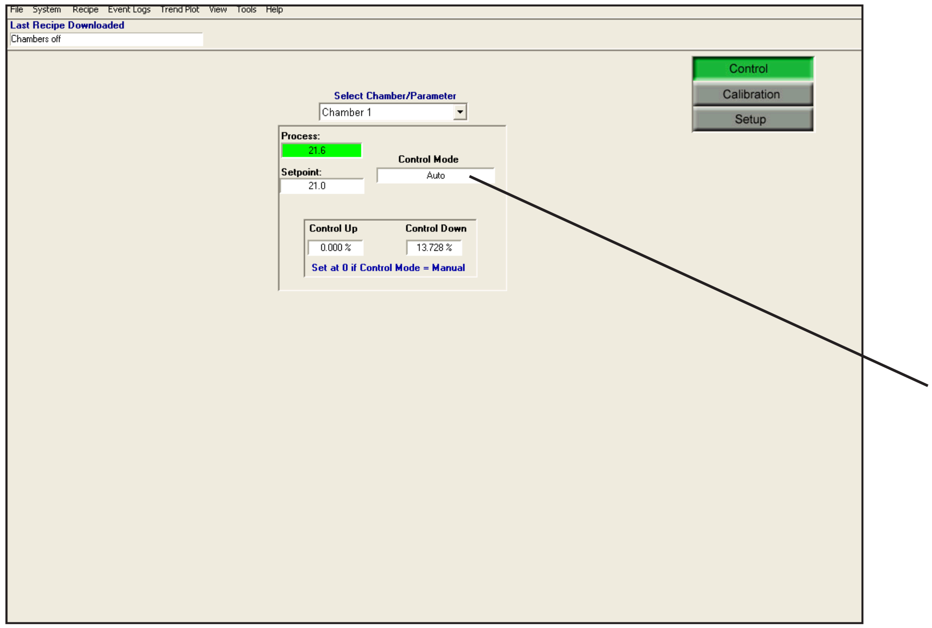
1. After using Single Setpoint Control shut off all of the gas control.
2. Click the **Control** button.



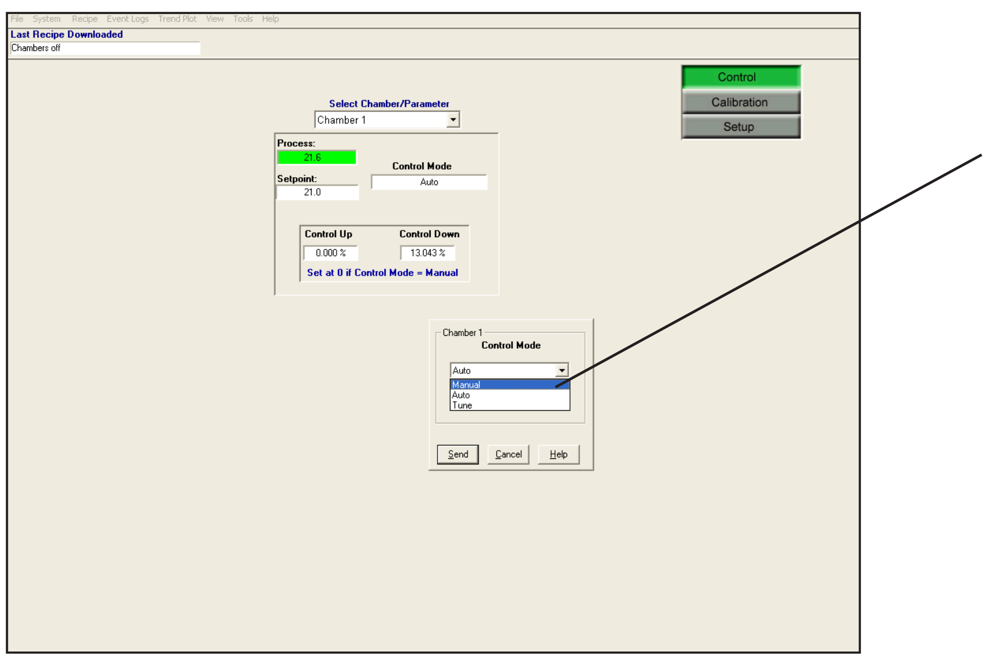
3. Under the *Select Chamber/Parameter* heading, select **Chamber 1** in the pull down menu.



4. Double click the reading underneath **Control Mode** to open the *Chamber 1 Control Mode* window.

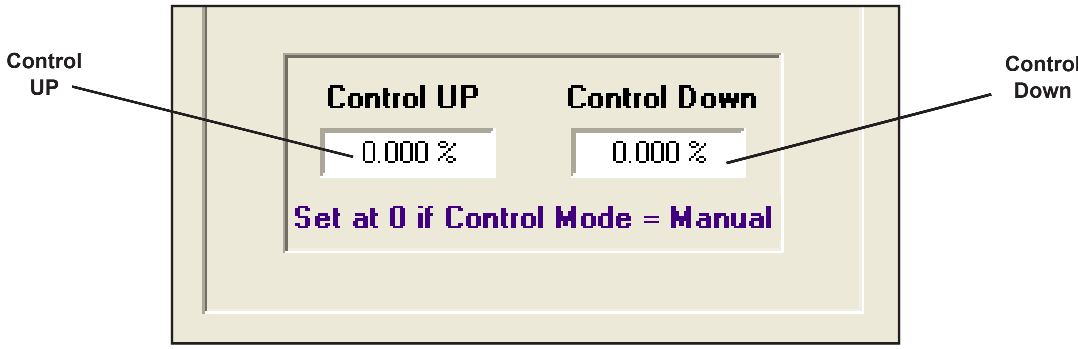


5. Change the *Chamber 1 Control Mode* to **Manual** in the pull down menu and click **Send.**



6. Make sure that the *Control Up* and the *Control Down* are both reading **0.000%.**

7. If either one or both don't read **0.000%** then double click the number in either column to bring up the popup window, adjust the number to **0** and click **Send.**



Set **Control UP** and **Control Down** to **0.000%**

8. Repeat this process for all the other Chambers.

12 Writing Profiles

This section will describe how to use the profiling feature. Profiling allows the user to program the controller to automatically increase and decrease gas levels in a specific amount of time.

Overview:

Profiling, also referred to as “ramp and soak,” is a significant feature of the Oxycycler model A84, allowing the unit to monitor and control preset setpoints without continuous user interaction.

Profiling consists of numerous segments, during which the gas(es) go from a previous segment’s setpoint to the current segment’s setpoint, automatically increasing and decreasing the gas levels in a specific amount of time.

A ramp and soak profile starts with the *Ready Segment.* The *Ready Segment* must be setup before the software lets the user do any editing or make any changes with the other segments. This prevents the user from forgetting to set information such as the *Number of Cycles, Continuous* option and *Tolerance Time-Out* limit. Once the *Ready Segment* is created, the additional segments can then be setup.

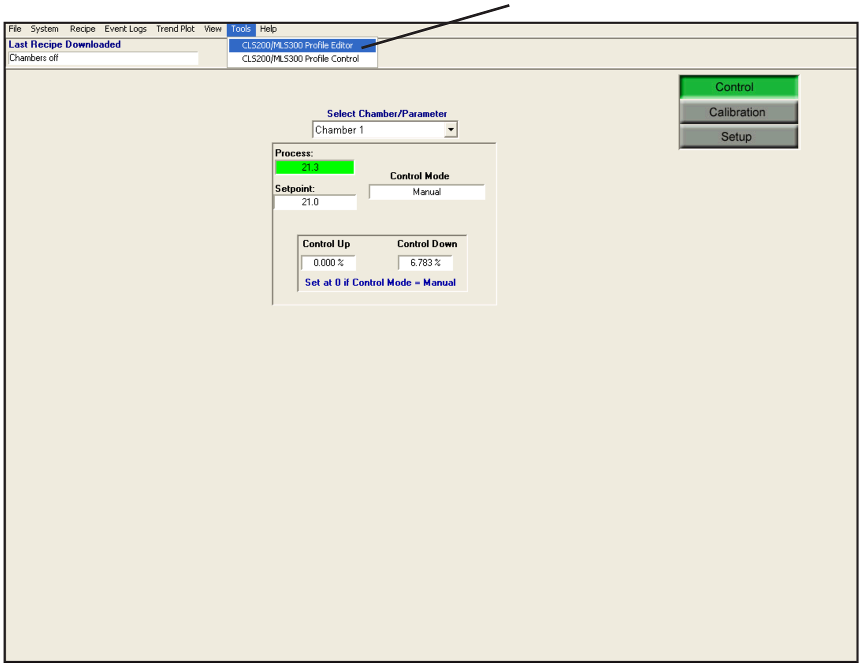
If the segment’s setpoint is set to increase gas levels, this is known as a “ramp segment.” If a segment’s setpoint is set the same as the previous segment’s setpoint (to level off), it is known as a “soak segment.”

Once the loop’s *Control* status is set to *Run*, the computer will launch the programmed segments until the *Number of Cycles* to be completed is finished.

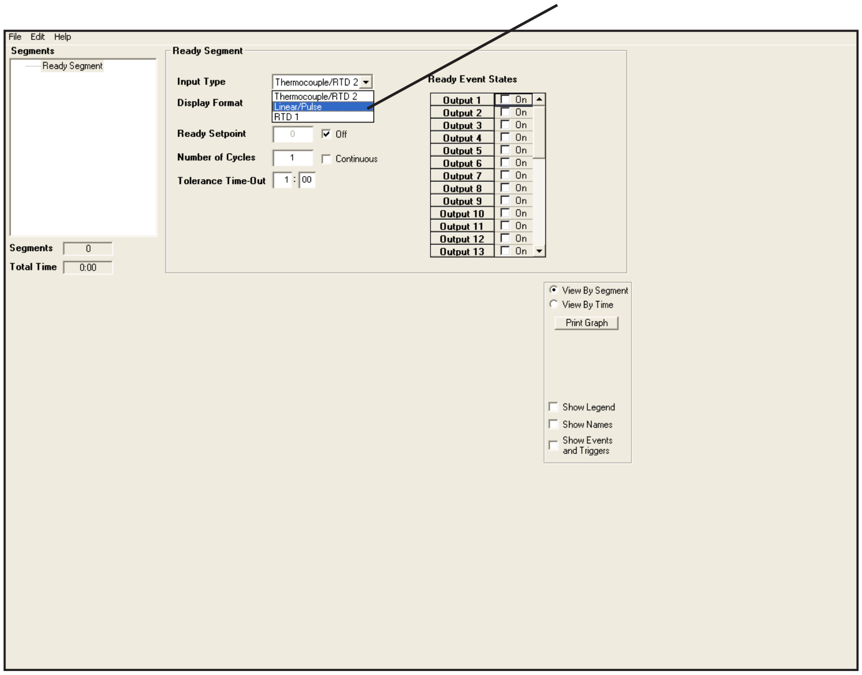
Once all the segments have been completed, the loop will then return to the *Ready Segment.* If the profile is programmed to *Repeat,* then the segment will automatically run through the cycle again. However, if it is not programmed to *Repeat,* then it will return to *Ready Segment* until it is either *Unassigned* or the user runs the profile again.

Create a Profile:

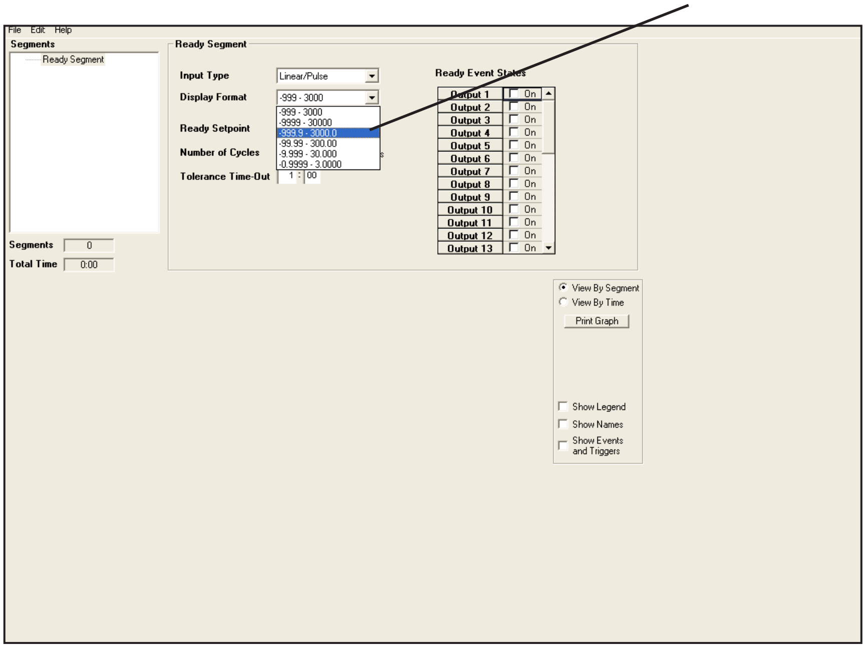
1. First, a Profile needs to be created. Click on **Tools** and select **Profile Editor.**



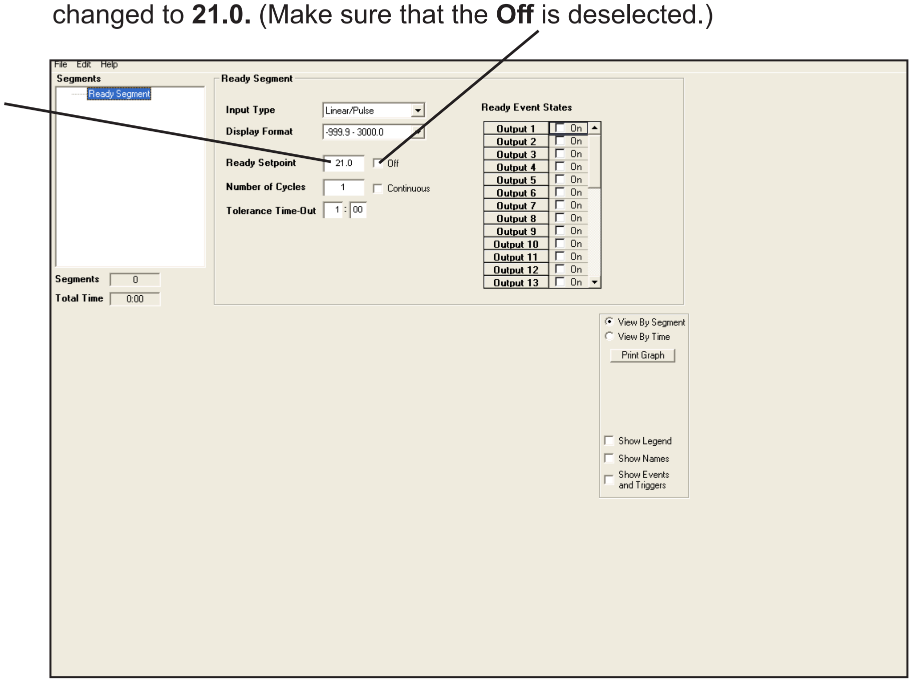
2. Some initial parameters need to be setup. The first one is *Input Type.* Change the *Input Type* to **Linear/Pulse.**



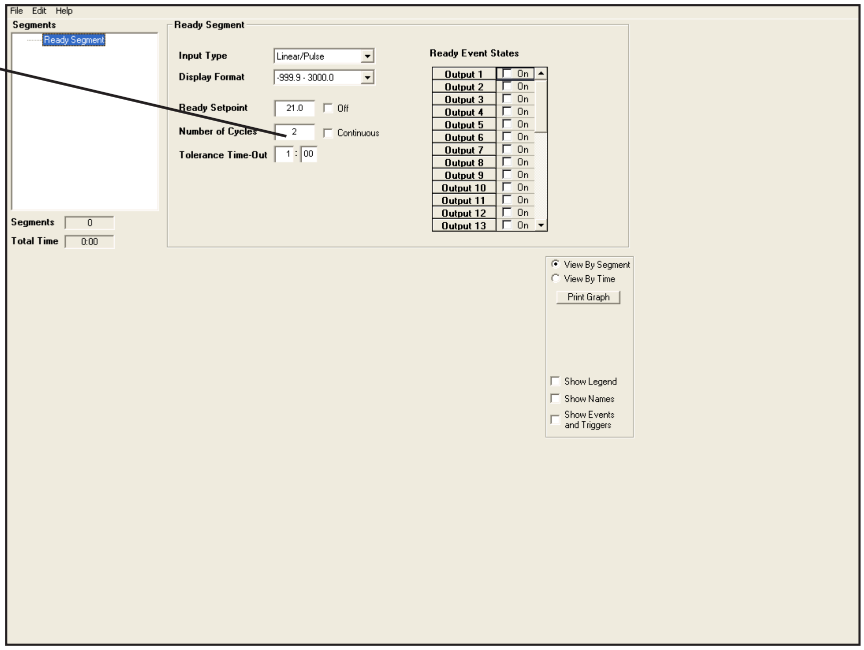
3. Change the *Display Format* to **-999.9-3000.0.**



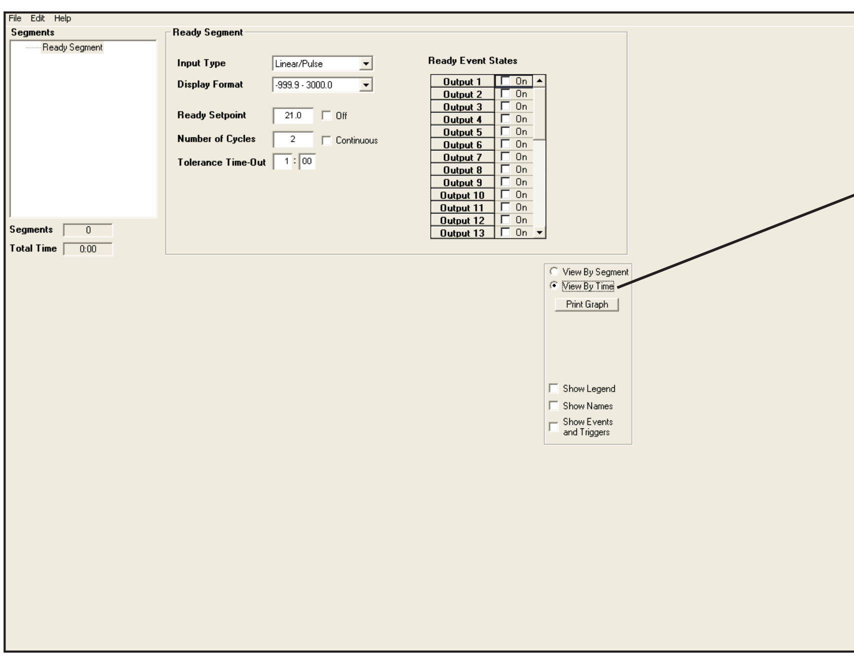
4. Next, the *Ready Setpoint* will need to be changed. The *Ready Setpoint* is the Setpoint where the profile will start and stop. In the following example the *Ready Setpoint* is changed to **21.0.** (Make sure that the **Off** is deselected.)



5. Now, the *Number of Cycles* will need to be changed. The number of cycles determines how many times the profile will run through its setpoints. Click in the box next to **Number of Cycles** in order to assign the profile a specific number. In the following example the **Number of Cycles** is set to **2**. The number of cycles can also be set to continuous**,** which would make the profile cycle through its setpoints continuously. In order to set the *Number of Cycles to Continuous, click in the box next to* **Continuous** so a checkmark appears.

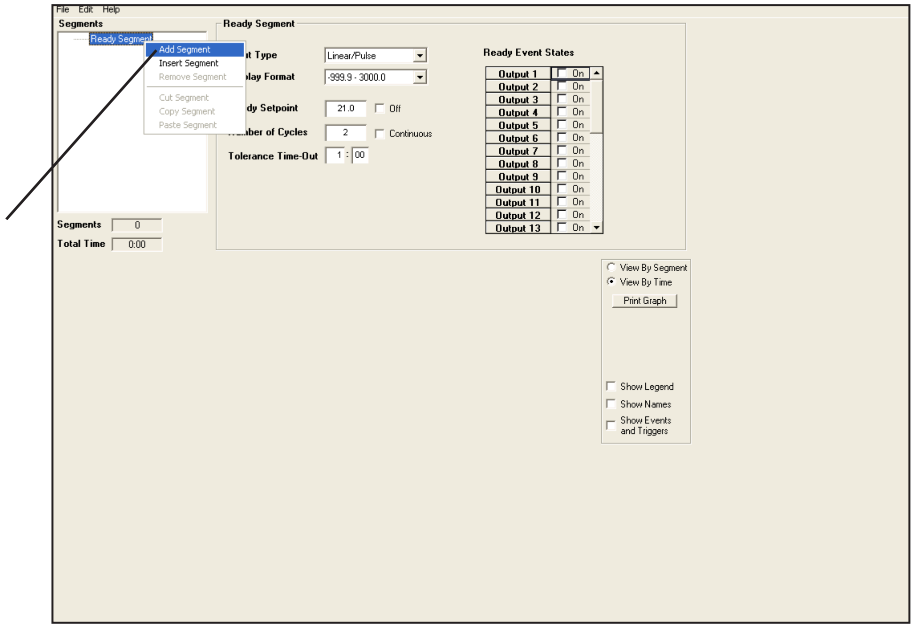


6. Change the graph to **View By Time.**



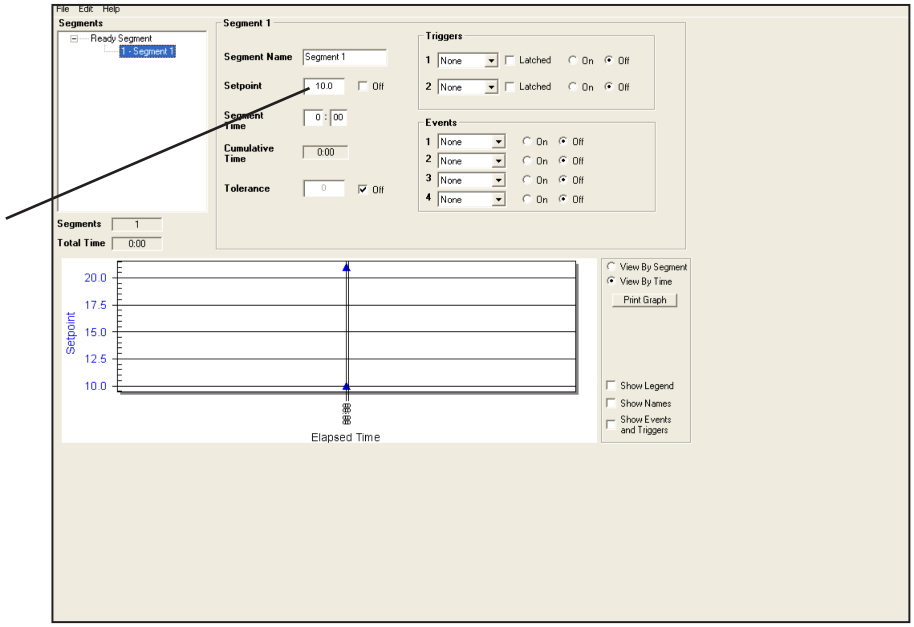
7. Next, is adding segments. Right-click on the **Ready Segment.**

8. Click **Add Segment.**

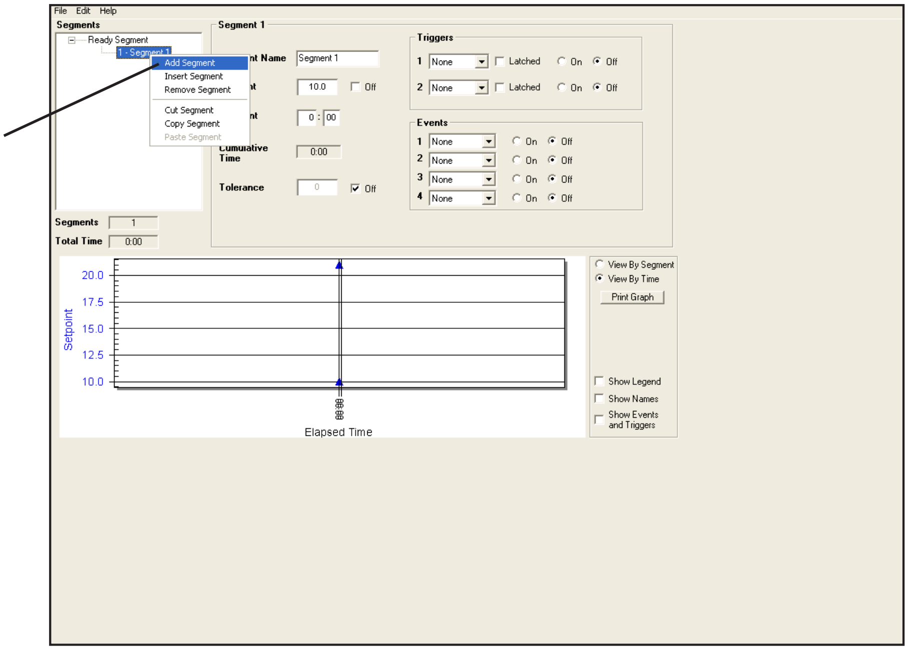


9. Click in the box next to *Setpoint* in order to change the setpoint to the desired value (make sure that the **Off** check box next to *Setpoint* is deselected). In the following example the setpoint value is changed to **10.**

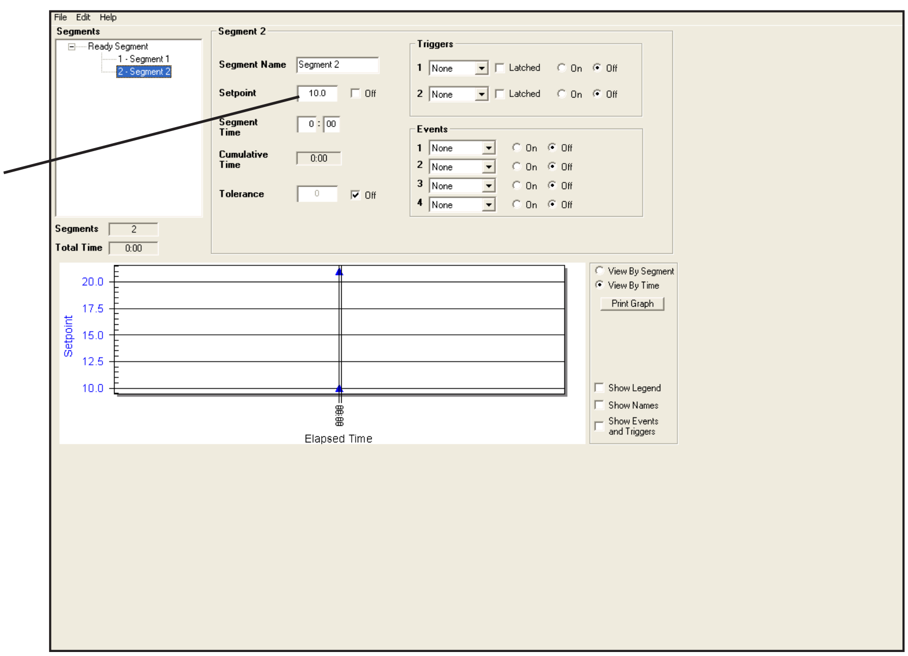
10. Leave the *Segment Time* at **0,** this will ensure that the setpoint reaches 10 as quickly as possible.



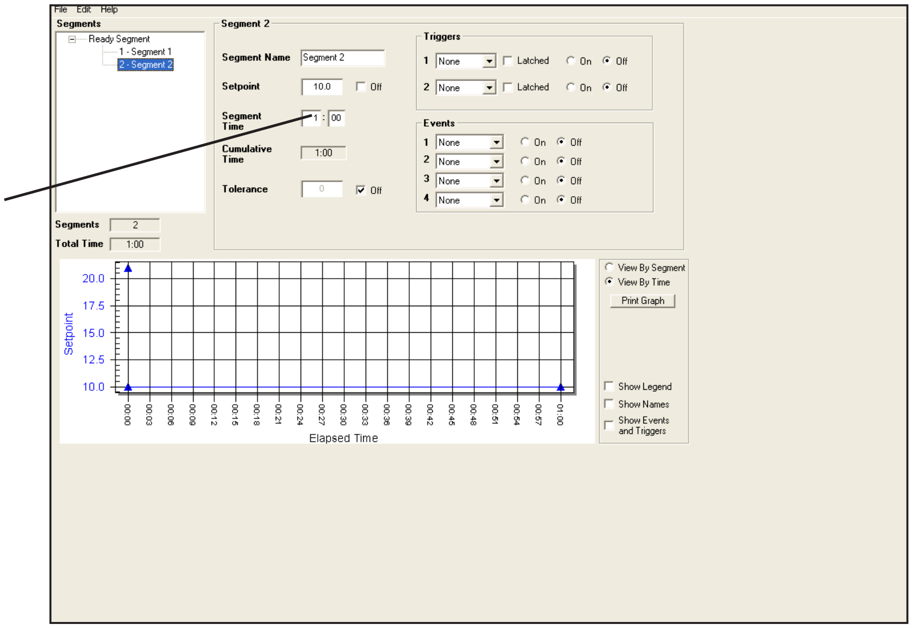
11. Next, add another segment. Right click on **Segment 1** and select **Add Segment.**



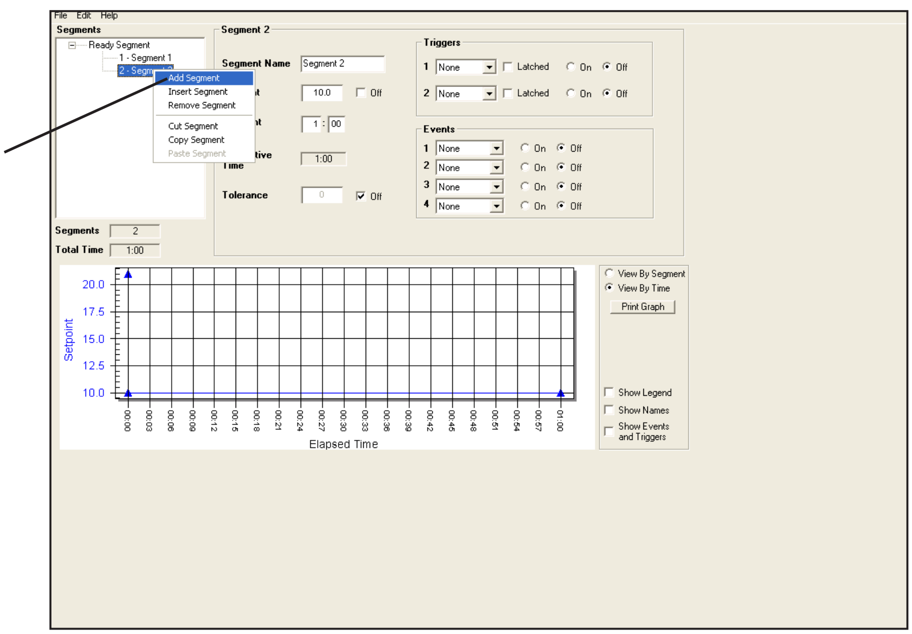
12. Change the **Setpoint** to **10.**



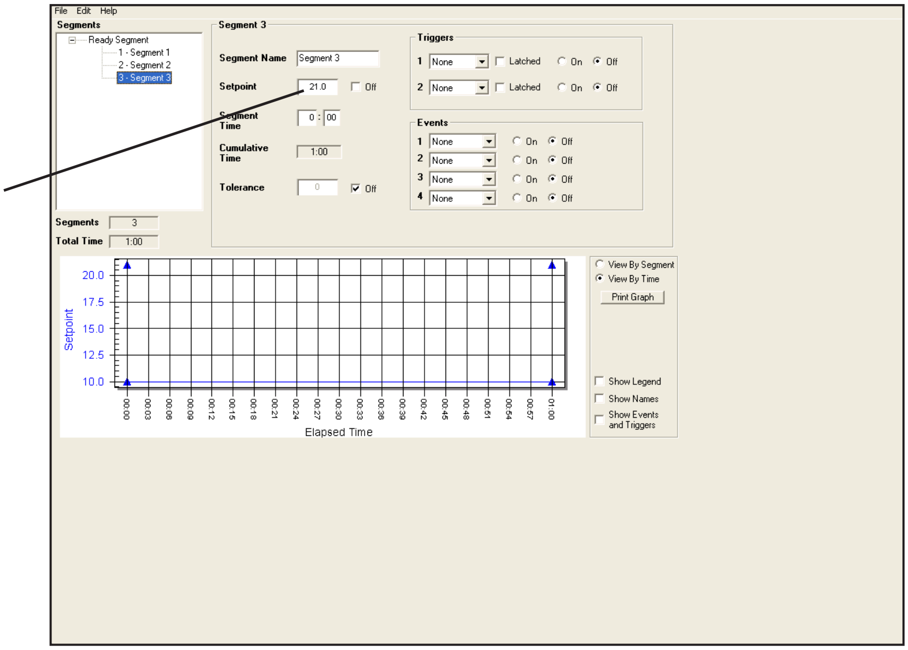
13. Change the **Segment Time** to **1 hour.** This will keep the setpoint at 10 for one hour.



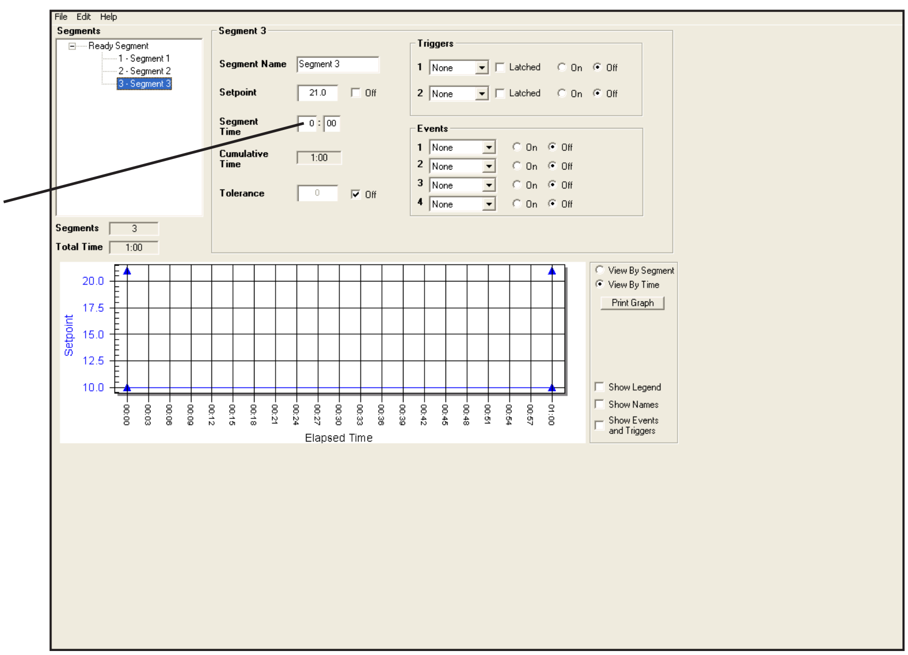
14. Add a third segment. Right click on **Segment 2** and select **Add Segment**.



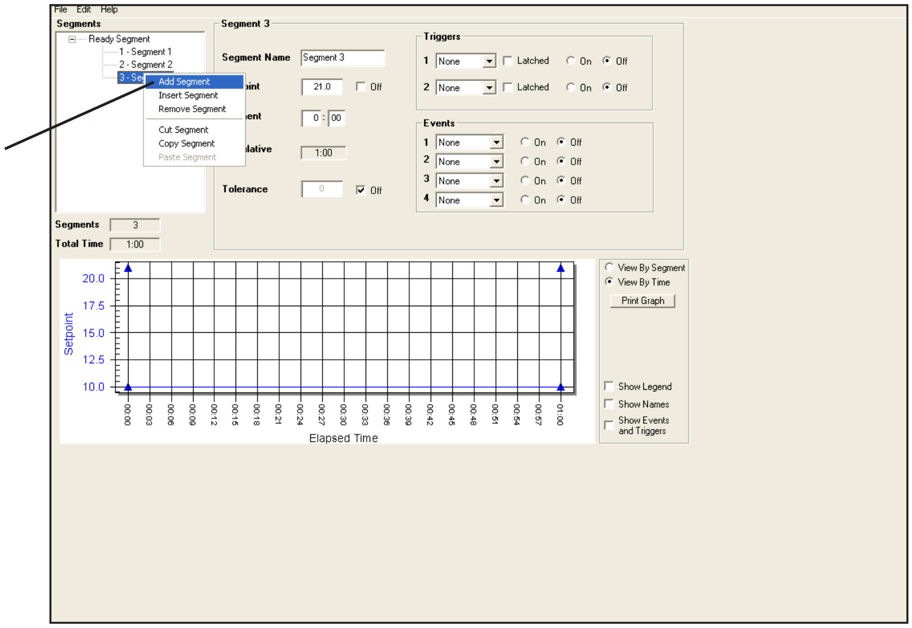
15. Change the **Setpoint** to **21.**



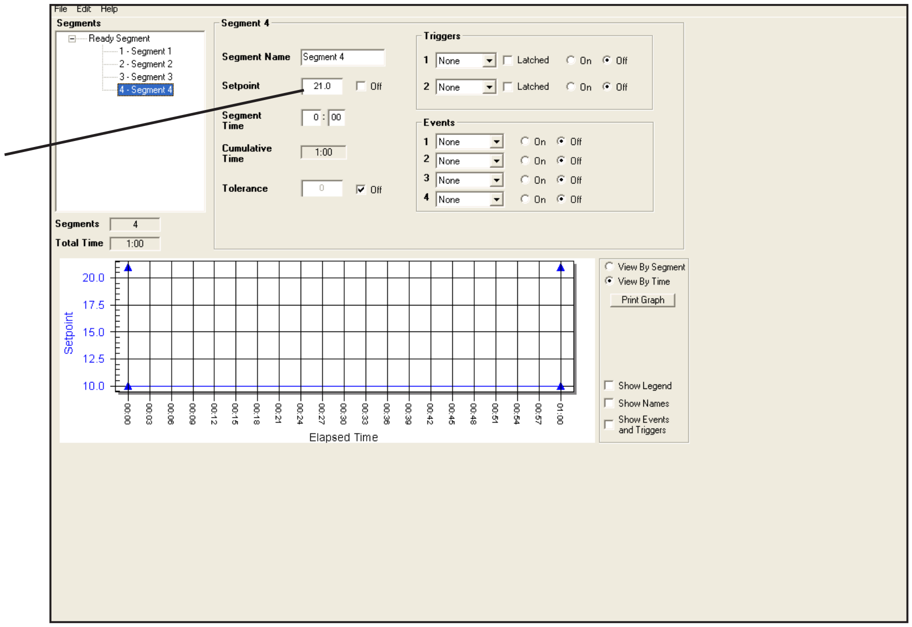
16. Leave the **Segment Time** at **0.**



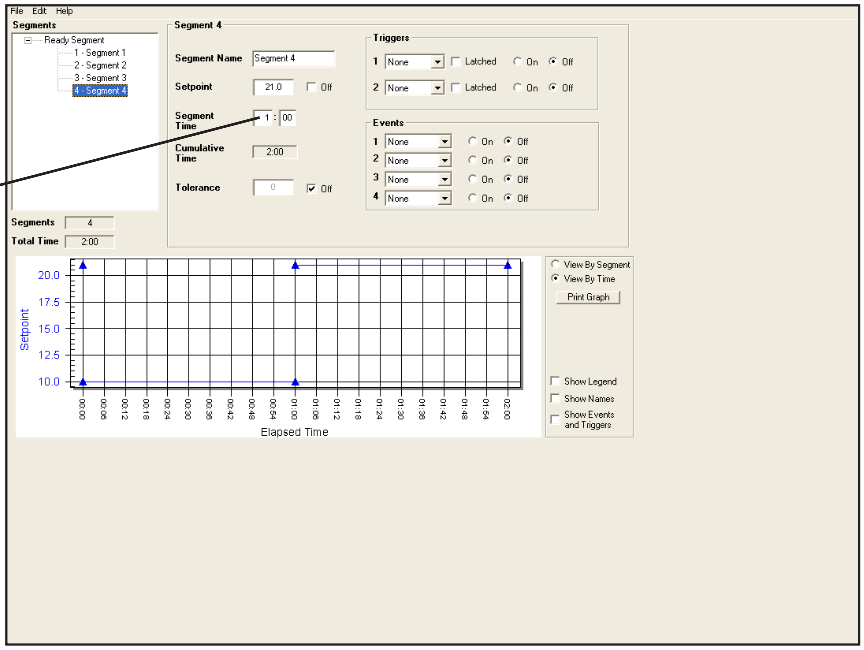
17. Add a fourth segment. To do this, right click on **Segment 3** and select **Add Segment**.



18. Change the **Setpoint** to **21.0**.

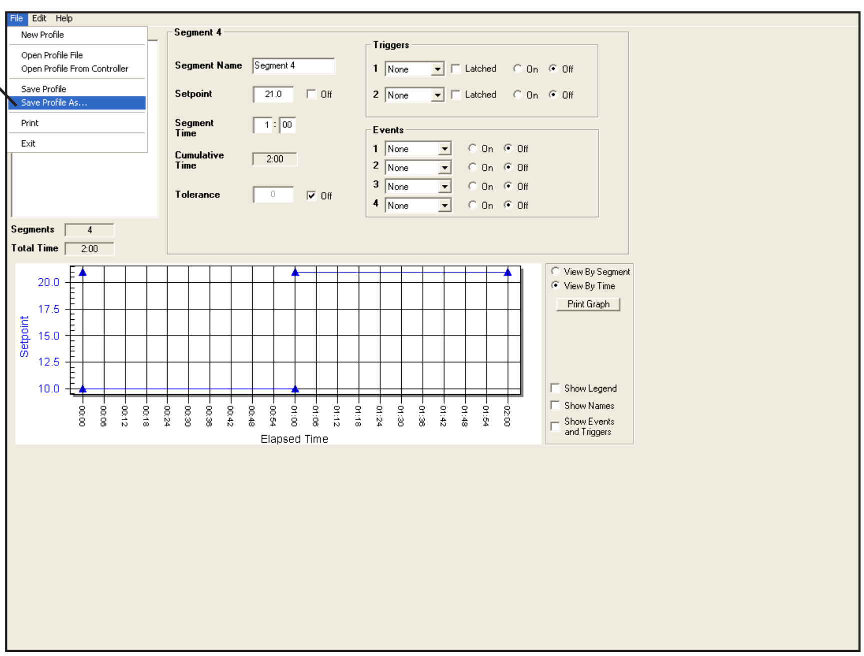


19. Change the **Segment Time** to **1 hour**.



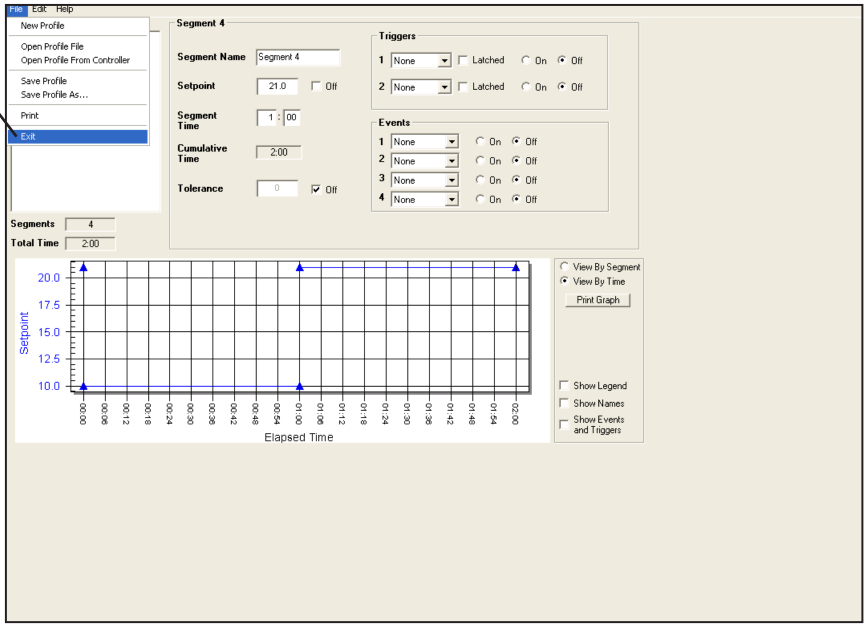
20. This profile will bring the *Setpoint* from *21* to *10* for one hour. Then, it will bring the *Setpoint* up to *21* for one hour. The profile will do this twice because the **Number of Cycles** is **2**.

21. Now, save the profile. Click on the **File** tab and select **Save Profile As.**



22. Name the profile and click **Save**.

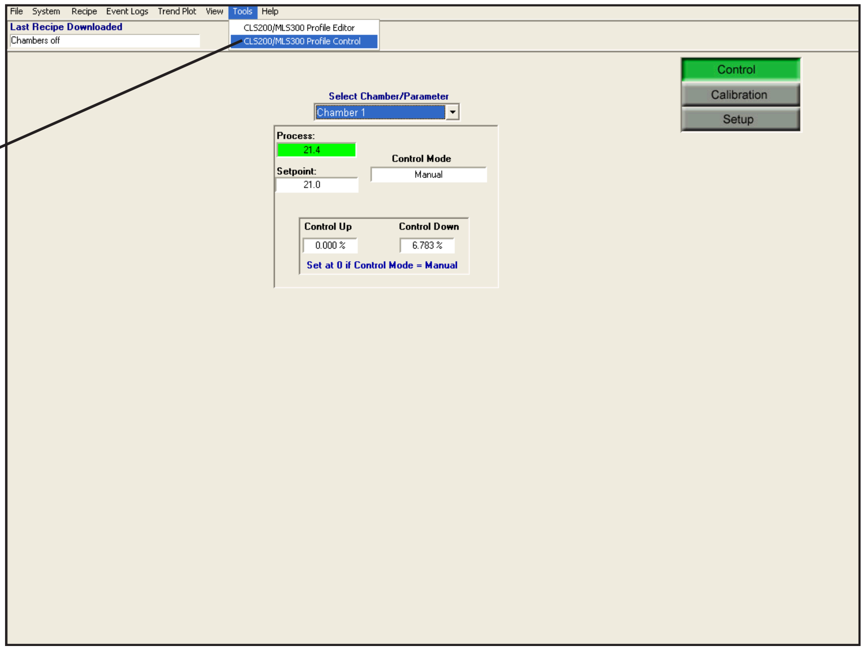
23. Now that the profile is created and saved, exit the *Profile Editor* window. Click on the **File** tab and select **Exit.**



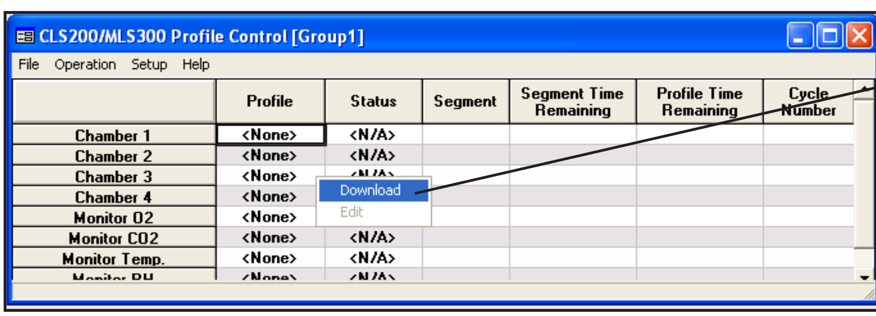
Running a Profile:

1. Under the *Select Chamber/Parameter* pull down menu select **Chamber (#).** The following example will show how to run a profile on *Chamber 1*.

2. Click on the **Tools** tab and select **Profile Control**.



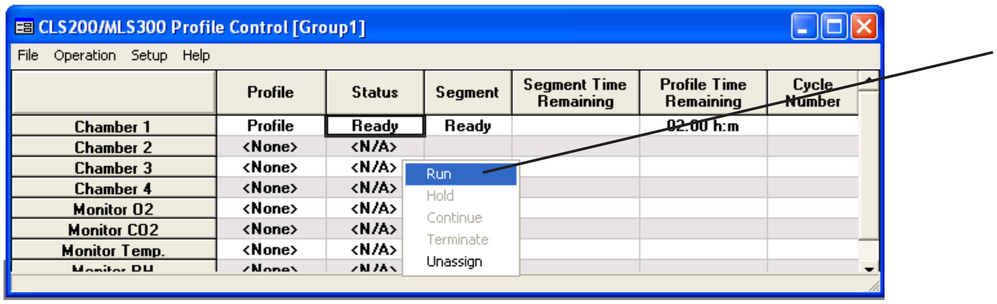
3. In the *Profile* column, right click next to the desired chamber and select **Download**.



4. Click the appropriate profile that was saved and click **Open**. Allow time for the computer to download the profile to the controller.

5. When it has been downloaded the **Status** will change from *N/A* to *Ready*.

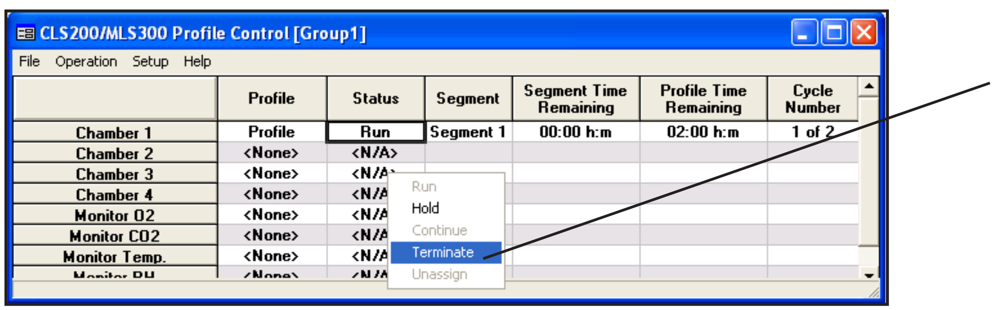
6. To run the profile, right-click on **Ready** in the *Status* column and then click on **Run**. The *Setpoint* will change as the system runs through the profile.



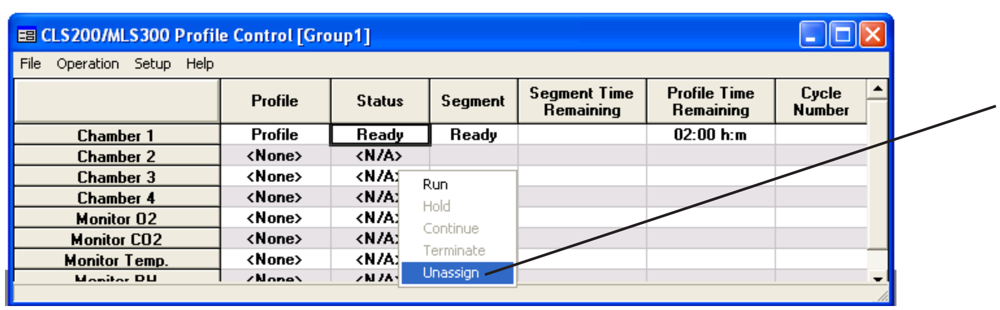
How to Stop a Profile:

1. In the *Profile Control* window, in the *Status* column, right-click on **Run** for the desired chamber.

2. Select **Terminate**.



3. Then, right-click on **Ready** in the *Status* column and click **Unassign**.



4. To exit this screen, click on the **red x** located in the upper right corner.

Setting a Tolerance

Setting a tolerance in a profile segment suspends the segment time clock until the process variable reaches the tolerance level, which is the **Setpoint** plus the **Tolerance**. Once the process variable reaches the tolerance level, the segment time clock resumes and the profile progression continues. If the **Segment Time** is set to **one minute***,* the current profile segment will end one minute after the process variable reaches the tolerance level. If **Segment Time** is set to **0:00**, the current profile segment will end immediately when the process variable reaches the tolerance level and the next segment will begin.

When *Tolerance* is set, the process variable is turned on 100% of the time, tuning parameters are not used until the tolerance level is attained. This means that significant overshoot of the process variable may occur, therefore setting a tolerance level short of the desired process variable is standard practice.

Negative Tolerance is used when controlling from a low level to a higher level. For example, going from 15% oxygen to 21% oxygen, setting a tolerance of -1 will start the segment time clock when 20% oxygen is attained.

Positive Tolerance is used when controlling from a high level to a low level. For example, going from 21% oxygen to 15% oxygen, setting a tolerance of 1 will start the segment time clock when 16% oxygen is attained.

The most common use of tolerance is in a situation where a process variable must be maintained for a certain amount of time, regardless of how long it takes to get there. For example, a hypoxia exposure that requires a level of 9% oxygen for exactly three minutes:

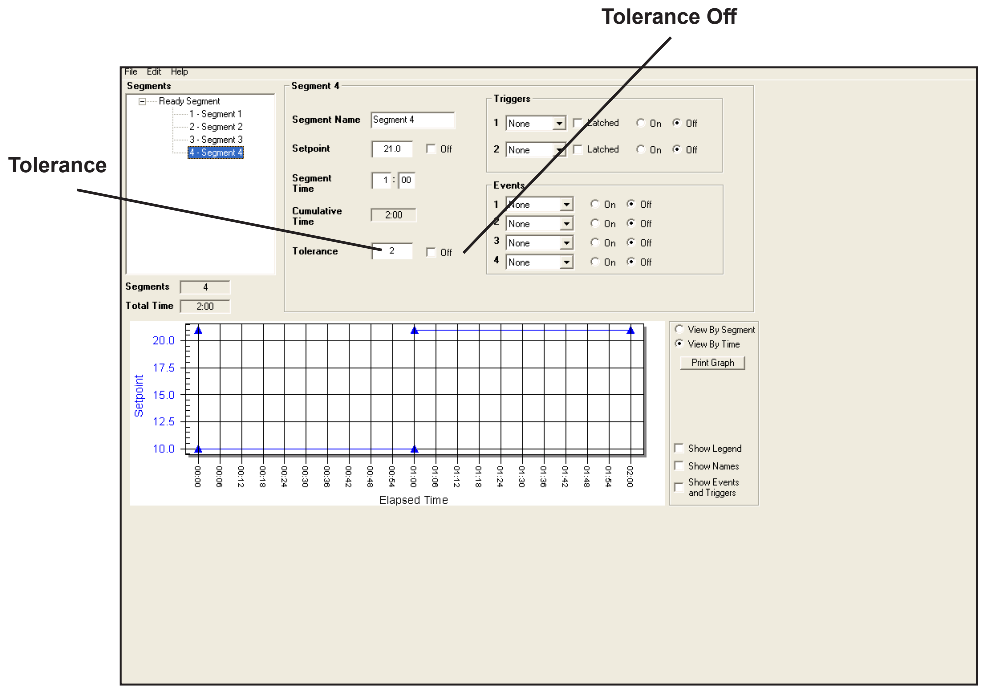
- When coming from an ambient level of 21% oxygen, it may take several minutes to reach 9% oxygen, depending on the size of the chamber. Normally, with segment time set at three minutes, if it takes two minutes to reach 9%, the desired hypoxia exposure level of 9% oxygen will only last one minute. By entering a tolerance of 1, the segment time clock will only start when the oxygen level reaches 10%, keeping the desired process variable within a 1% tolerance of 9% for the desired time, three minutes.

Another use of *Tolerance* is a situation where a certain process level must be attained as quickly as possible and then immediately turned around to a new process level. For example, controlling from an ambient level of 21% oxygen to 9% oxygen as quickly as possible and then immediately going back to 21%:

- With a **Setpoint** of **9%**, **Segment Time** of **0:00** and **Tolerance** set to **1**, once the oxygen level is reduced from 21% to 10%, the *Profile Segment* will end and the new segment will begin. Assuming the new *Profile Segment Setpoint* is *21%*, the system will instantly turn around, raising the oxygen level back to *21%*.

The optimal tolerance will vary depending on the specific amount of overshoot that occurs for each variable, therefore tests must be conducted to fine tune each profile to fit the specific needs and the custom settings that are required.

Tolerance is set by un-checking **Tolerance Off** and entering a tolerance level in the *Tolerance* field. Tolerance levels can be positive or negative and must be whole numbers.



Tolerance Time-Out

Set a limit on how long the process variable can be outside the tolerance set for the segment before the tolerance alarm occurs. If the process variable does not return within tolerance, the tolerance alarm will recur after the tolerance alarm time elapses again. If the alarm persists, you may want to reset the profile.

13 Recipes

A recipe is a collection of parameter settings from one or more controllers on a network saved in a file. Recipes provide a powerful tool for automating operations and switching the configuration of a system for a variety of processes.

Before you can create a recipe you will first need to create a recipe type. A recipe type is a group of user selected variables that can be used within a recipe. Creating a recipe type allows you to select specific parameters and indexes that you want to save within your recipe. The recipe types are created by accessing the *Recipe Type Builder* screen.

Recipe Type Builder Screen

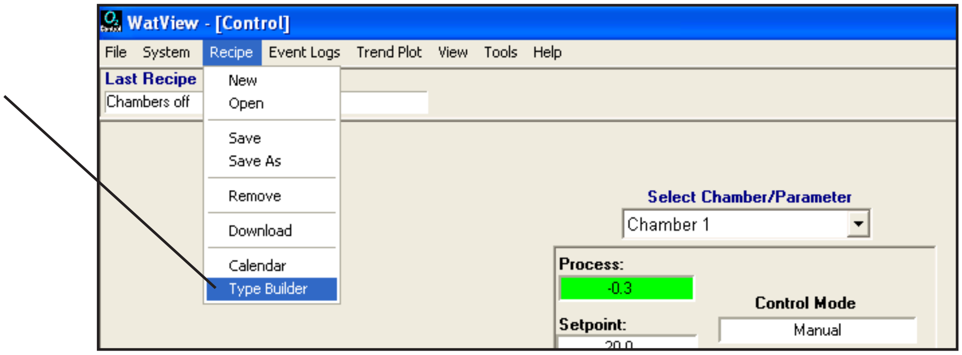
The *Recipe Type Builder* screen contains a list of all parameters and indexes. While creating a recipe type you can select specific parameters that you want to save within your recipe. The *Indexes* and *Parameters* that are selected in the *Recipe Type Builder* screen determine what the recipe will be able to change. For example: If you want your recipe to change the setpoint and the control mode for chamber 1, then you will need to select **Setpoint, Control Mode** and **Chamber 1** in the *Recipe Type Builder* screen.

A recipe type can include parameters from many controllers, including any type of controller that is configurable by WatView. Once the recipe type has been created you will now be able to create a recipe which you will be able to download and use.

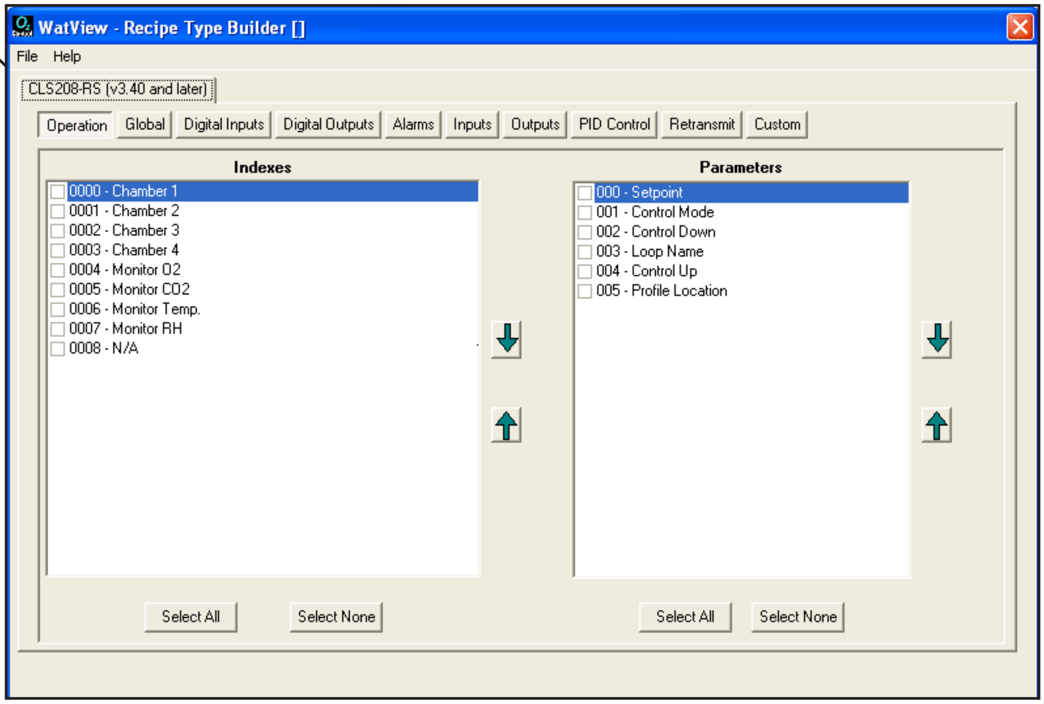
> **NOTE**
>
> In order to keep the recipes simple to edit and fast to download include *only* the parameters you need to change.

Create a Recipe Type

1. Click on **Recipe** in the toolbar and select **Type Builder**. This will open the *Recipe Type Builder* screen.



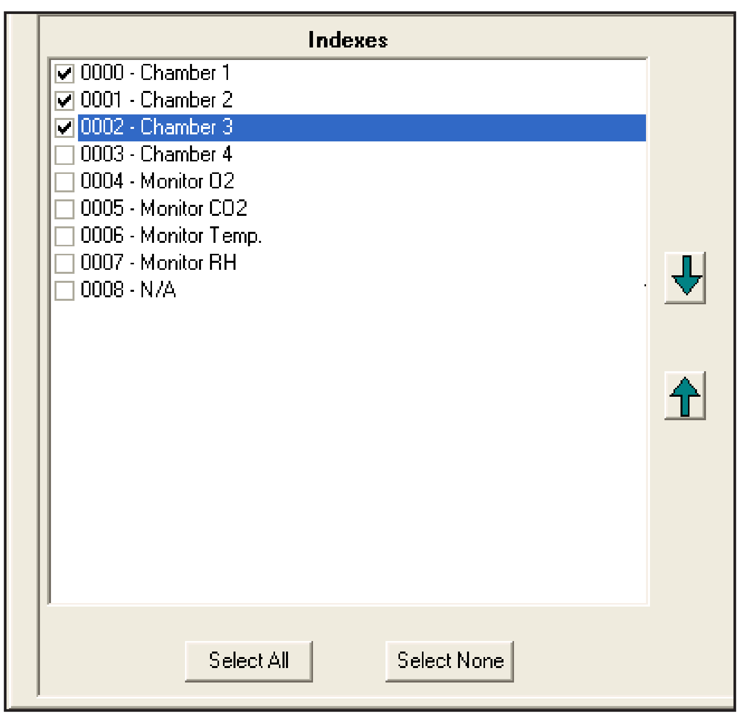
2. In the *Recipe Type Builder* window, select the tab for the particular type of controller you want to include in this recipe type. In the following example we will select controller **CLS208-RS**.



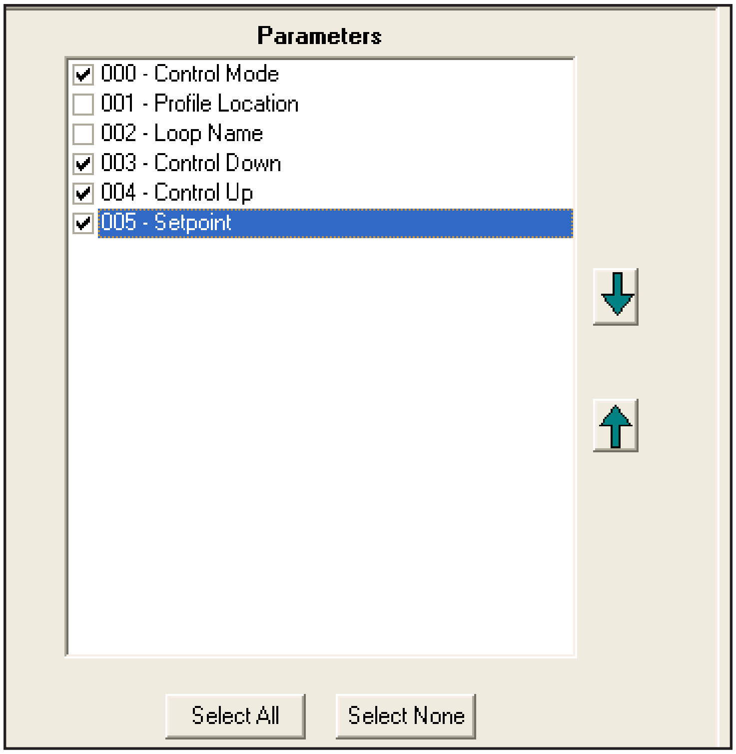
Recipe Type Builder Screen

3. Repeat the following steps for each type of parameter that you want to include in the recipes:

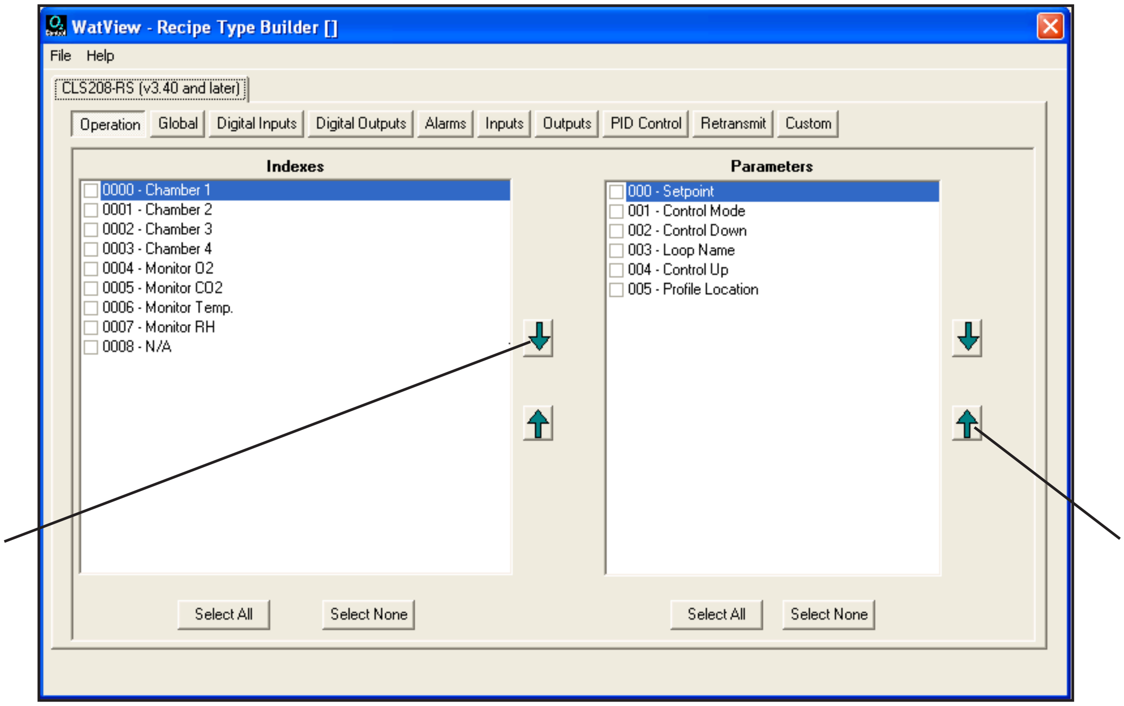
   I. Under the **Indexes** list, select each index that should appear in the recipes by clicking in the check box. To select all indexes click on **Select All**.



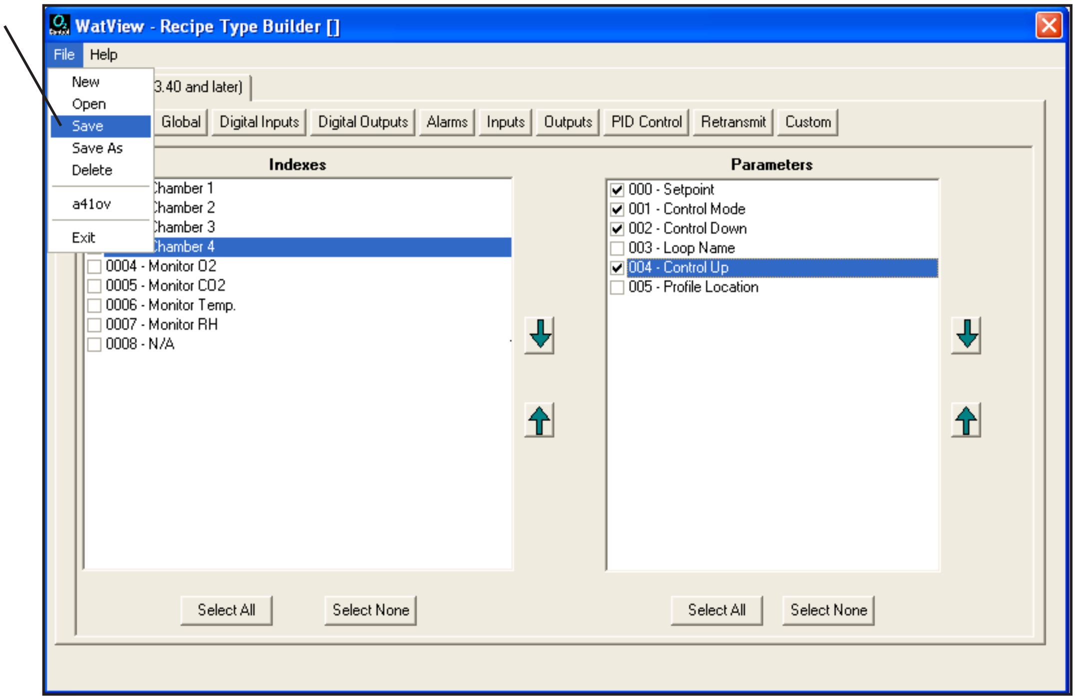
II. Under the **Parameters** list, select each parameter that should appear in the recipes by clicking in the check box. To select all parameters click on **Select All**.



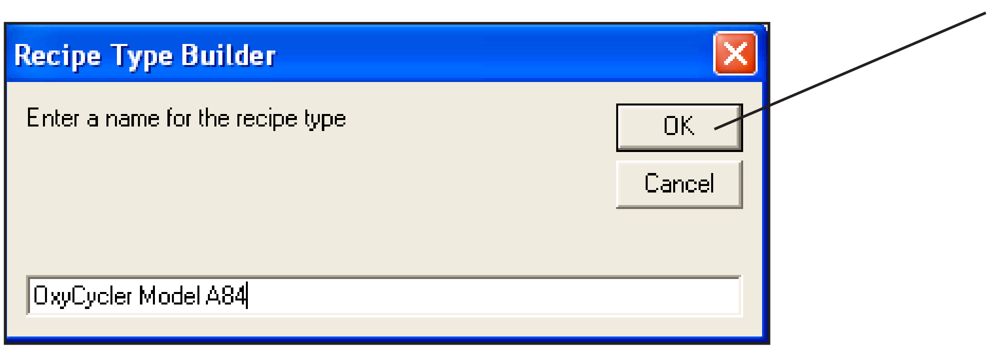
III. To change the order in which *Indexes* or *Parameters* appear in recipes, select an item in the **Indexes** or **Parameters** list, then click the up or down arrow.



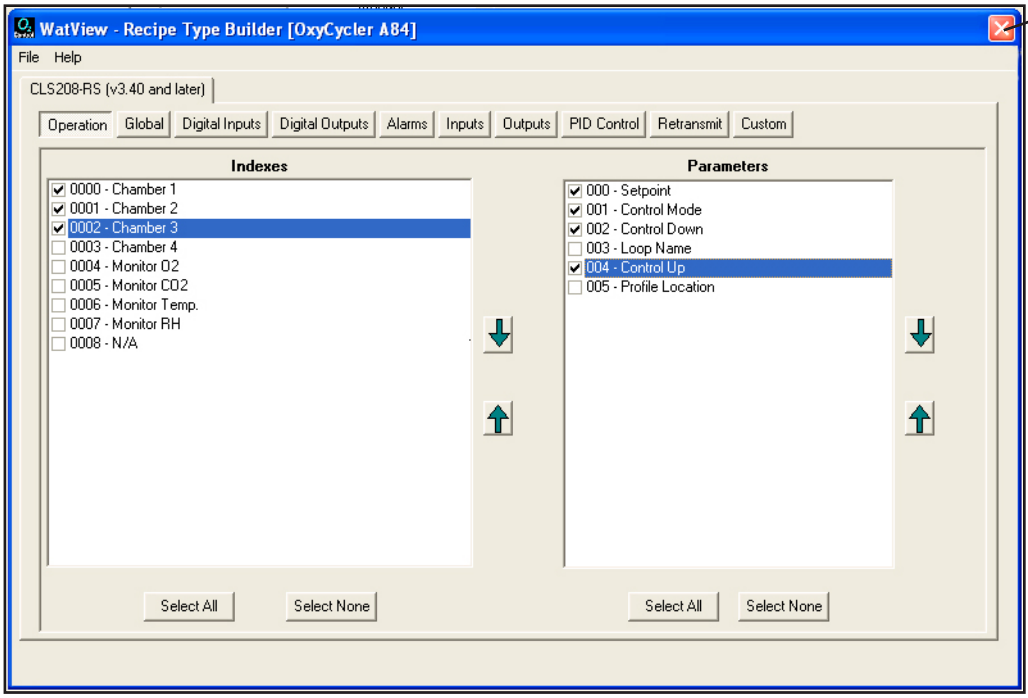
4. Once all *Indexes* and *Parameters* have been chosen, click on **File** and select **Save**.



5. In the *Recipe Type Builder* screen, enter a name for the recipe type and then click **OK**.

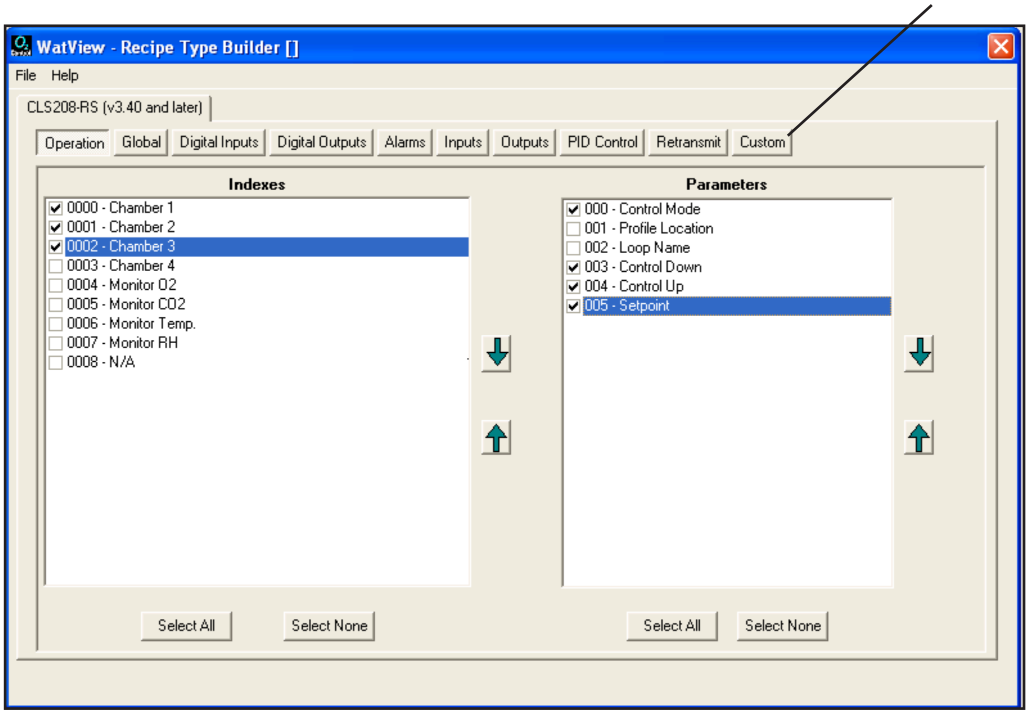


6. To exit the *Recipe Type Builder* screen, click on the **red X** in the upper right corner. Watview software provides you the ability to include custom parameters in the recipe type. To include custom parameters in the recipe type, please follow the instructions below.



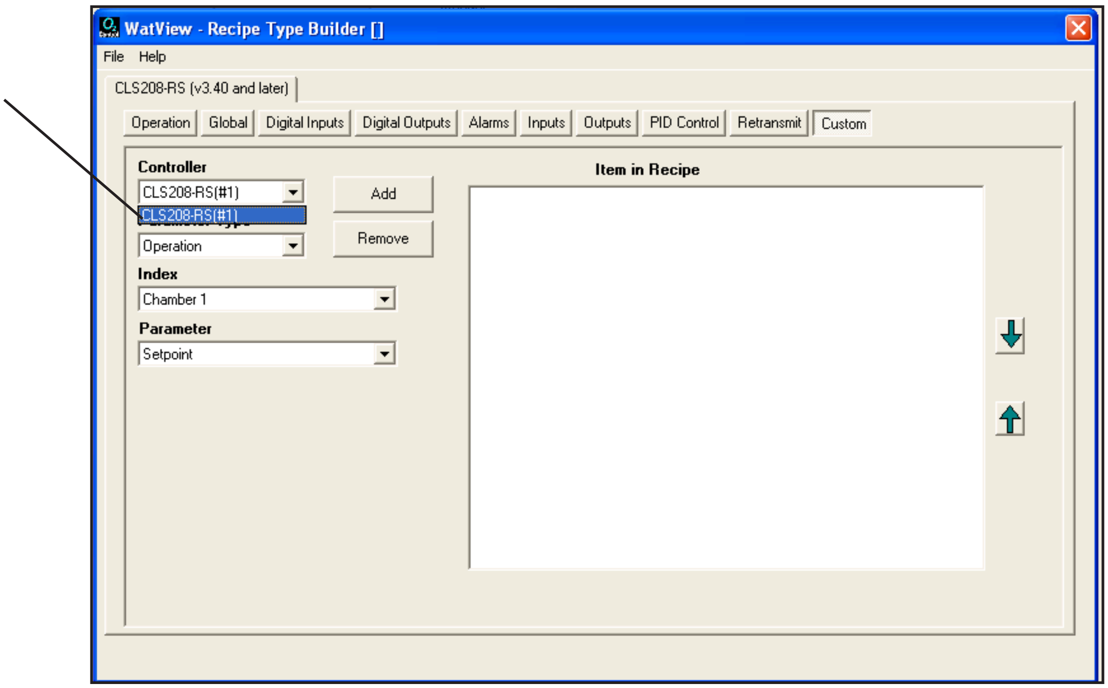
Custom Parameters

1. Click on the **Custom** tab from the *Recipe Type Builder* screen.

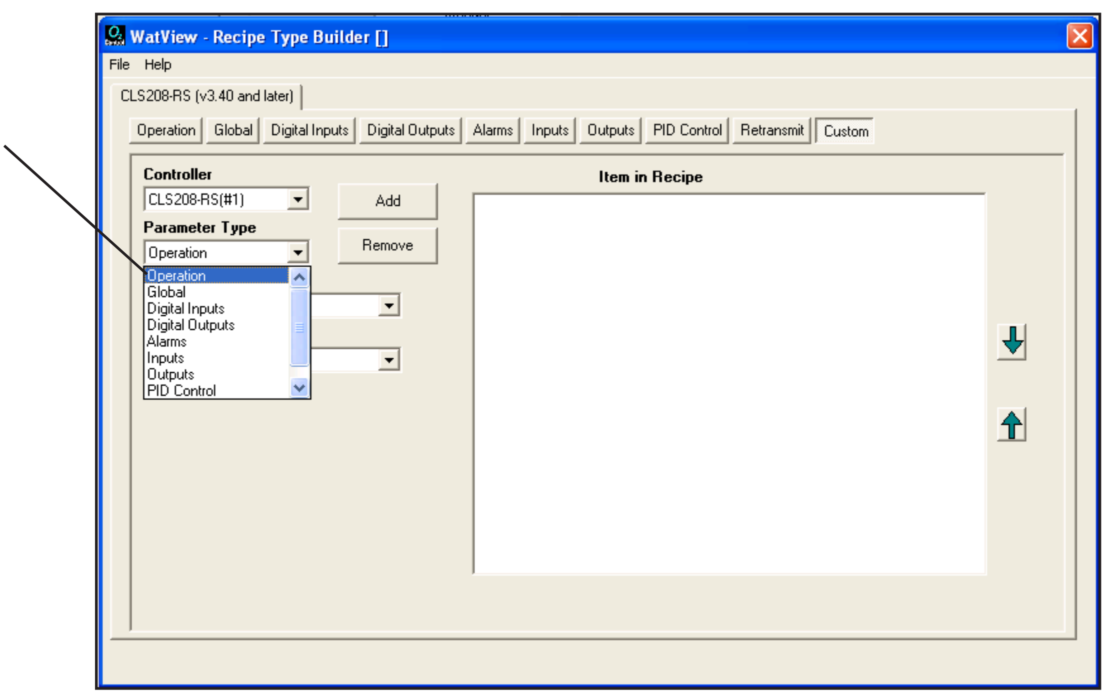


2. Once the *Custom* tab is selected, you can create a recipe type. Repeat the following steps for each custom parameter.

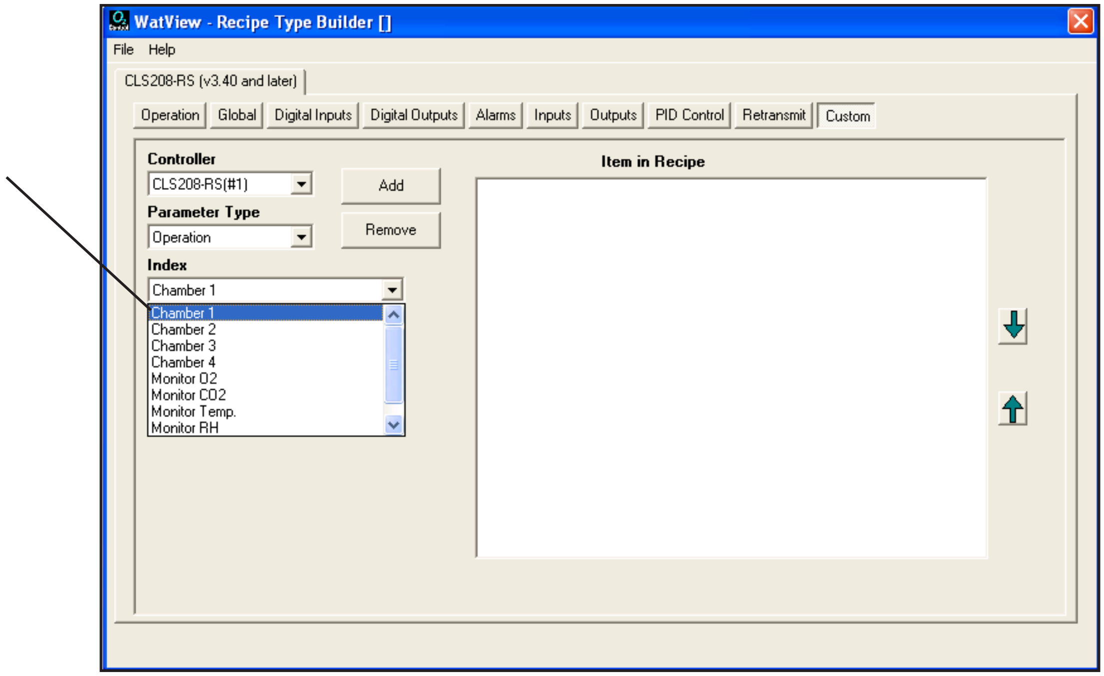
   I. Under the **Controller** heading, click on the arrow to open the drop down menu and select the controller to include in the recipe type. In the following example we will select **CLS208-RS**



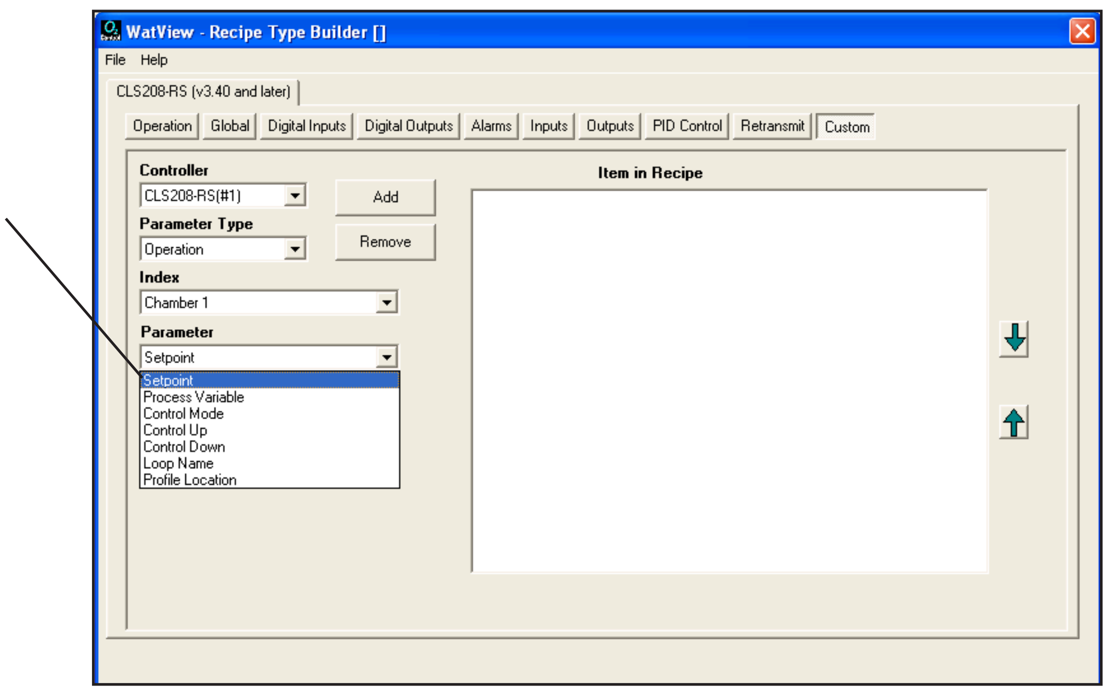
   II. Under the **Parameter Type** heading, click on the arrow to open the drop down menu and select the type of parameter you want to add as a custom parameter.



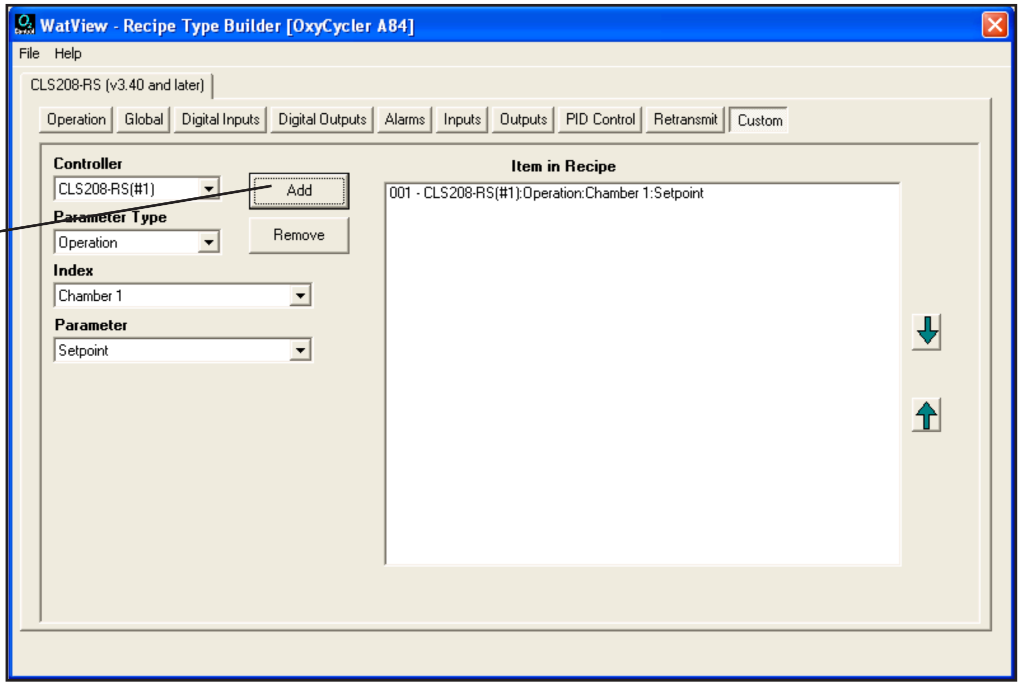
III. Under the **Index** heading, click on the arrow to open the drop down menu and select the specific index to include as a custom parameter.



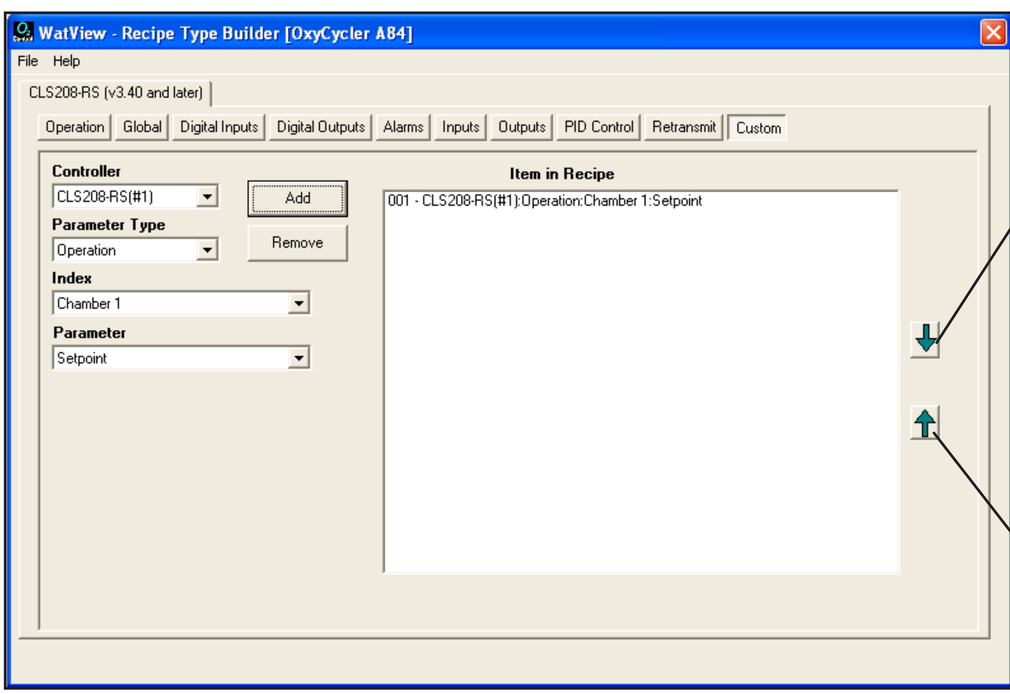
IV. Under the **Parameter** heading, click on the arrow to open the drop down menu and select the specific parameter.



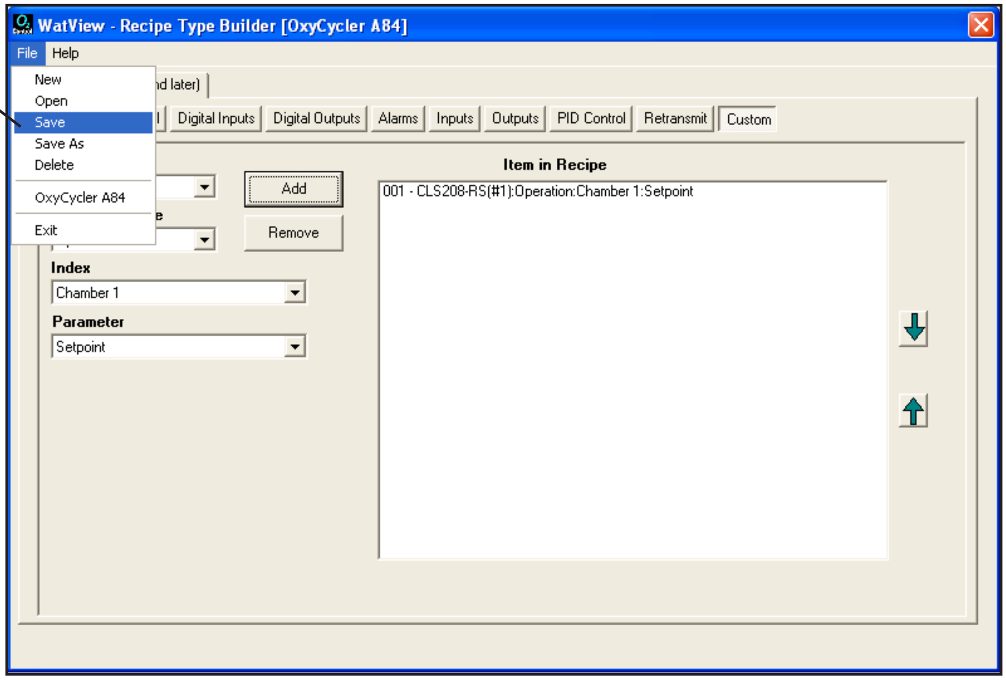
V. Click the **Add** button. Your new recipe type will appear under the *Item in Recipe* Column.



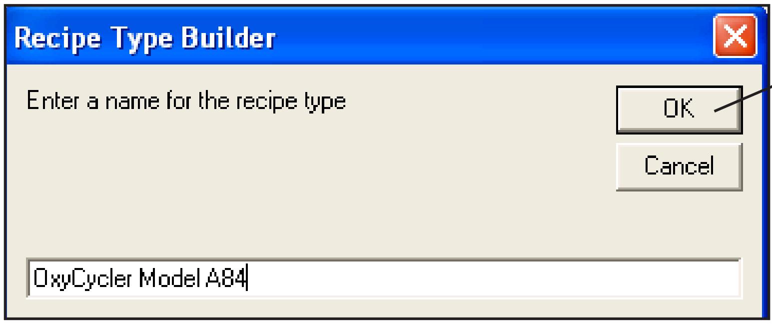
VI. If you have more than one items in the recipe list, you can change the order in which the custom parameters appear in recipes. To do this, select one of the custom parameters in the **Items in Recipe** list, then click the up or down arrow.



3. Click on the **File** menu and select **Save**.



4. In the *Recipe Type Builder* window, enter a name for the recipe type and then click **OK**.



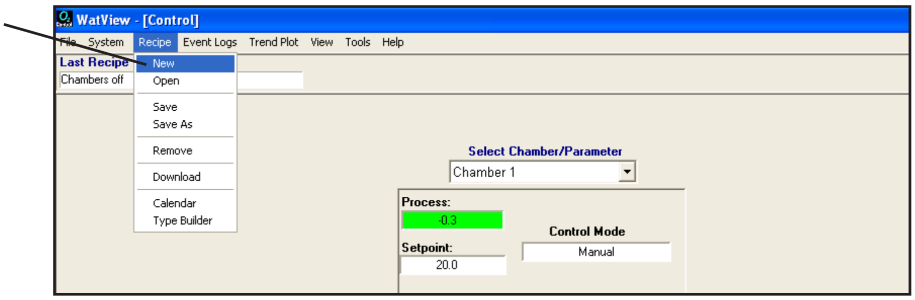
Create a Recipe

Once you have created a recipe type, you can use the *Recipe Editor* to create new recipes. Editing values in a recipe does not alter settings in the controller directly. After you have set all the parameters the way you want them, save your recipe. Once your recipe has been saved you will be able to send all the settings you made to the controllers by downloading the recipe that was created.

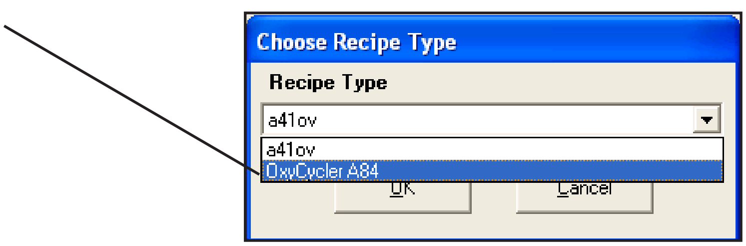
Before creating a recipe there must be at least one recipe type. If no recipe types exist, refer to *Create a Recipe Type.*

To create a new recipe:

1. In the toolbar, click on **Recipe** and select **New**.



2. The *Choose Recipe Type* window will open. If more than one recipe type exists, select the type to use as a model for the recipe, then click **OK** to open the *Recipe Editor* window. If only one recipe type exists then the *Recipe Editor* window will open automatically, skip to step 3.

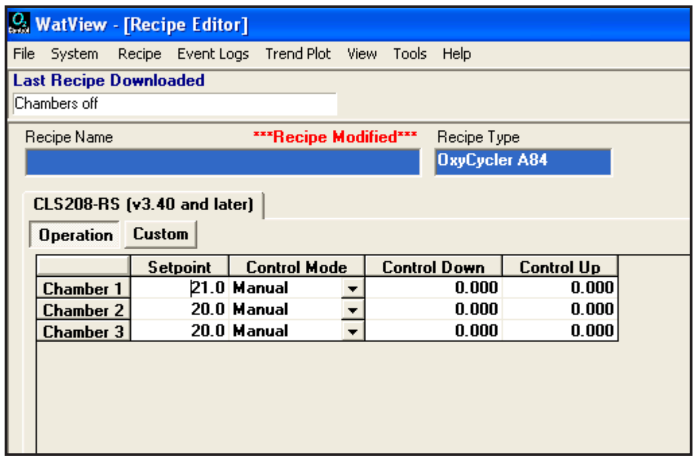


NOTE

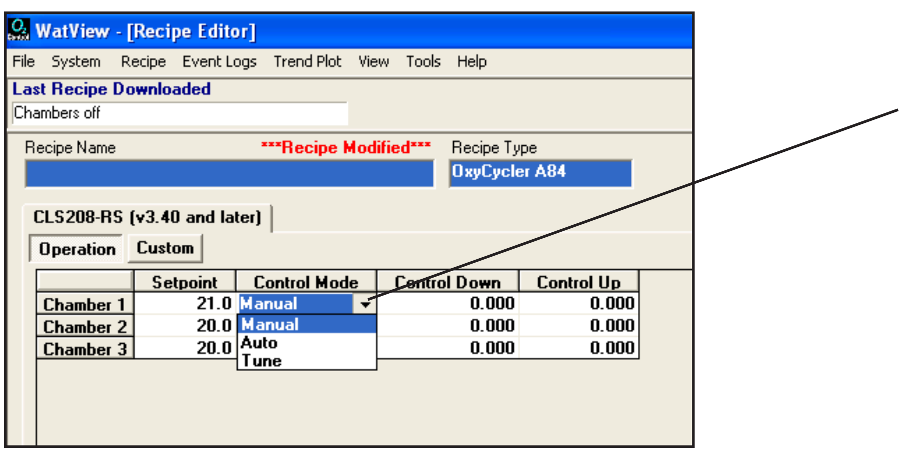
The new recipe contains settings that are the same as those currently in the controller(s). However, editing the values in the recipe has no effect on the controller(s) until the recipe is downloaded.

3. In the *Recipe Editor* window, you can edit the parameter settings:

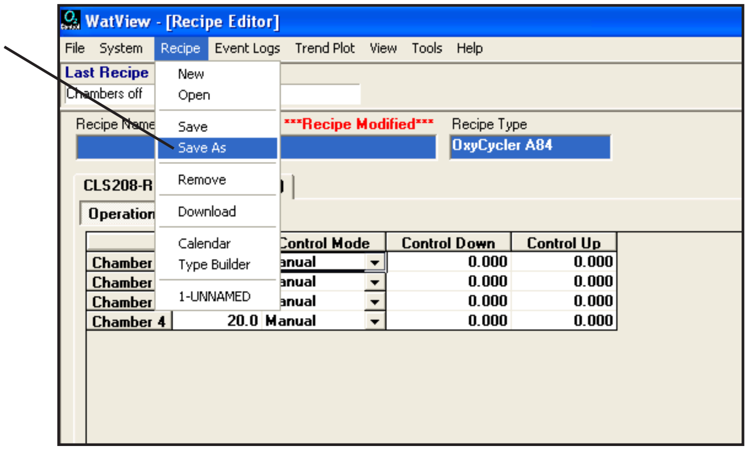
I. Double-click in a cell to edit the value.
If there are several parameters then you may need to scroll through the spreadsheet in order to see the cells that are off the screen.



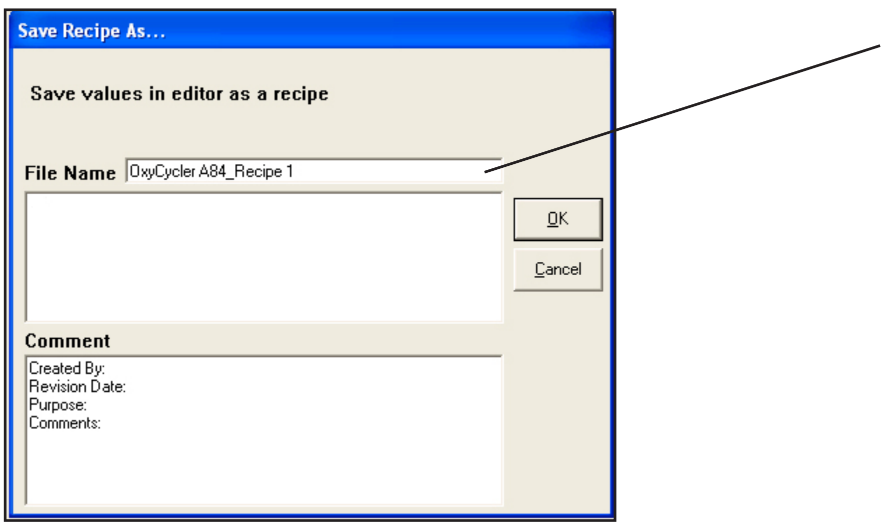
II. You can also view and edit other parameters by selecting the parameter in the cell and using the drop down arrow to change the settings.



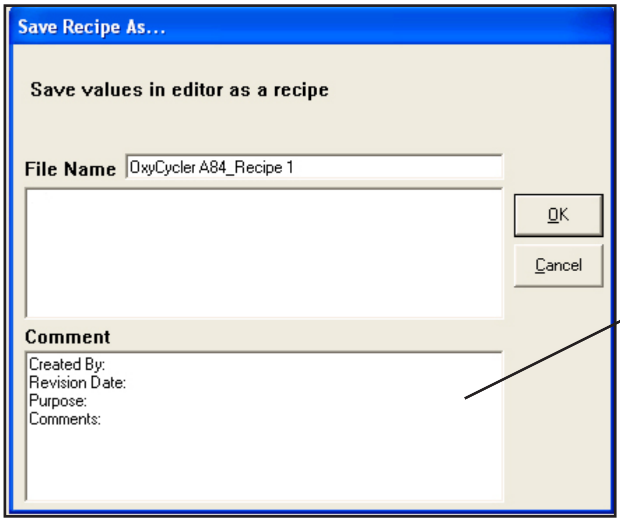
4. Once you have finished editing the parameters, click on **Recipe** in the toolbar and select **Save As**.



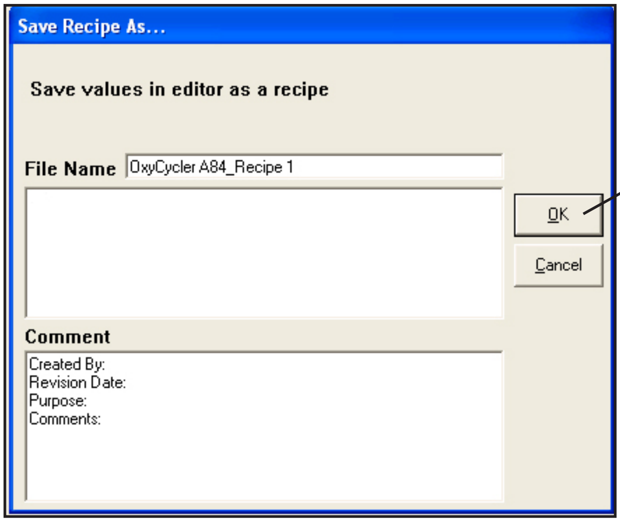
5. When the *Save Recipe As* window pops up, provide the recipe with a name. In the **File Name** field, enter a unique name for the recipe.



6. Double click in the **Comment** field to enter any notes that will help you recognize the recipe at a later time.



7. Click **OK**.

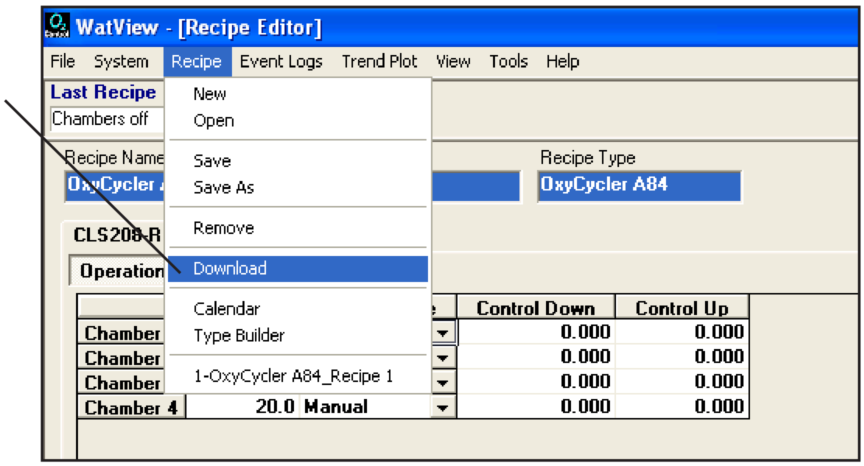


Download a Recipe

Recipe settings are sent to the controllers when a recipe is downloaded. Downloading a recipe will only affect the parameters and controllers specified in the recipe.

The following procedure will explain how to download a recipe from the computer to the controller(s):

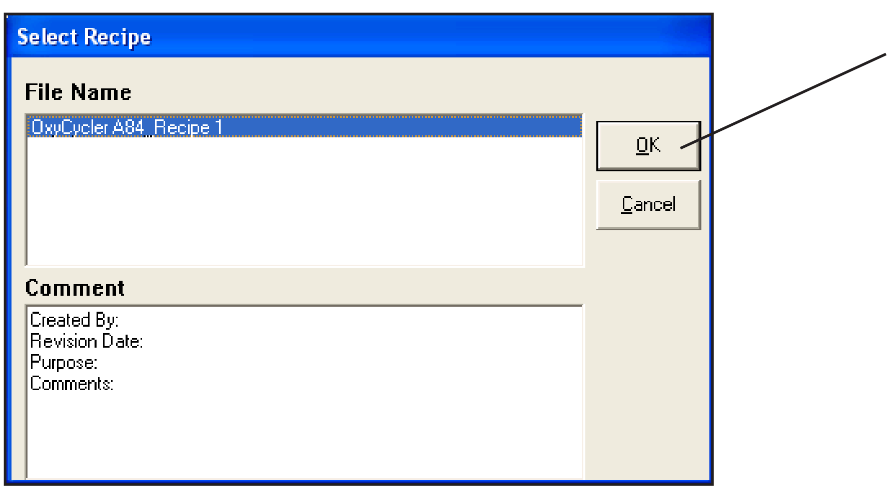
1. In the toolbar, click on **Recipe** and select **Download**. This will open the *Select Recipe* popup window.



NOTE

If you want to use the current controller settings again, save them in a new recipe before downloading another recipe.

2. From the *File Name* list, select a recipe and click **OK**.

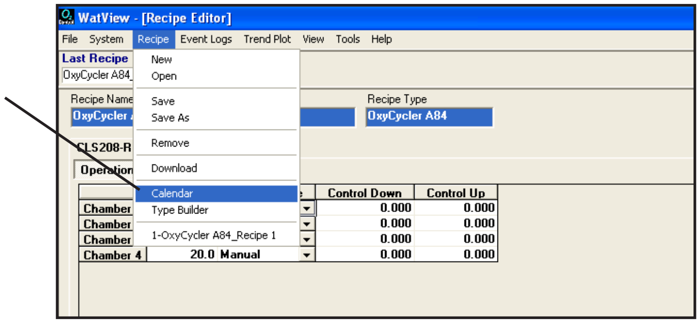


Using a Recipe

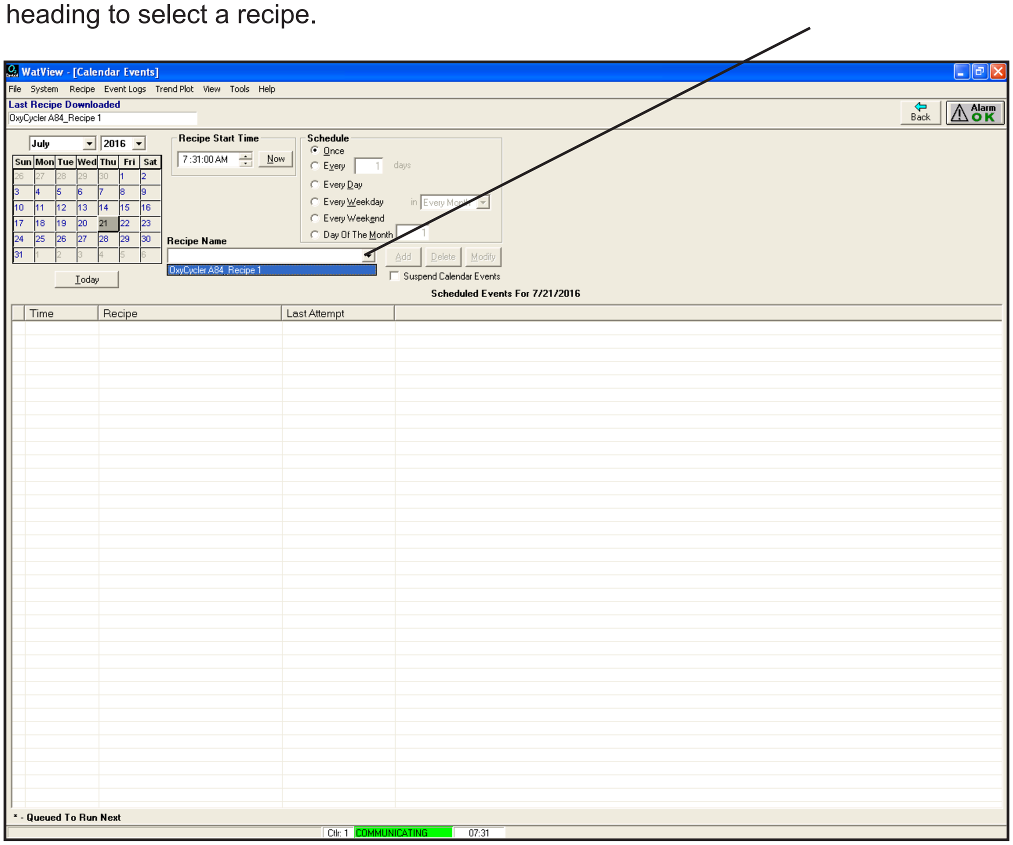
In addition to downloading a recipe manually, *Process Variable* recipes can be automatically downloaded based on the time and date or on startup conditions.

Automatic recipe downloads can be scheduled in the *Calendar Events* window. WatView can be set to download a recipe at a certain time and on a certain day, or on a regular schedule. This feature can be used to prepare a process before the operators arrive or to automate recipe changes and eliminate operator error.

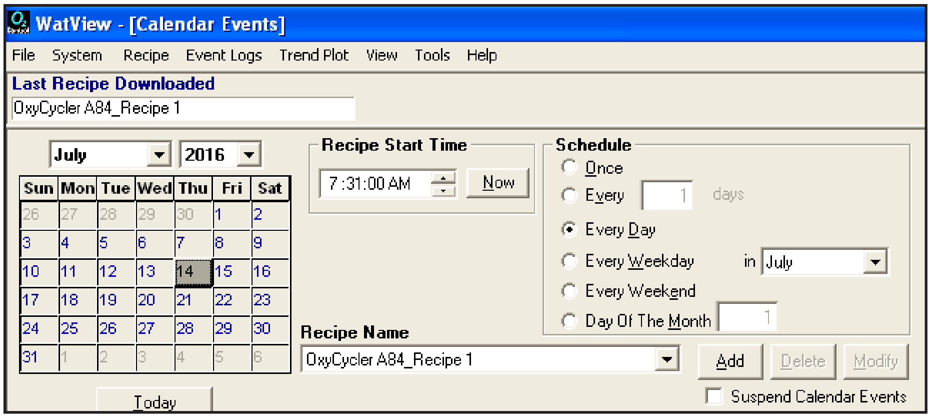
1. In the toolbar, click on **Recipe** and select **Calendar.**



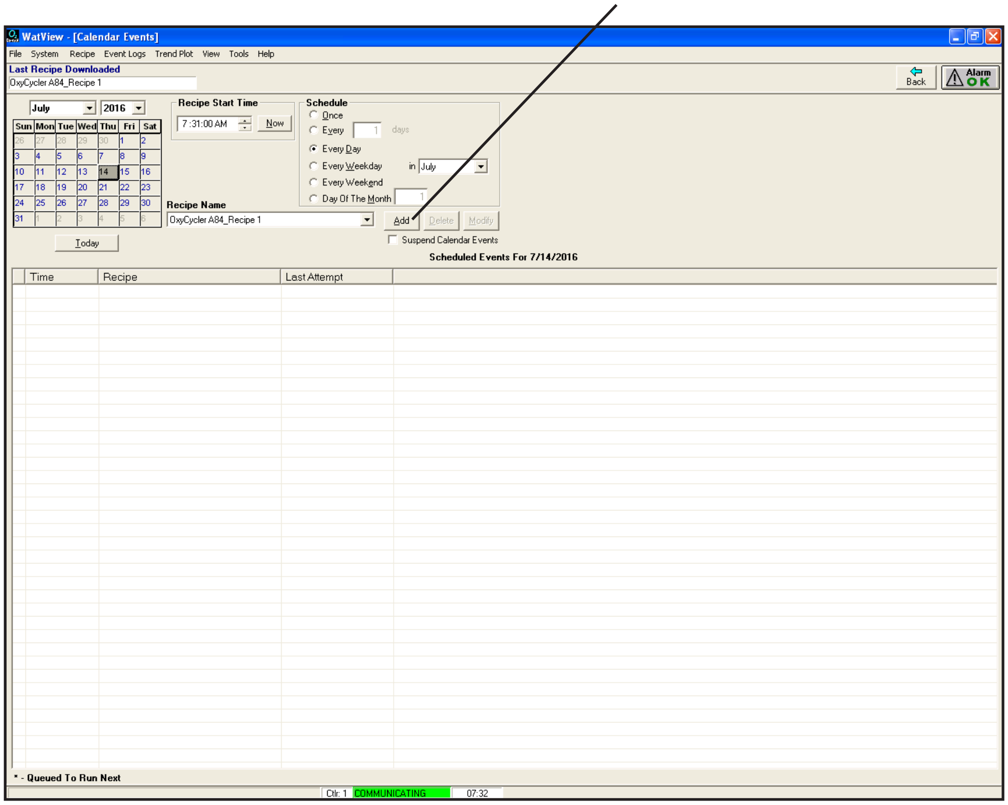
2. If you have more than one recipe, use the drop down menu under the **Recipe Name** heading to select a recipe.



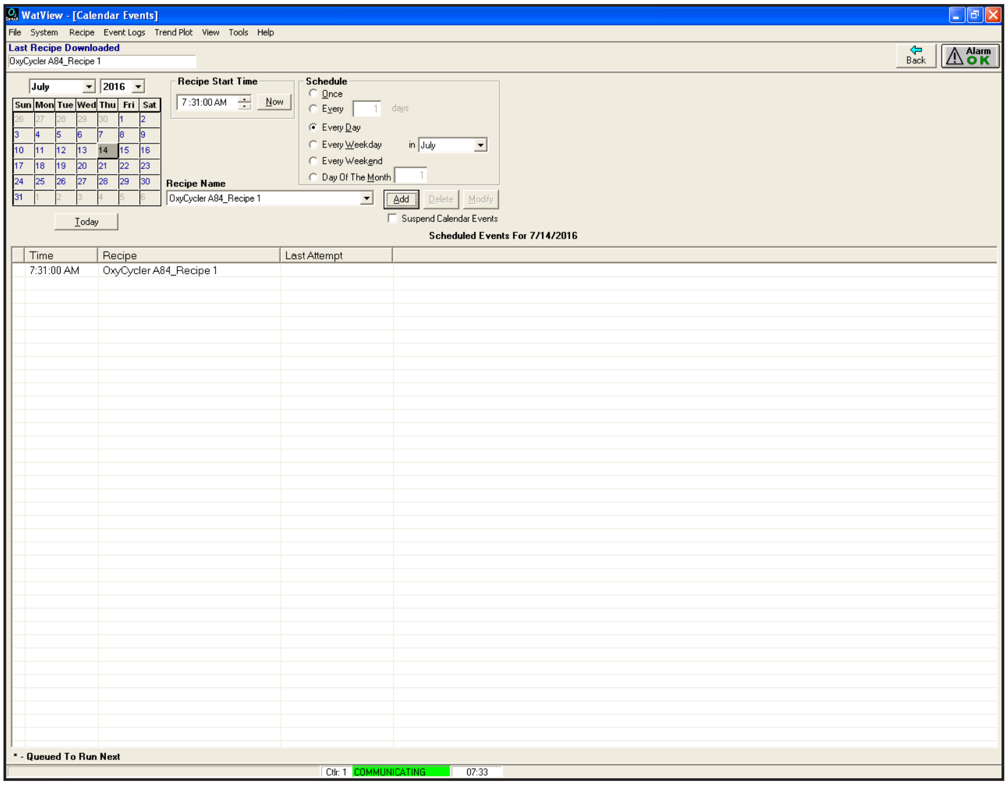
3. In the *Calendar Events* window, schedule the **Recipe Start Time** as well as the date you would like the recipe to begin. In the following example, the **OxyCycler A84 _Recipe 1** will start on **July 14th** and it is scheduled to run **Every Day** in **July**.



4. Once all settings have been selected, click on the **Add** button.



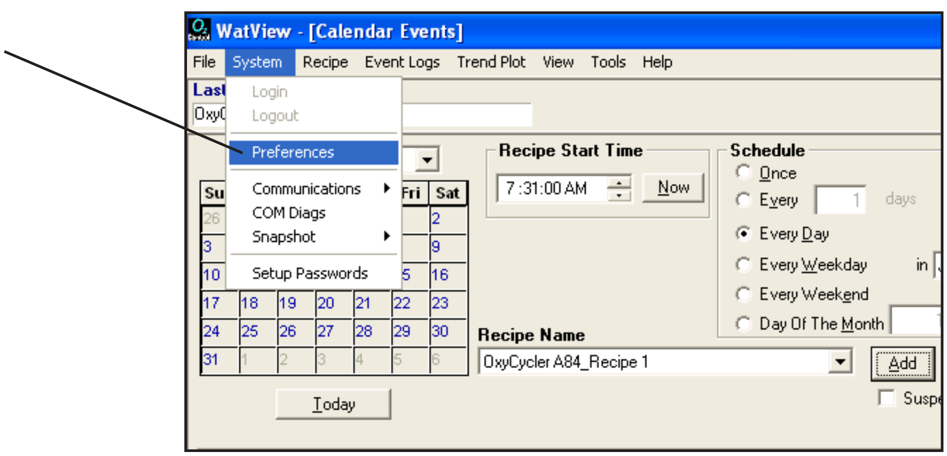
5. Once the recipe has been added it will appear in the *Scheduled Events* spreadsheet.



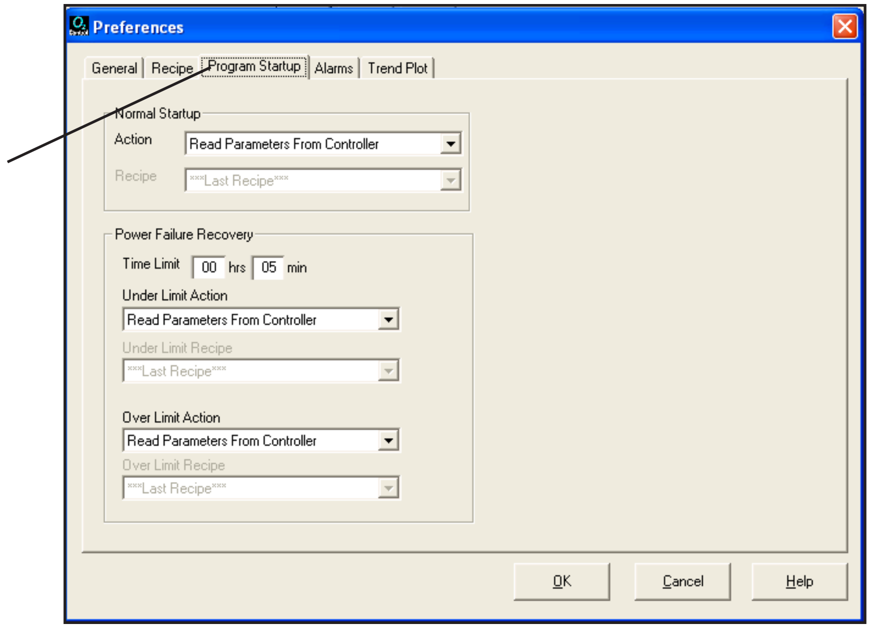
Downloading a Recipe After a Power Failure

Watview can automatically download a recipe on rebooting the computer after a power failure.

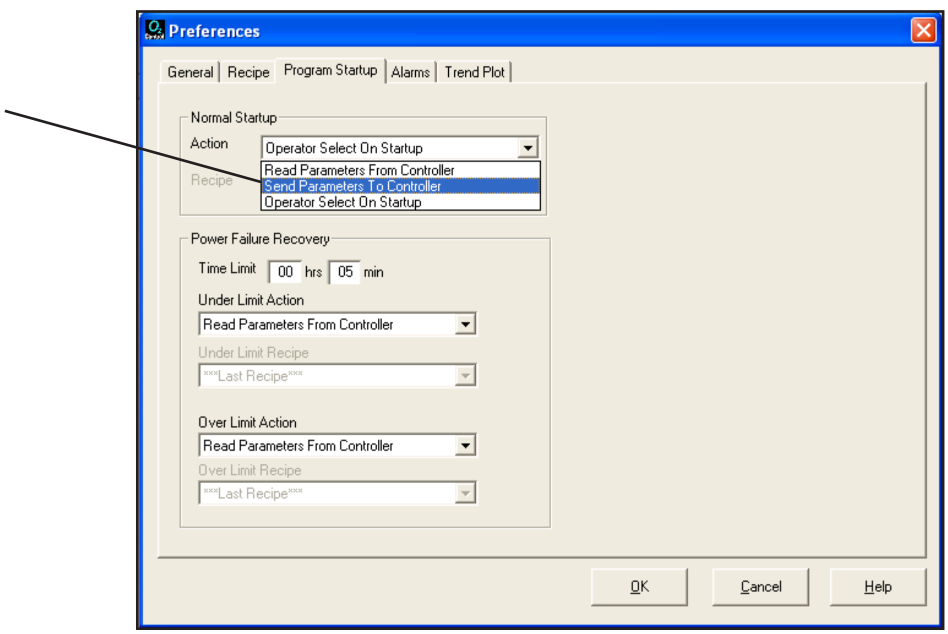
1. In the toolbar, click on **System** and select **Preferences.**



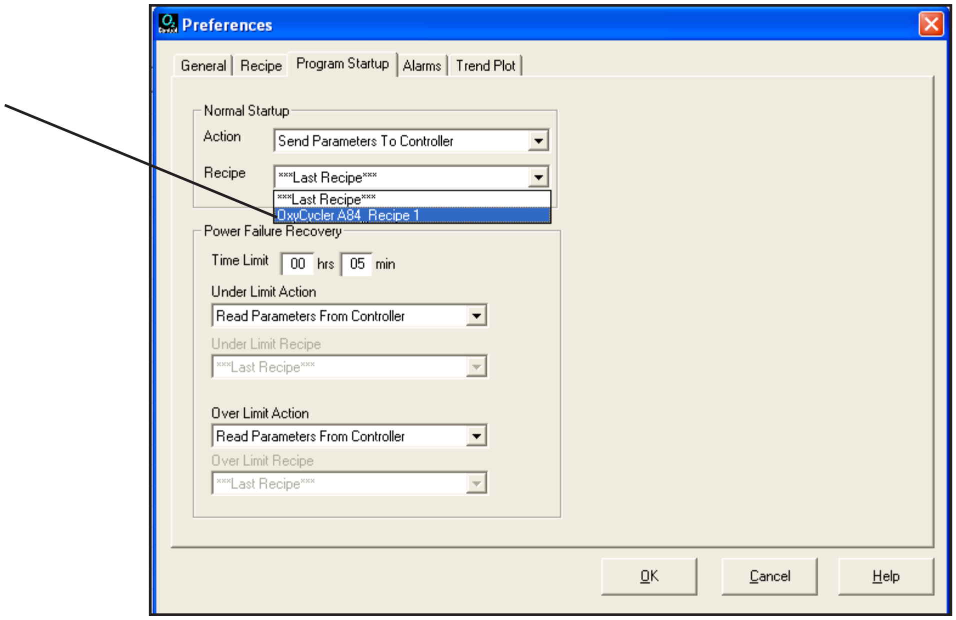
2. When the *Preferences* window pops up, click on the **Program Startup** tab.



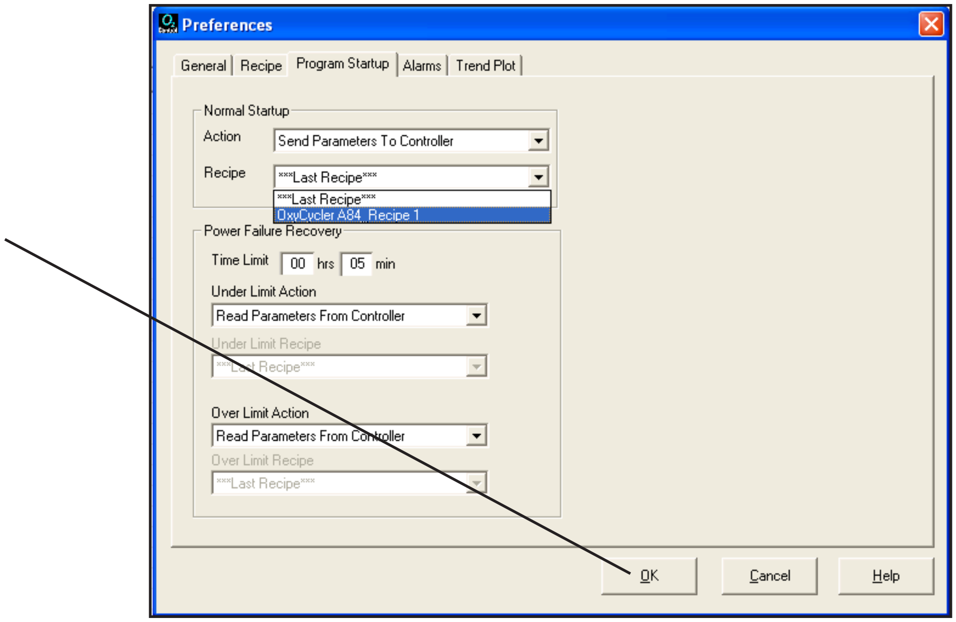
3. Under the *Normal Startup* heading click on the drop down menu next to **Action** and select **Send Parameters to Controller.**



4. Click on the drop down menu next to **Recipe** and select a recipe. In the following example, we are selecting *OxyCycler A84 _Recipe 1.*



5. Click **OK.**



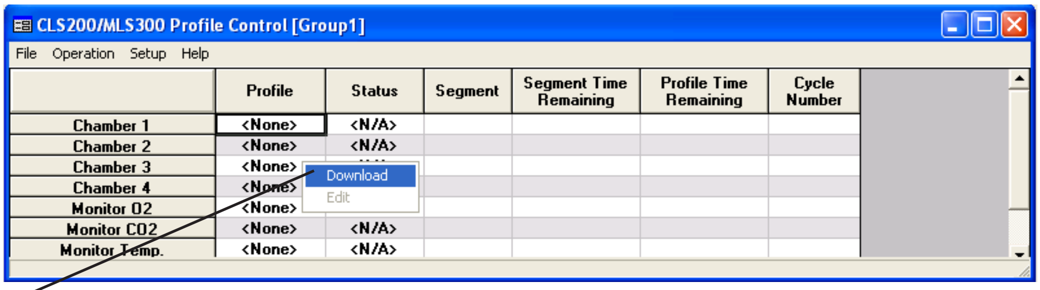
14 Use a Recipe to Run a Profile

The Watview software enables users to set multiple profiles to run automatically on specific days and at specified times through the use of the recipe feature. The following procedure will explain how to properly download profiles to the controller and how to program them to run automatically within a recipe.

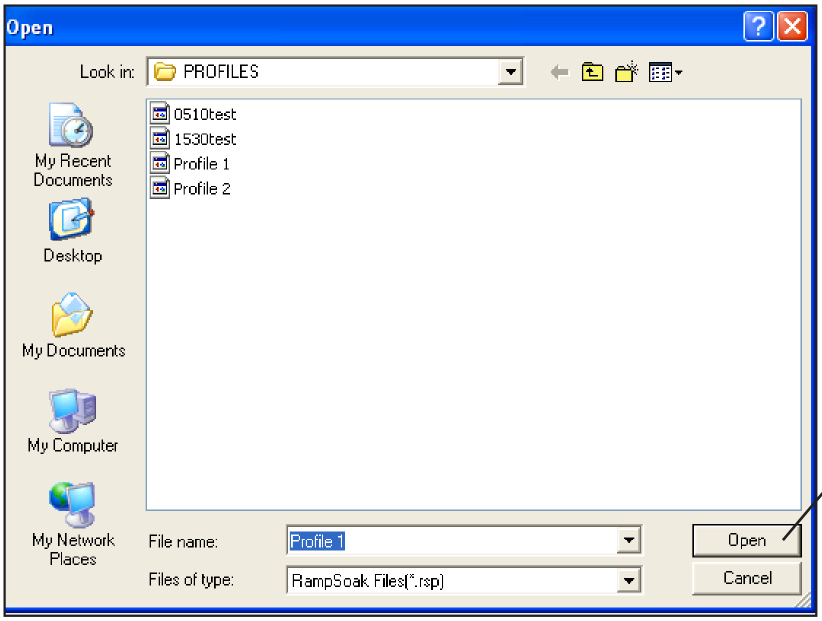
> **NOTE**
>
> Profiles must already be setup and saved to the computer prior to downloading them to the controller.

Download a Profile to the Controller

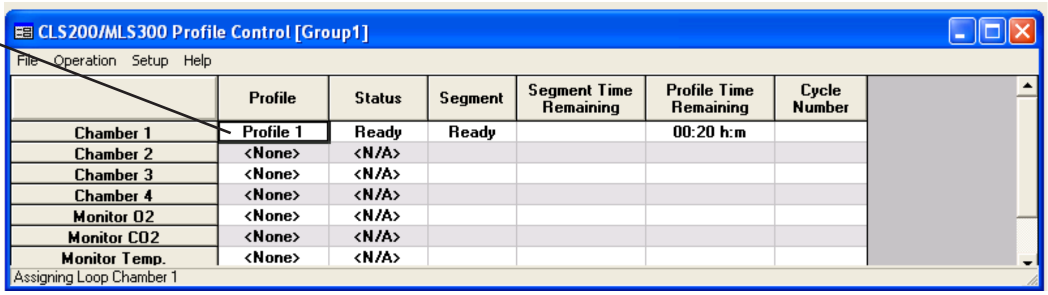
1. In the *Profile Control* window, right click in the **Profile** coulmn for the chamber that you want to download the profile for. In the following example we will be downloading a profile to Chamber 1. Once you right click in the appropriate profile coulmn select **download.**



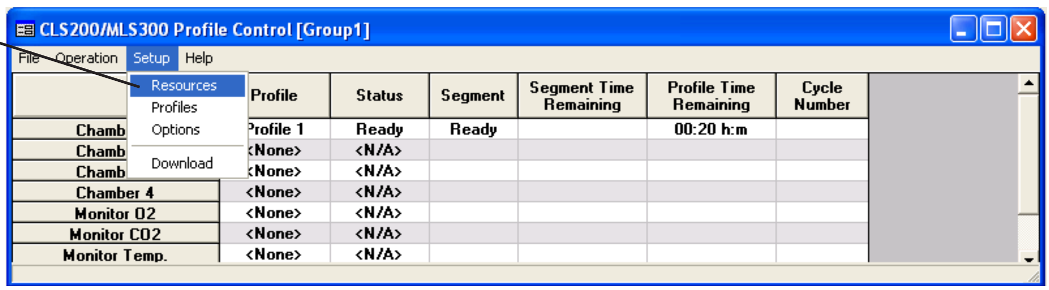
2. A list of saved profiles will popup. Select which profile you want to download to the controller and click **Open.** In the following example we are selecting *Profile 1.*



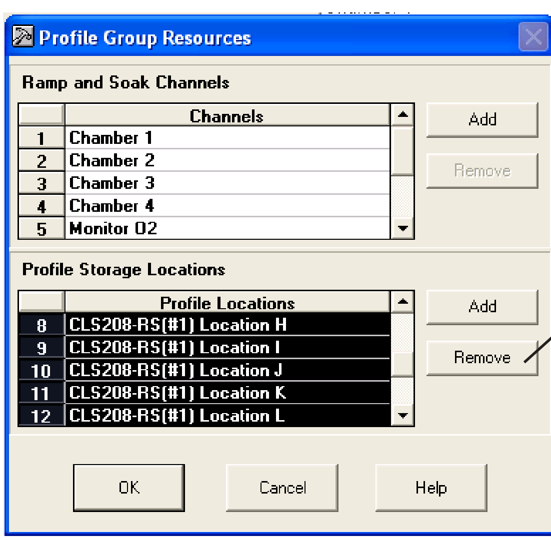
Once the profile is downloaded to the controller, in the *Chamber* row underneath the *Profile* column, the status will change from <*None*> to the name of the profile that was just downloaded to the controller.



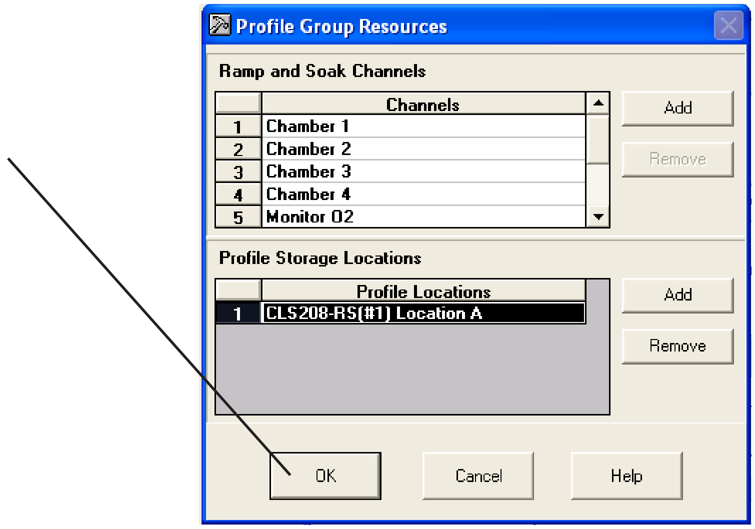
3. In the toolbar, click on **Setup** and select **Resources.**



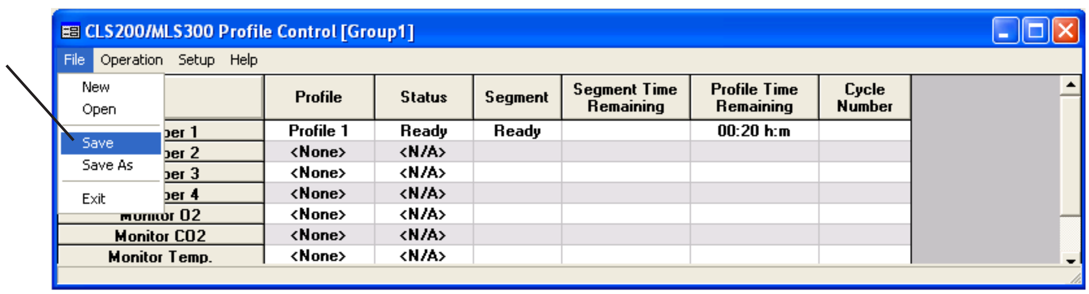
4. When the *Profile Group Resources* popup window opens, select ALL Locations under the **Profile Locations** heading <u>except</u> for Location A. Location A is where Profile 1 will be stored. Once all Locations (except for A) have been selected, click the **Remove** button.



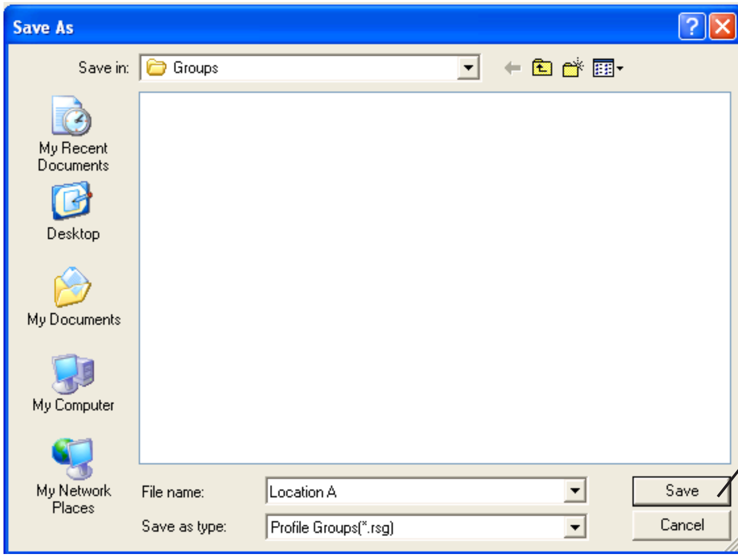
5. Location A should be the only location left underneath the *Profile Locations* heading. Now click **OK.**



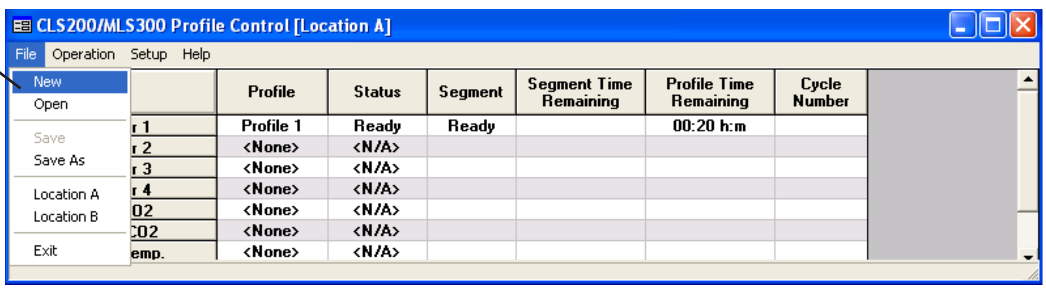
6. In the toolbar, click on **File** and select **Save.**



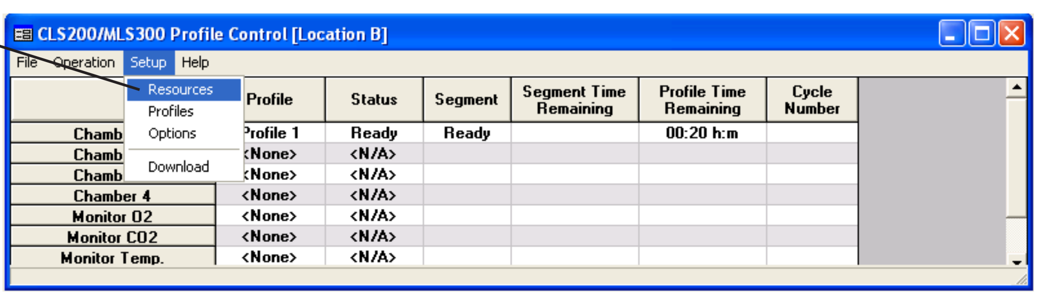
7. Name the file a unique name and select **Save.** In the following example the file is named *Location A,* so we now know that Profile 1 is saved to Location A.



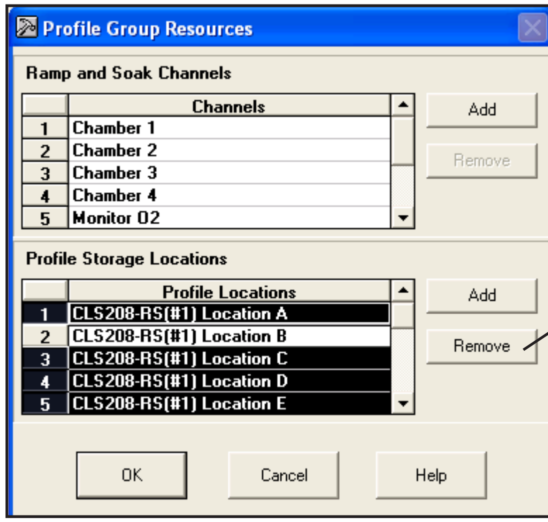
8. To download another profile to the controller, in the toolbar, click on **File** and select **New.**



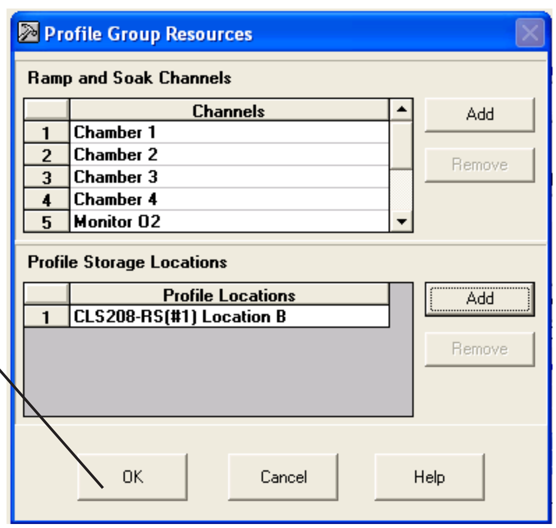
9. Now click on **Setup** and select **Resources.**



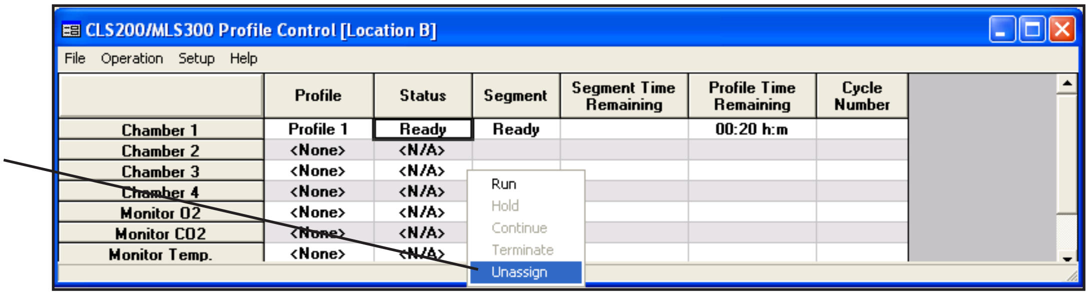
10. When the *Profile Group Resources* popup window opens, select ALL Locations under the **Profile Locations** heading except for Location B. Location B is where Profile 2 will be stored. Once all Locations (except for B) have been selected, click the **Remove** button.



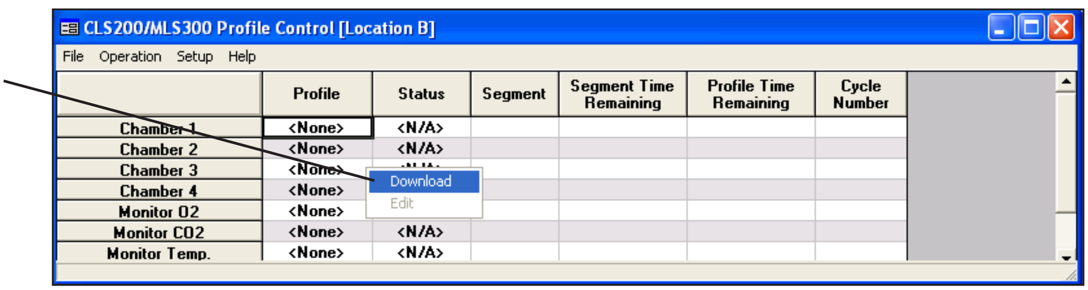
11. Location B should be the only location left underneath the *Profile Locations* heading. Now click on **OK.**



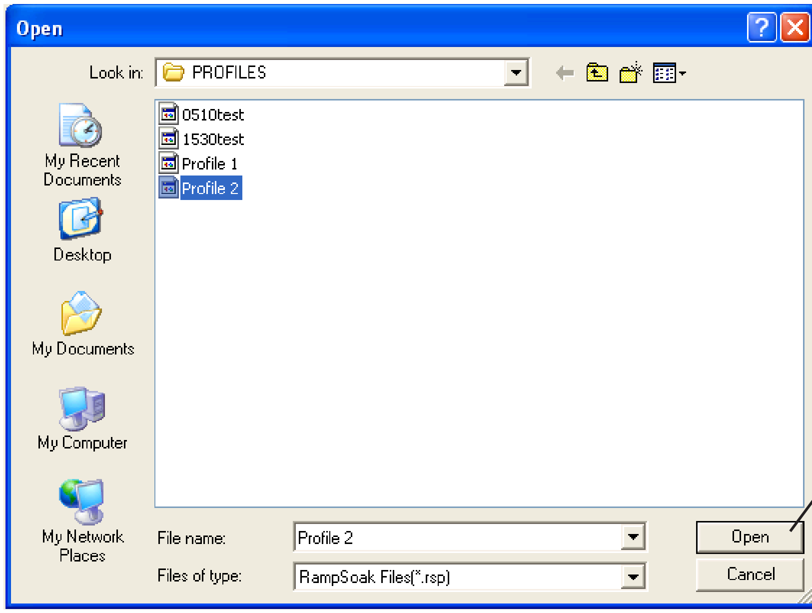
12. In the *Chamber 1* row underneath the *Status* column, right click on the *Ready* status and select **Unassign.** Doing this will unassign Profile 1.



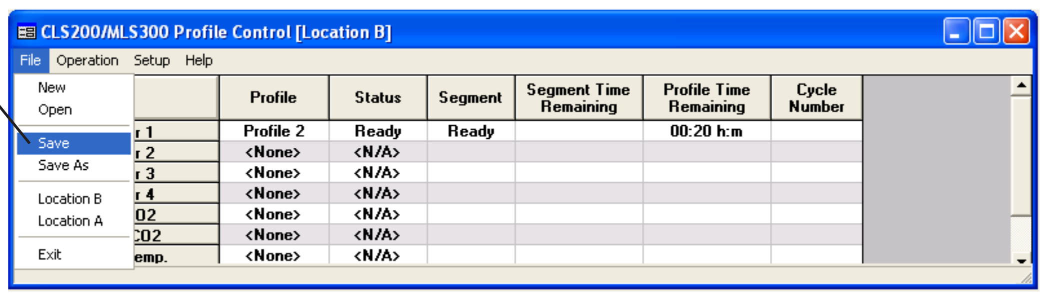
13. To download profile 2 onto the controller right click in the **Profile** coulmn for the chamber that you want to download the profile for. In the following example we will be downloading profile 2 to the same chamber that profile 1 is downlodaded to (Chamber 1). Once you right click in the appropriate profile coulmn select **Download.**



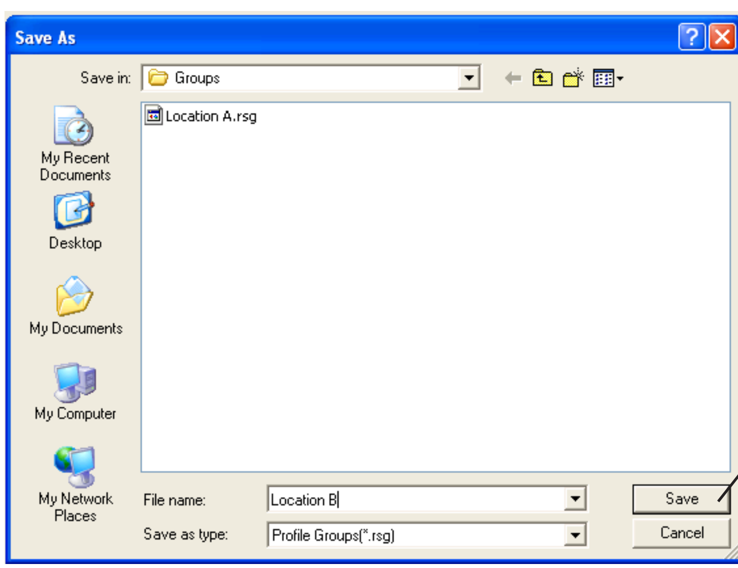
14. Select which profile to download to the controller and click **Open.** In the following example we are selecting *Profile 2.*



15. Once the profile has been loaded to the controller, click on **File** and select **Save.**



16. Name the file a unique name and select **Save.** In the following example, the file is named *Location B,* so we now know that Profile 2 is saved to Location B.



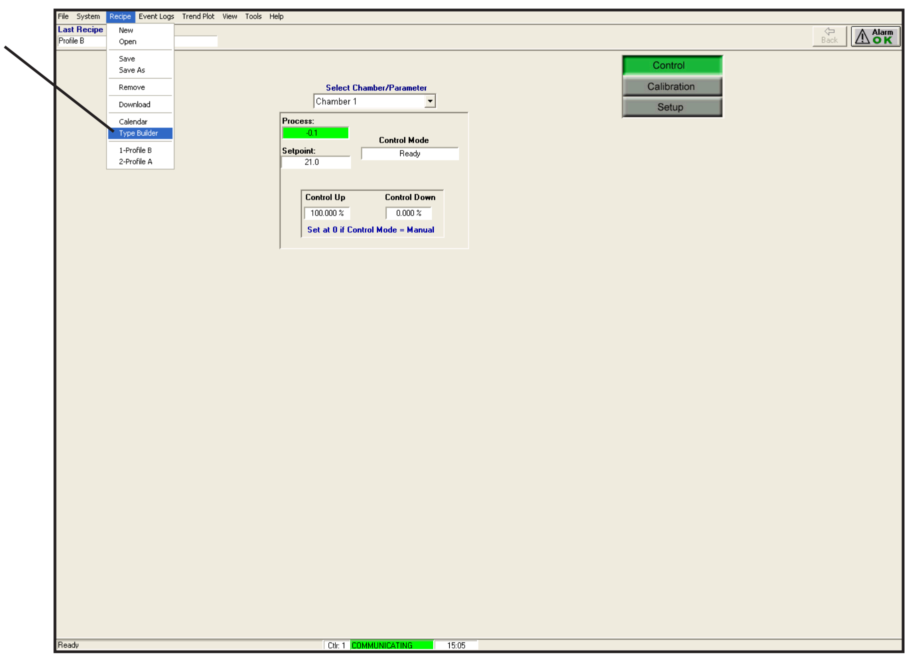
NOTE

Watview software provides several locations to store the profiles onto the controller. You can assign a profile to every location that is available. If you are assigning multiple profiles to several different locations, make sure to create new profile groups and name them according to the location of the profile. Doing this, will help to avoid losing track of where each profile is stored.

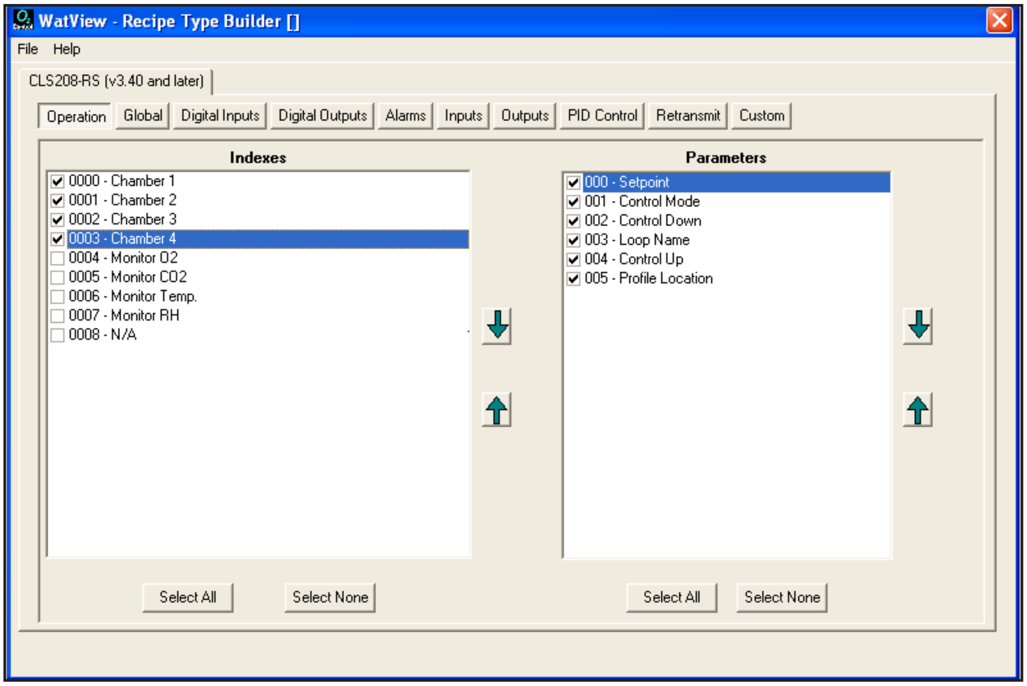
Creating a Recipe for Downloaded Profiles

Now that the profiles are downloaded to the controller, you can create a recipe for these profiles.

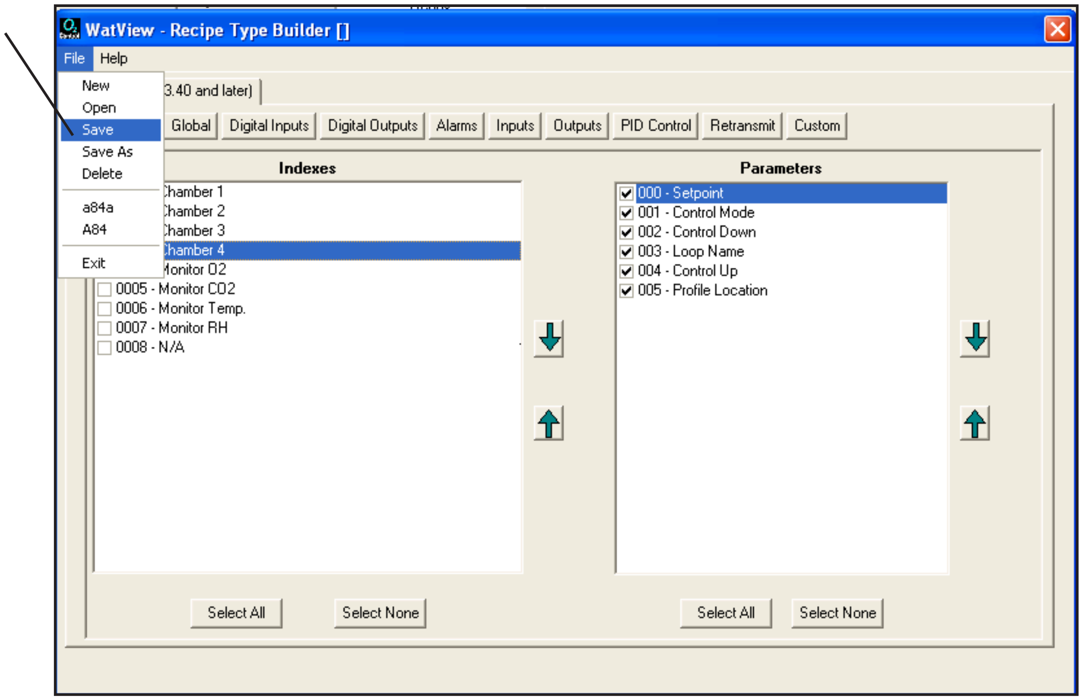
1. In toolbar, click on **Recipe** and select **Type Builder.**



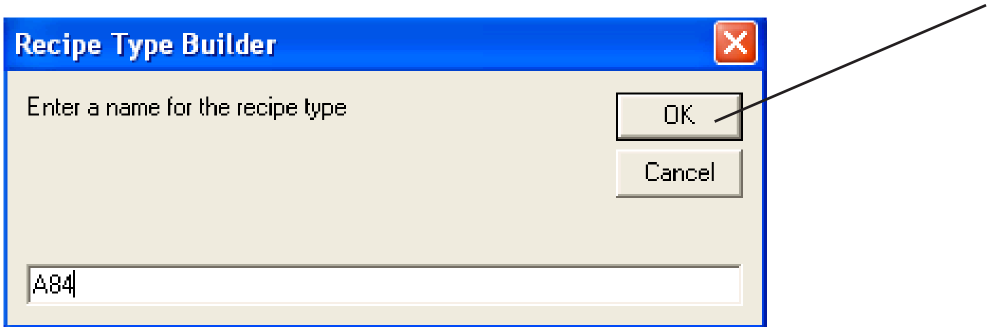
2. Select which *Parameters* and *Indexes* to include in the recipe. In the following example, all parameters and all chambers (1-4) have been selected.



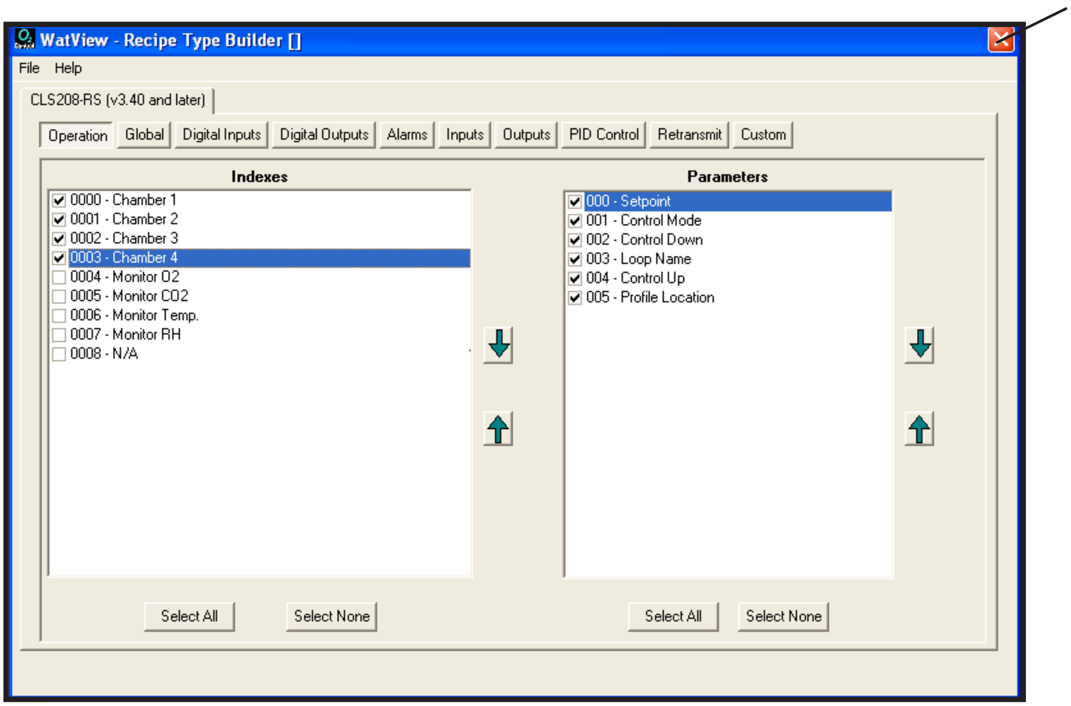
3. Once all *Indexes* and *Parameters* have been chosen, click on **File** and select **Save**.



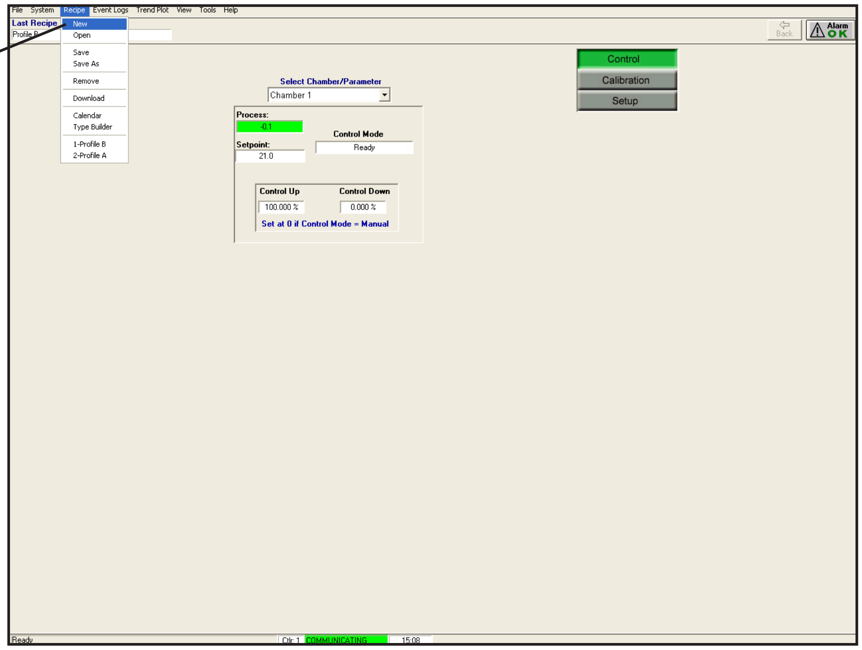
4. In the *Recipe Type Builder* screen, enter a name for the recipe type and then click **OK**.



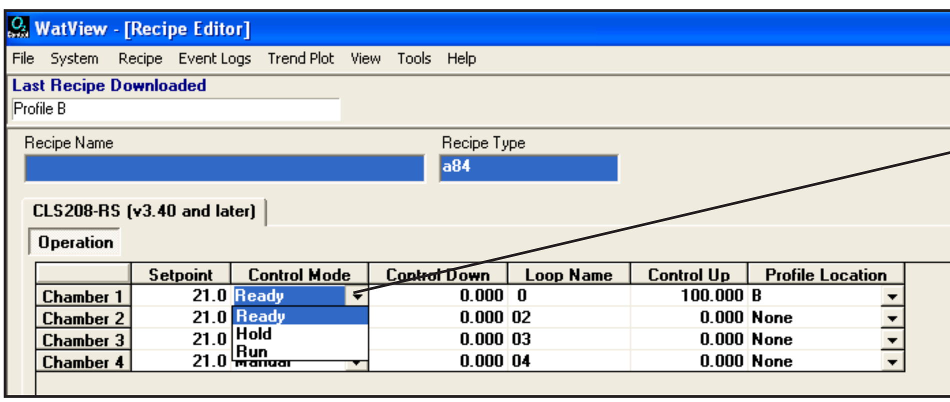
5. To exit the *Recipe Type Builder* screen, click on the **red X** in the upper right corner.



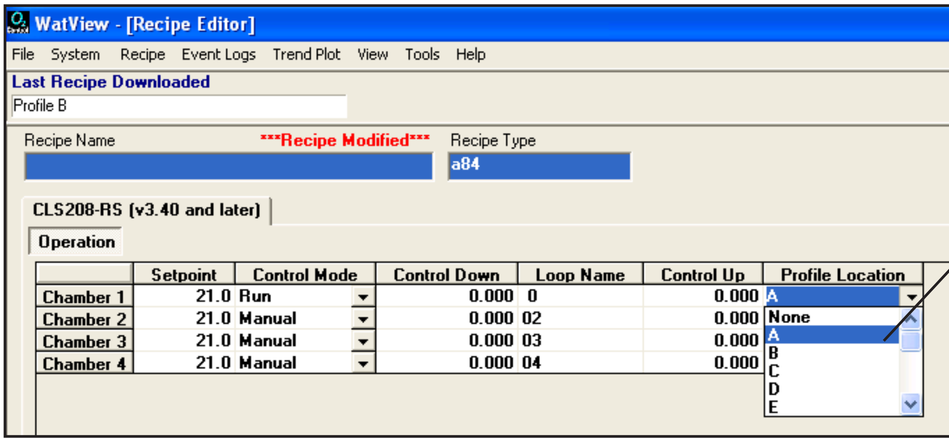
6. In the toolbar click on **Recipe** and select **New.**



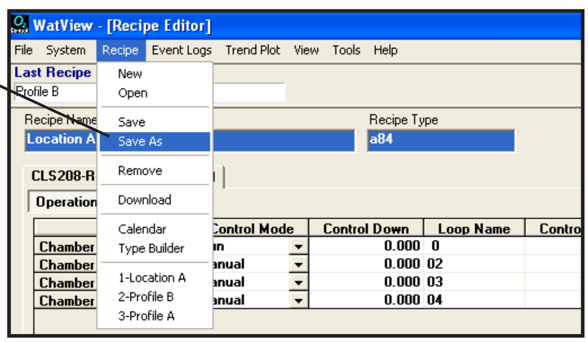
7. When the *Recipe Editor* window opens, right click in the **Chamber 1** row underneath the **Control Mode** column and select **Ready.**



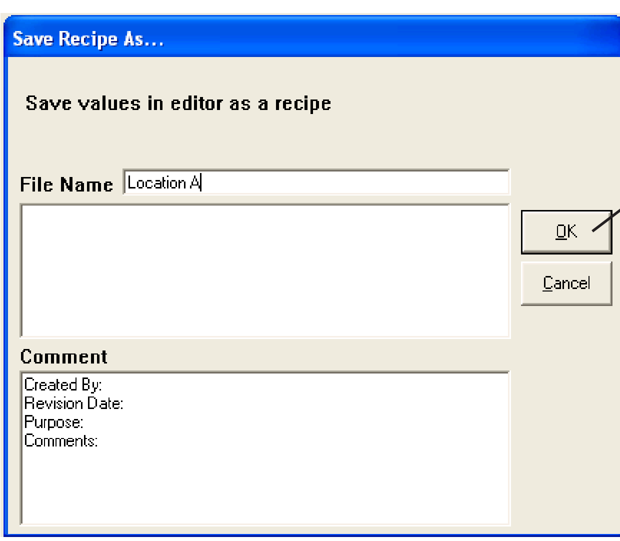
8. Now, right click in the **Chamber 1** row underneath the **Profile Location** column and select **A** from the drop down menu.



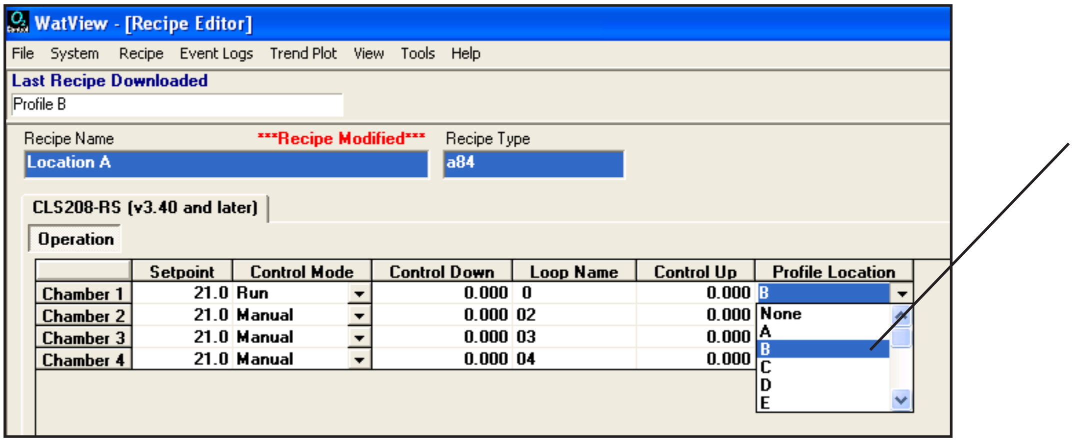
9. In the toolbar, click on **Recipe** and select **Save As.**



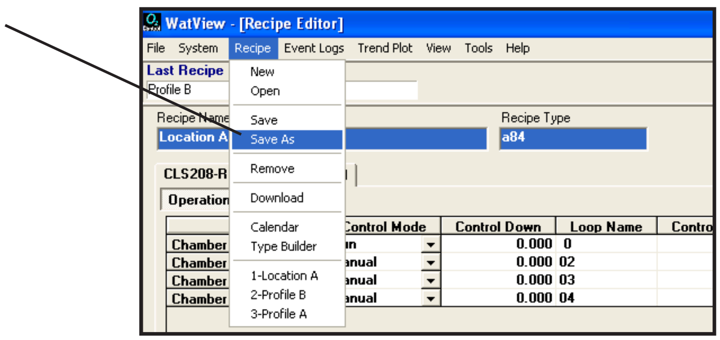
10. When the *Save Recipe As...* window opens, provide the recipe with a name in the **File Name** field. Here the recipe is named **Location A.** Once the recipe has been named select **OK.**



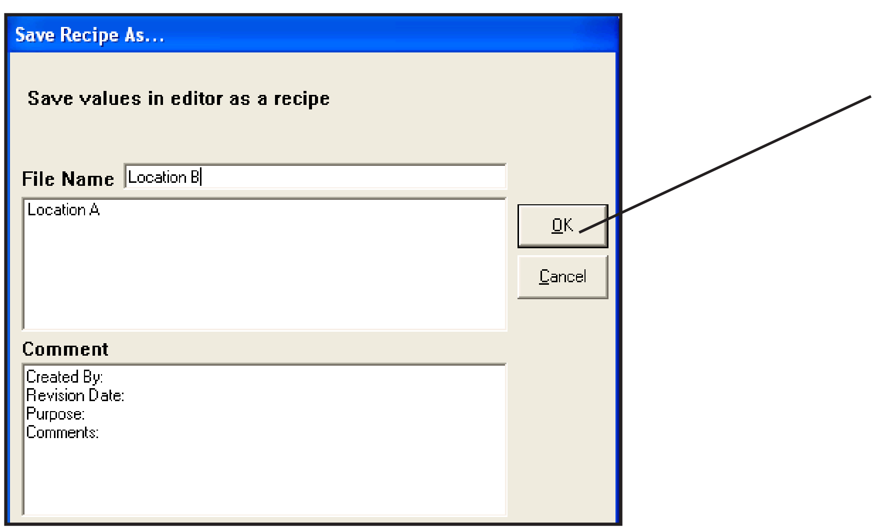
11. Now, right click in the **Chamber 1** row underneath the **Profile Location** column and select **B** from the drop down menu.



12. In the toolbar, click on **Recipe** and select **Save As.**



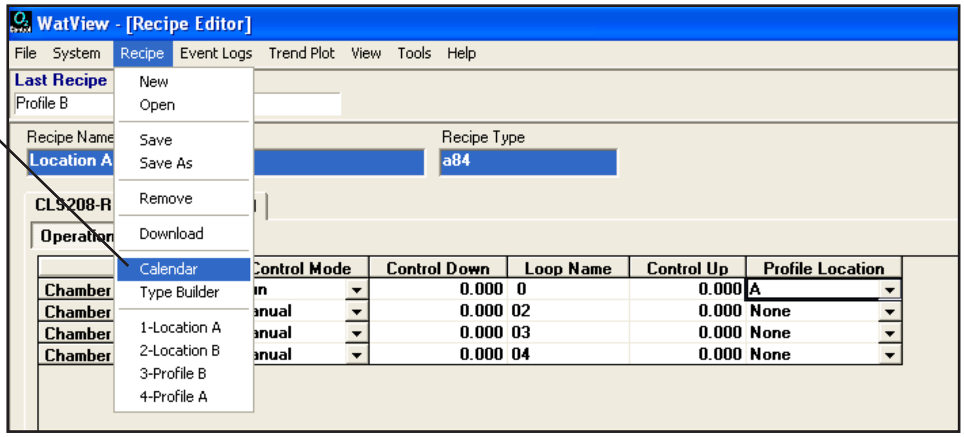
13. When the *Save Recipe As...* window opens, provide the recipe with a name in the **File Name** field. Here the recipe is named **Location B.** Once the recipe has been named select **OK.**



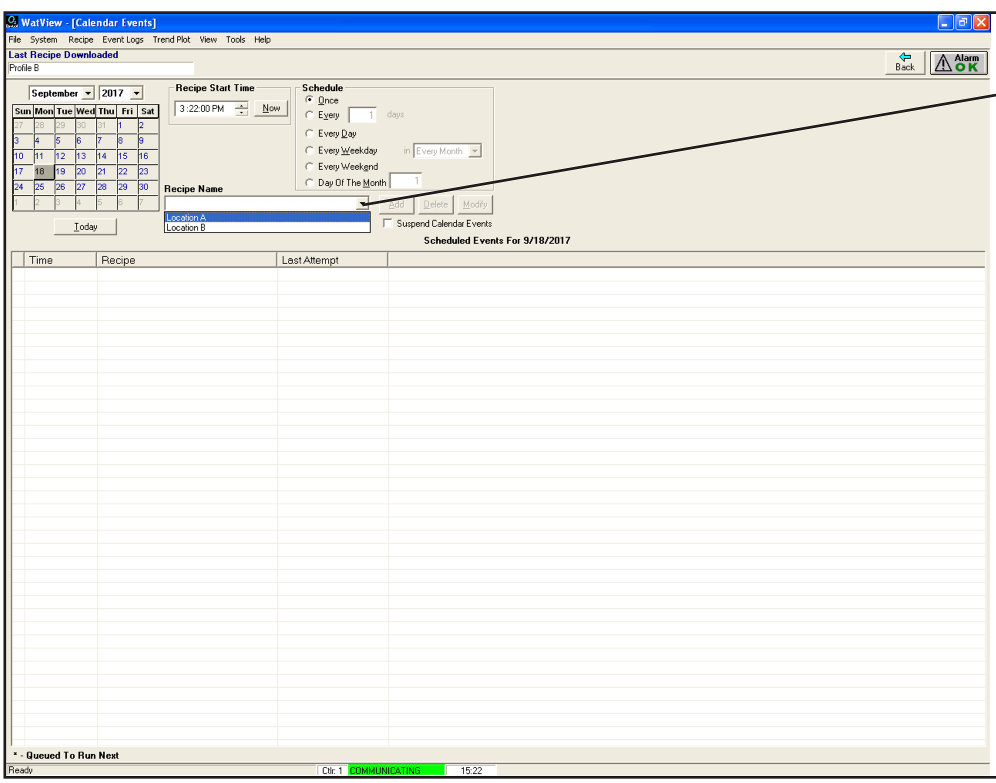
Setting the Profiles to Run Within a Recipe

Once the profiles are dowloaded and stored to their locations, they can be used within a recipe.

1. In the toolbar, click on **Recipe** and select **Calendar** to open the *Calendar Events* window.

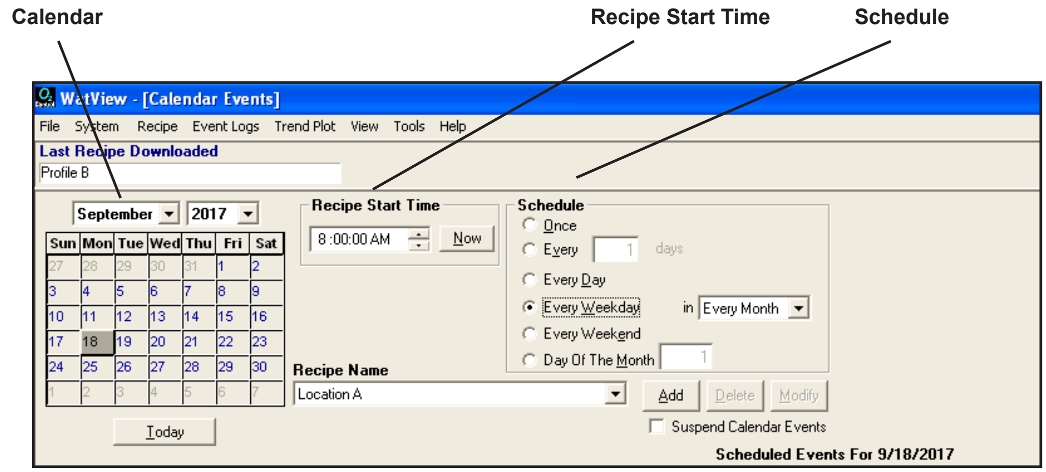


2. Once the *Calendar Events* window opens, select a recipe from the **Recipe Name** drop down menu. This will load the chosen recipe to the calendar. In the following example we we will select **Location A.**

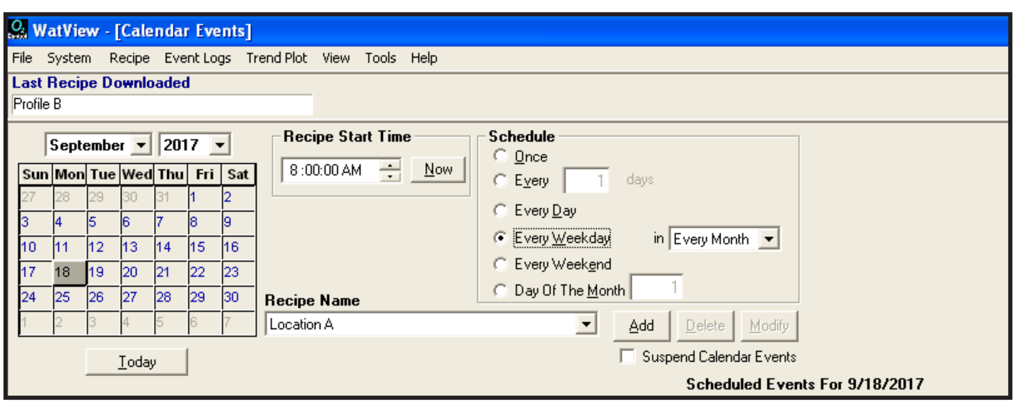


3. Once Location A has been selected, choose the specific preferences for this recipe.

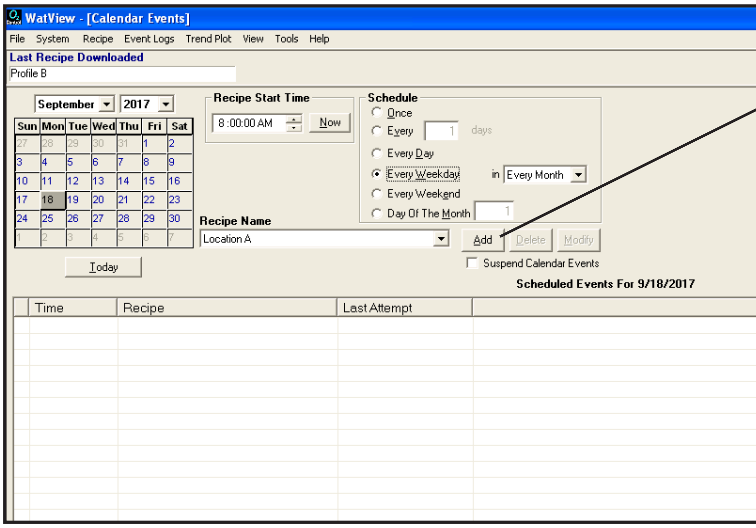
- **Recipe Start Time -** Allows you to select what time you want Location A (profile 1) to start running. Once a start time is selected, profile 1 will run automatically on that start time.
- **Schedule -** This is where you can select how often you want the the profile to start. You can select once a day, once every few days, every day, etc. Whichever options you select is how often that profile will run automatically. The calendar on the left side of the screen allows you to choose your start day and end day.



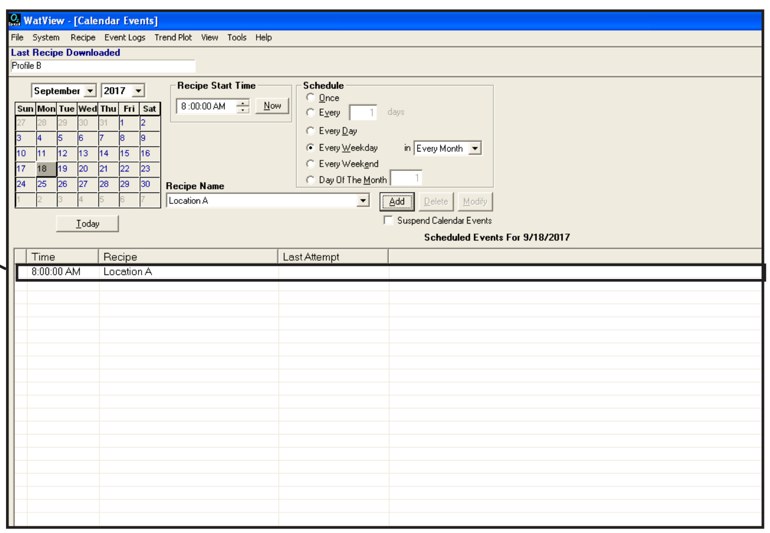
In the following example, **Location A** is setup to start on **September 18th** at **8:00 am** and it is going to run automatically every weekday in every month.



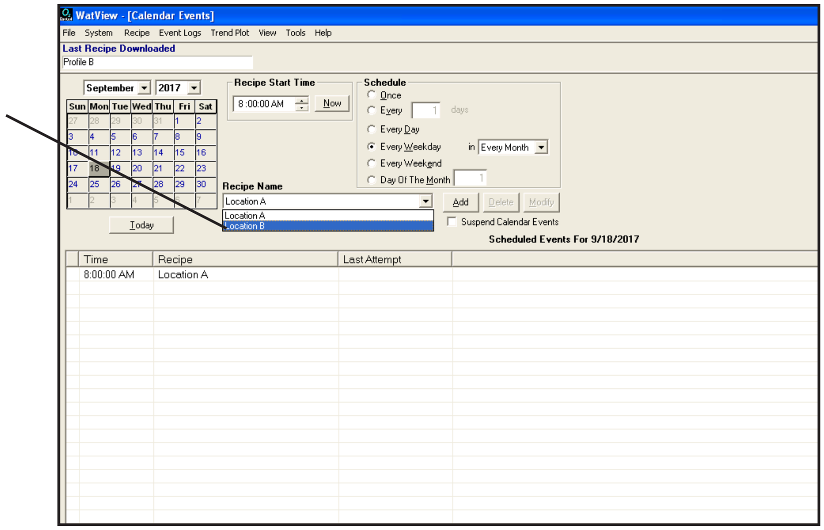
4. Once all preferences have been selected, click **Add.**



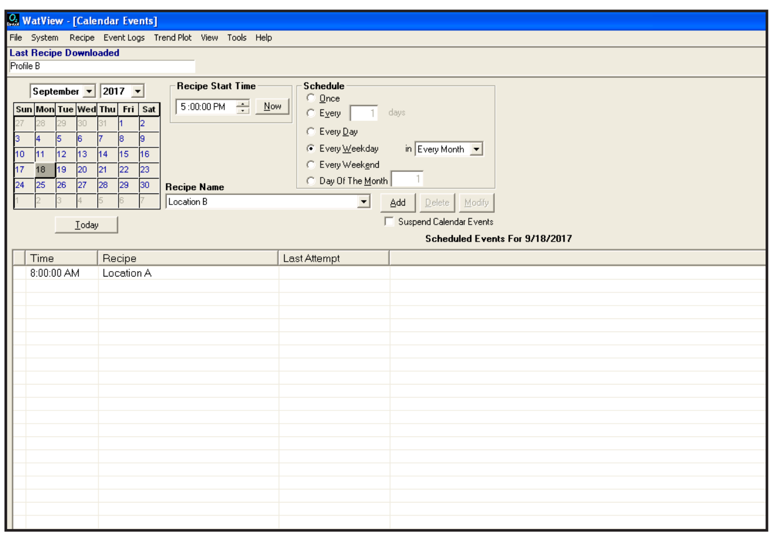
Once Location A has been added to the recipe calendar, profile 1 will automatically run on the specified days and times that were selected.



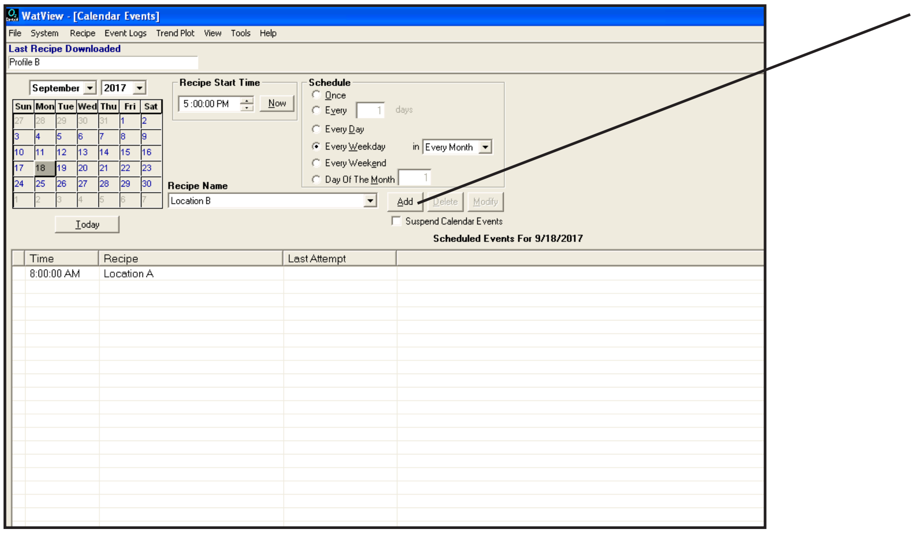
5. Now select another recipe from the **Recipe Name** drop down menu. This will load another recipe to the calendar. In the following example we we will select **Location B.**



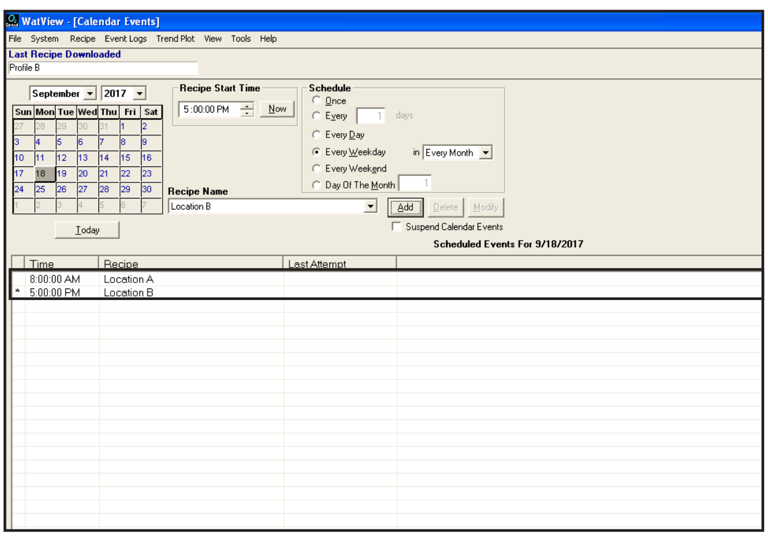
6. Once Location B has been selected, choose the specific preferences for this recipe. (The same way the preferences were setup for Location A.)



7. Once all preferences have been selected for Location B click **Add.**



Once Location B has been added to the recipe calendar, Profile 1 and Profile 2 will automatically run on the specified days and times that were selected.



NOTE

The controller must be connected to the computer in order to run the recipes automatically. If the computer is disconnected from the controller, the profiles will no longer load to the controller.

15 Data Logging

Overview

Specific data parameters, recording times and data recording intervals are configured by the user, recording only the information that is considered critical for an experiment or system test. The data files are stored in a Microsoft Excel format (.xls, .xlsx) at any location specified by the user. This allows the implementation of Microsoft Windows security or a third party security system to protect, secure and backup this critical data.

> **NOTE**
>
> Data logging is the primary method for obtaining your data for backup purposes.

Data Log files are only created if data logging is enabled by the user. Once enabled, the user must select the specified data to log. When data logging is enabled the log files are updated as data is collected at the rate specified by the user. Once this data is stored in a file WatView does not use it again. Logged data can be viewed with third-party programs such as Microsoft Excel® or Notepad®, however, not with WatView.

Data logs are files in which the values of the parameters you select can be saved as they are read from the controllers on the network. You can create any number of data logging sets, though often a single data logging set will do the job. For example, logging all the process temperatures every 10 minutes may meet your requirements. However, if more detail is required, when, for example, the oxygen level in a certain chamber exceeds 15%, you can create a second set that records specific values more frequently at that time.

Data logging is very flexible. Options allow you to:

- Include any or all of the parameters that appear in the *Spreadsheet Overview* screen;
- Determine how frequently values are recorded;
- Select the drive and folder where the log file will be saved;
- Determine whether a file is used for an entire day or a new file is created each time logging begins;
- Prompt the user for batch information to include in the log;
- Include the user login, if passwords are enabled;
- Specify file name options;
- Set criteria to start and stop logging based on parameter values.

Setting Data Storage Preferences

> **NOTE**
>
> Watview must be running and communicating with the controller in order to collect any data.

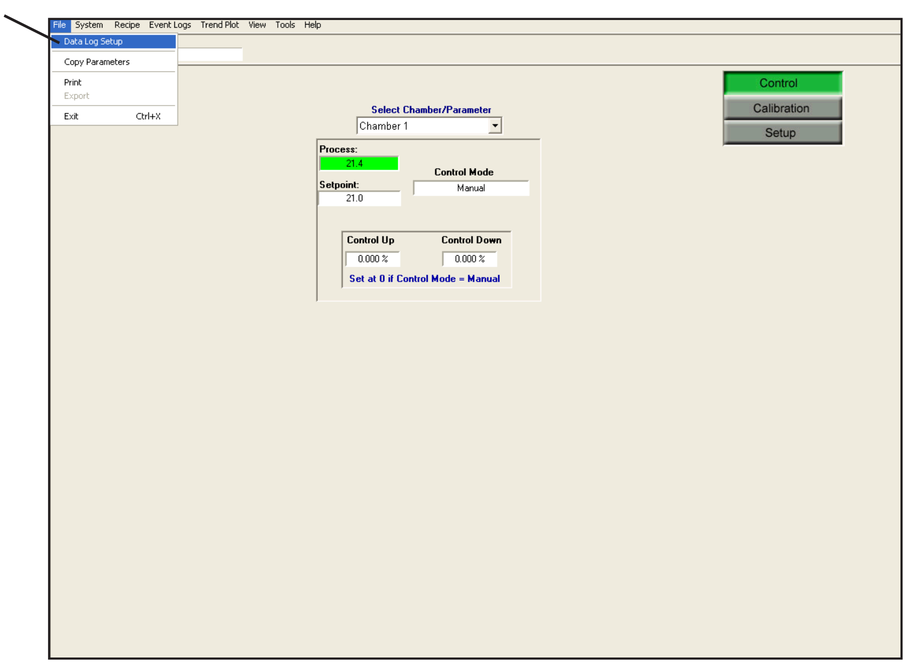
Data logging is not setup to log data automatically. Prior to beginning any experiments it is important that the appropriate settings are configured in order to store and backup your data. If the appropriate settings are not set prior to beginning an experiment, then there will be potential for data loss.

Depending on the amount of days the data is being stored for and how much data is being backed up, data logging could fill up your hard drive quickly. BioSpherix, Ltd. has many customers who set their preferences to track their data for 365 days. BioSpherix, Ltd. highly recommends exporting your data immediately once that run is complete. Once exported, verify that the data backed up correctly and save the data using your facilities backup practices.

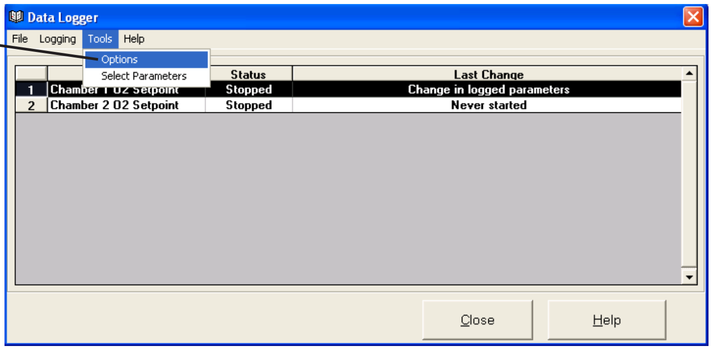
To ensure that your data is being recorded and saved successfully for a set amount of days, you must fill out the appropriate fields in the *Data Logger Options* window. To access the *Data Logger Options* window please refer to the steps below:

> **NOTE**
>
> BioSpherix, Ltd. strongly recommends routinely backing up all data. Please remember it is important to save the data to an acceptable format, such as a CSV file. The backup should be put on media, rather than being stored on the PC. Please follow your facilities backup practices.

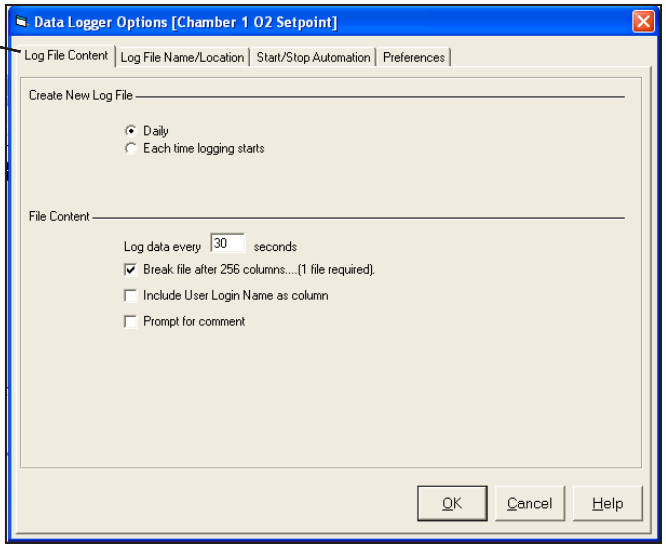
1. Click on the **File** tab located on the toolbar and select **Data Log Setup**.



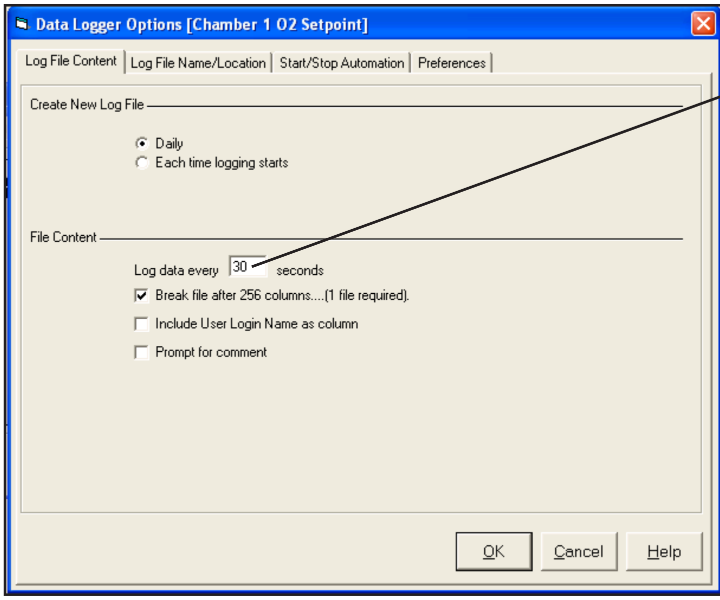
2. In the *Data Logger* window, click on **Tools** and select **Options**.



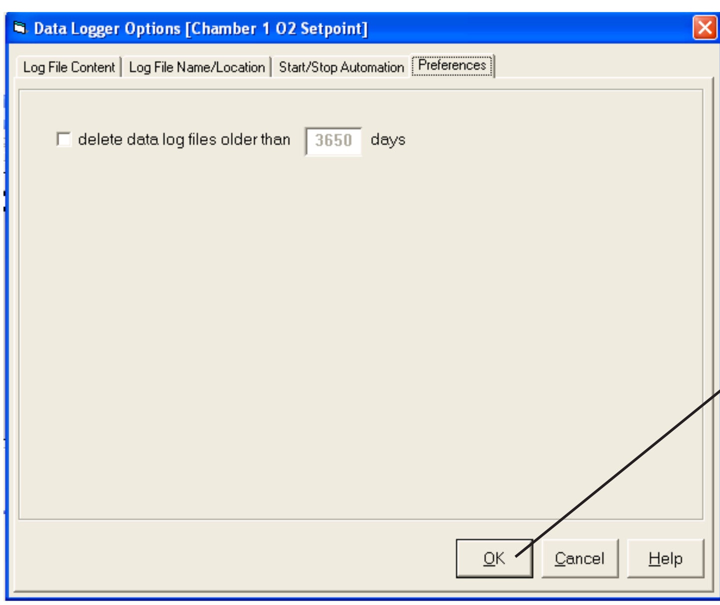
3. The *Data Logger Options* popup window will appear. Click on the **Log File Content** tab and under the *Create New Log File* heading, choose whether to create a new log file daily, or to create a new log file each time logging starts.



4. Underneath the *File Content* heading, fill out the field next to **Log data every.** This will tell the software how often to log the data. In the following example, **30 seconds** was typed in the *Log data every* field. The data will now be logged every 30 seconds for the process variable as well as the setpoint for *Chamber 1 O2.*



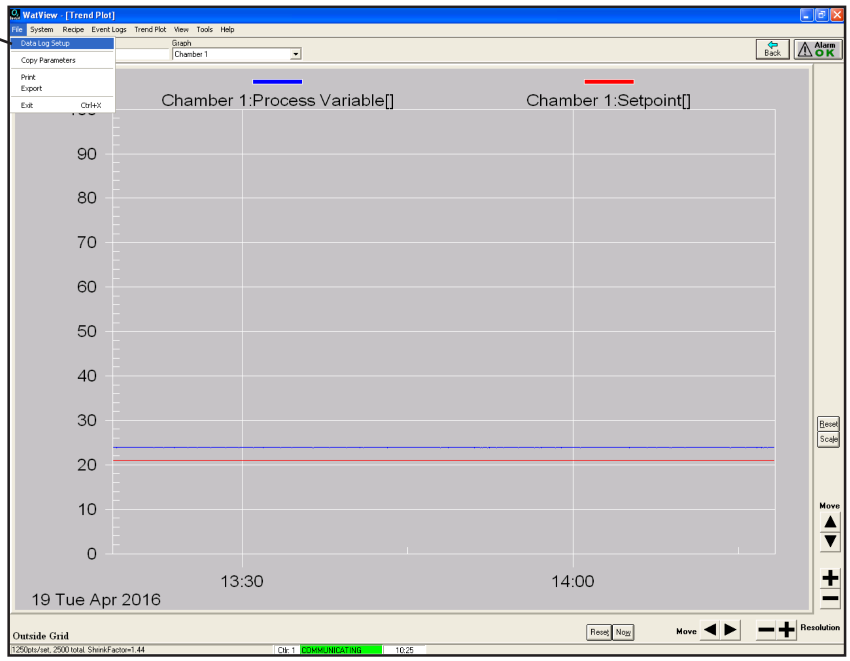
5. Now, click on the **Preferences** tab. This option provides the ability for the software to automatically delete data log files after a set amount of days. This field does not need to be filled out and can remain empty. In order to delete data after a set amount of days, click in the box to the left of *delete data log files older than*, type in a specific number of days and then click **OK**. To log data indefinitely, leave the field empty and click **OK**.



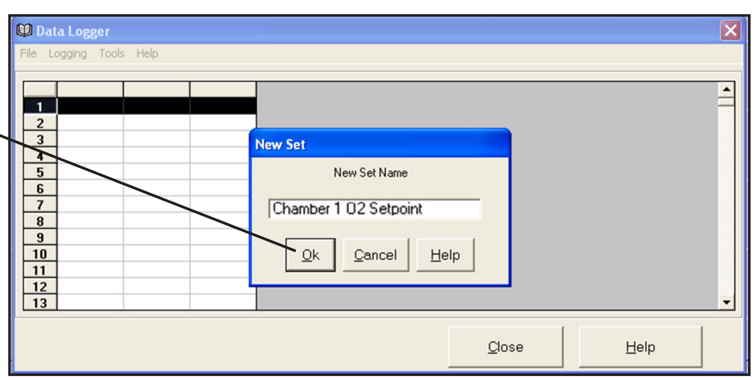
Exporting Data

When exporting data from the data logger all of the data that is selected will actively log to the file. This particular method works effectively to those who have many processes occurring at a given time. This is the only reliable way to back up your data and it can be put into different programs. This can be set up in the software so that only the information that was chosen to be logged will appear in the saved folder. For example, if there are 4 data points occurring at a time and only information from data point 1 needs to be exported, the preferences can be set up to only extract information from data point 1.

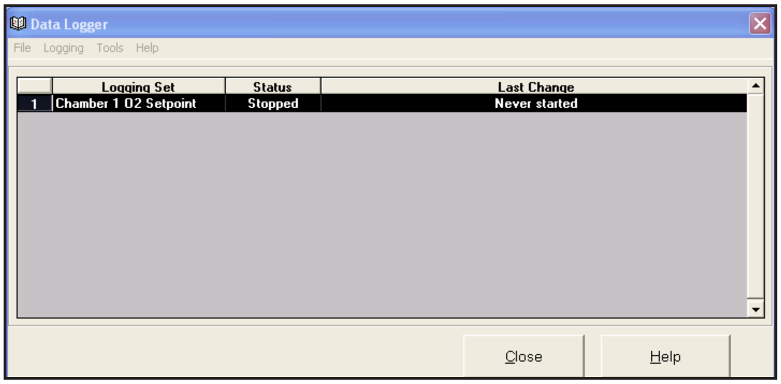
1. From the *Trend Plot* graph, click on the **File** tab located on the toolbar and select **Data Log Setup**.



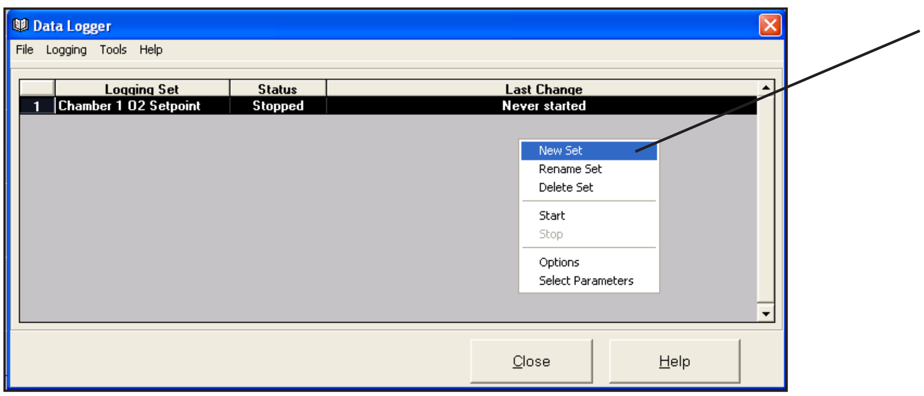
2. The *New Set* popup window will appear. Provide a name for the set that is being logged. In the following example, the set is named *Chamber 1 O2 Setpoint*. Once the set has been named, click **OK**.



3. The *Data Logger* popup window will appear, displaying the new set.

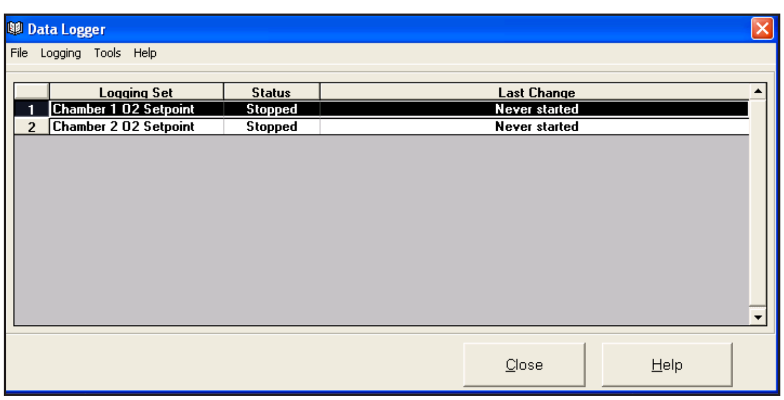


4. To add an additional set, click on the existing set to highlight and then right click and select **New Set**. Follow this procedure every time a new set is being added to the data logger.

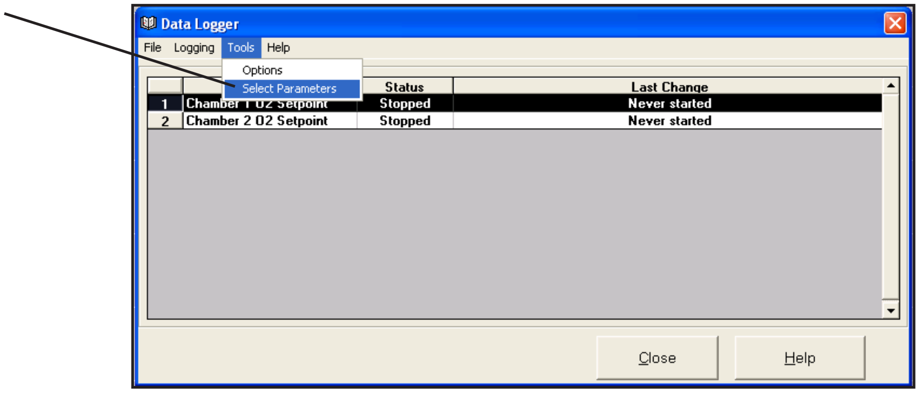


5. In the following example a new set is being added and this set is being named *Chamber 2 O2 Setpoint*. Once the second set has been typed in, click **OK**.

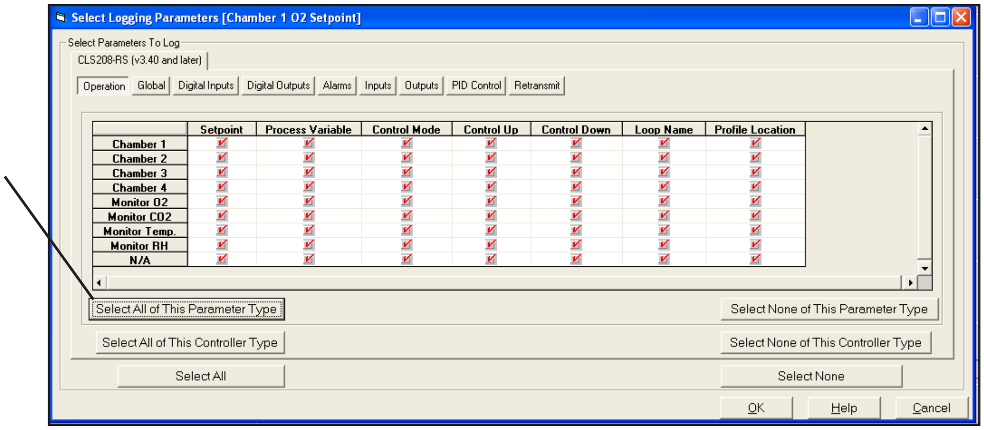
6. The *Data Logger* window will now appear, displaying both sets.



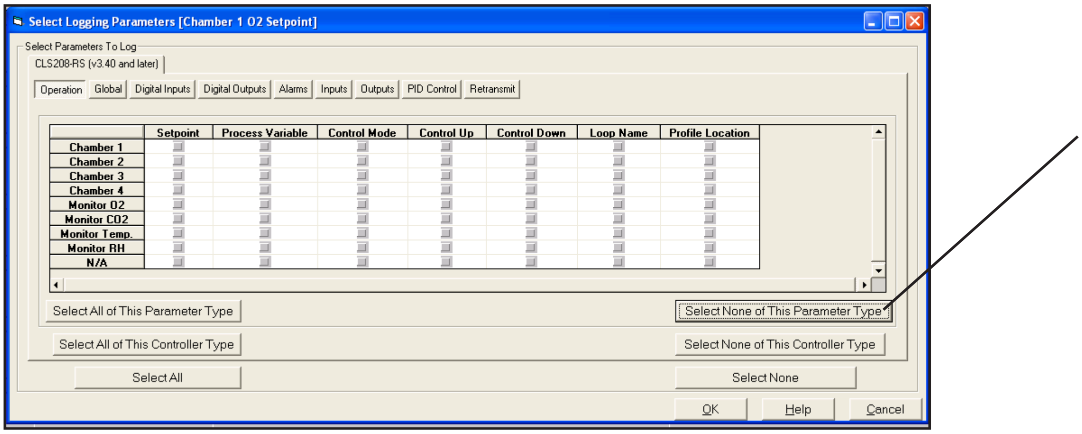
7. Click on a set to highlight it. Once the set is highlighted, select the parameters to log. To do this, click on **Tools** and then click **Select Parameters**.



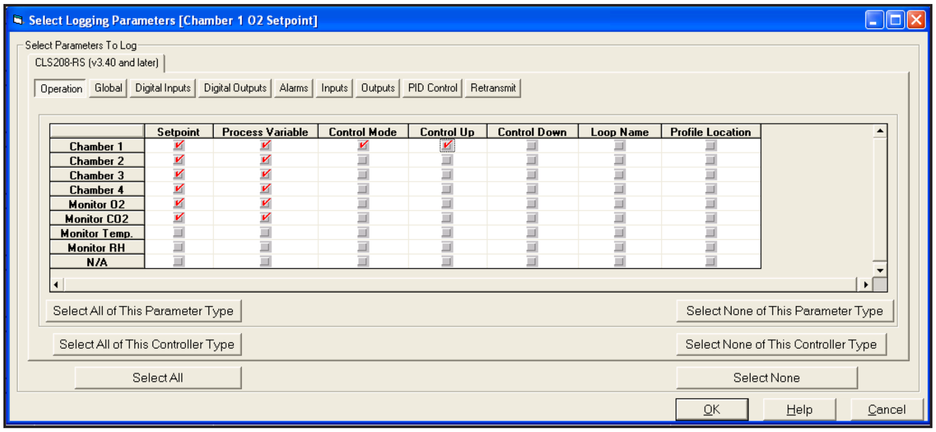
8. The *Select Logging Parameters [Chamber 1 O2 Setpoint]* popup window will appear. To select all parameters to log, click on **Select All of This Parameter Type**.



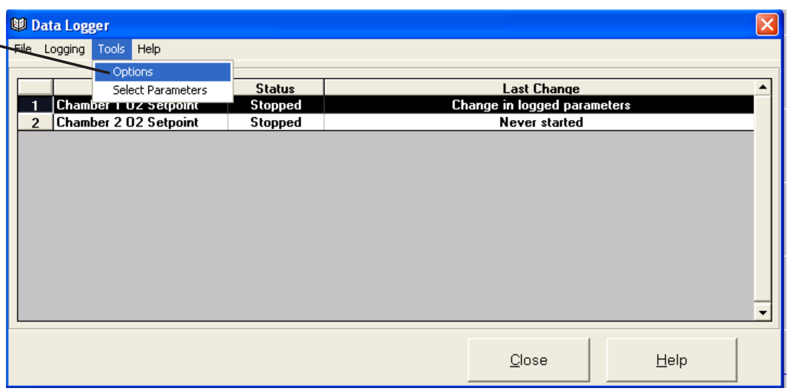
9. To select specific parameters to log, click on **Select None of This Parameter Type** and then manually choose the parameters to log by clicking on the appropriate boxes.



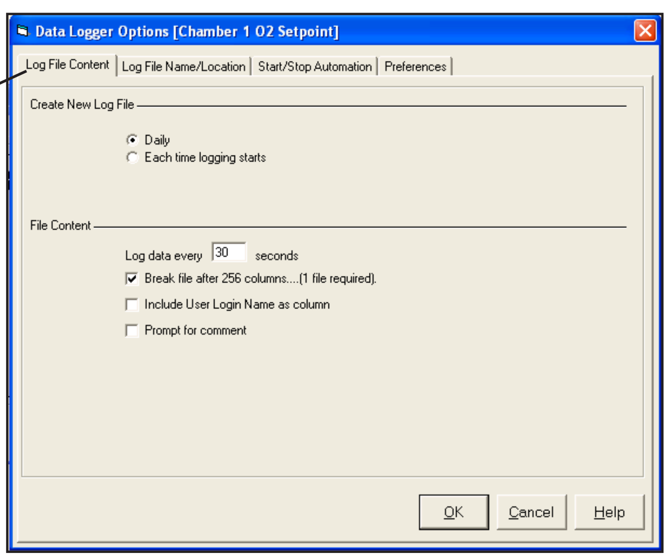
10. Once all parameters have been selected, click **OK**. In the following example, the **Setpoint** and **Process Variable** have been selected.



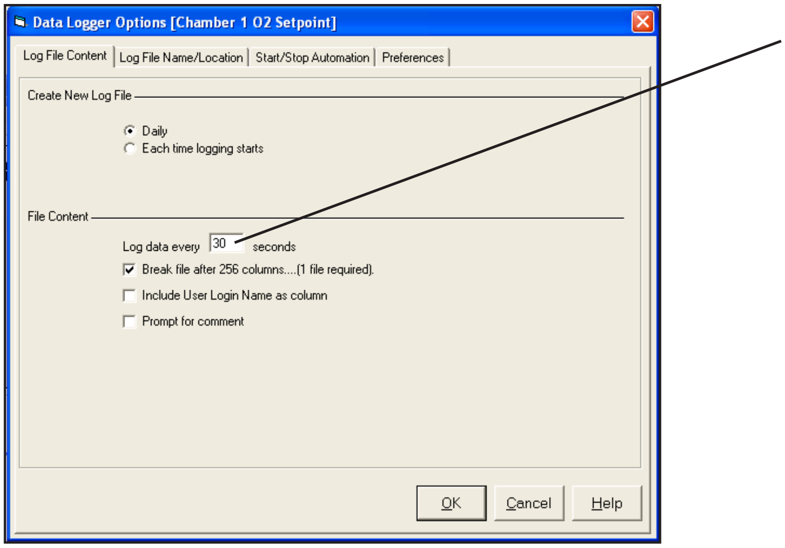
11. There are also a variety of options that are specific to each set. Click on a set to select it, then click on **Tools** and select **Options**.



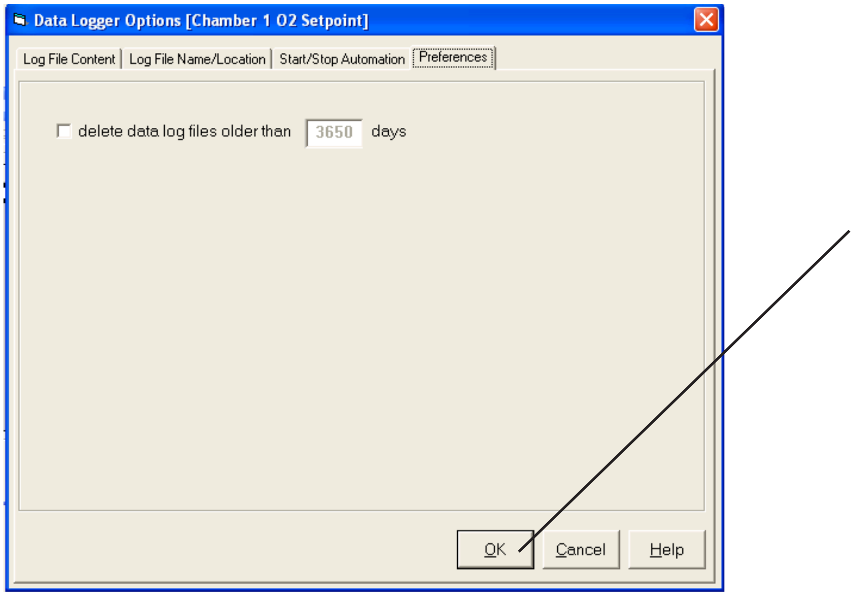
12. The *Data Logger Options [Chamber 1 O2 Setpoint]* popup window will appear. Click on the **Log File Content** tab and under the *Create New Log File* heading, choose whether to create a new log file daily or to create a new log file each time logging starts.



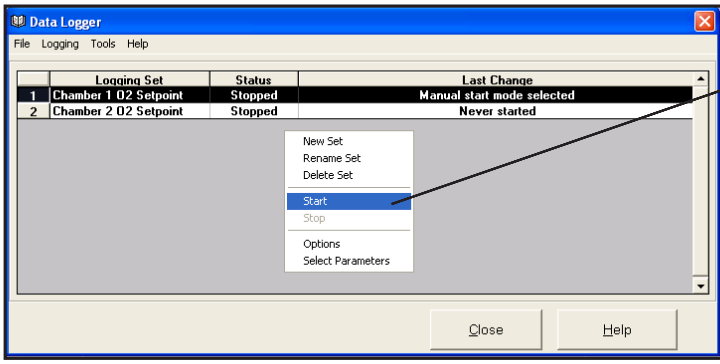
13. Underneath the *File Content* heading, fill out the field next to **Log data every.** This will tell the software how often to log the data. In the following example, **30 seconds** was typed in the *Log data every* field. The data will now be logged every 30 seconds for the process variable as well as the setpoint for chamber 1.



14. Now, click on the **Preferences** tab. This option provides the ability for the software to automatically delete data log files after a set amount of days. This field does not need to be filled out and can remain empty. In order to delete data after a set amount of days, click in the box to the left of *delete data log files older than*, type in a specific number of days and then click **OK**. To log data indefinitely, leave the field empty and click **OK**.

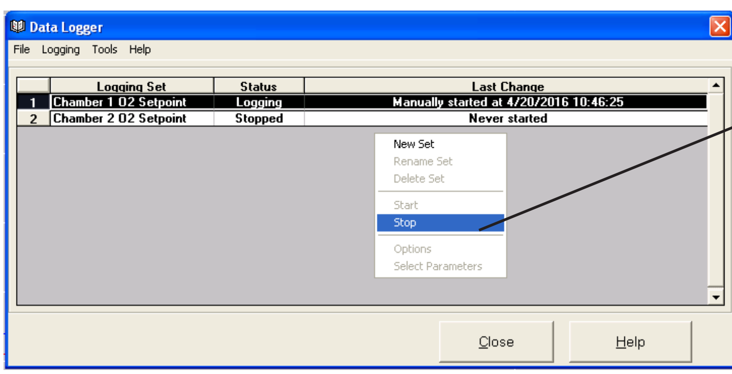


15. The *Data Logger* popup window will appear. Click on a set to select it. Once the set is highlighted, right click and then select **Start**.



16. The data for the *Incubation Chamber 1 O2 Setpoint* will now log into the **Datalogs** folder in the Anafaze software. To retrieve this data go to the Program files **Anafaze** folder, click on the **Watview** folder and the data will be stored inside the **Datalogs** folder.

17. To stop logging data for a specific set, click on the set to select it. Once the set is highlighted, right click and then select **Stop**.



16 Trend Plot Database

Overview

The trend plot database automatically collects data for the trend plot feature, whether or not data logging is enabled. The data is collected at a rate that you can specify and then records the values of all parameters that may be graphed in all controllers that are communicating. This data is saved for a user-defined period of time. If you forgot to enable data logging, you can export data from the trend plot database into a file formatted the same as the data log.

NOTE

Trend plotting is a very useful tool, however it is significantly different from data logging. Trend plotting will not back up your data. This is only used to gather a data snapshot of what the graph is currently showing. Long-term gathering of data will not work with this method. *For instructions on how to gather and backup your data for an extended period of time please refer to the “Data Logging” section of this manual.*

Trend plotting provides the ability to consistently track data. The trend chart screen will provide a graphical representation of data over a certain period of time. By using the average between data points, as well as the time scale, the chart will provide a line displaying how the data trends.

It is a visual representation between all of the data points. Utilizing this chart can help to provide insight as to how the data will progress over time.

By following the trend chart, it can help to identify whether the data is producing a positive trend, a negative trend or if the data is remaining constant. This tool is beneficial because it is a good way to determine whether something is occurring within the process that needs to be addressed.

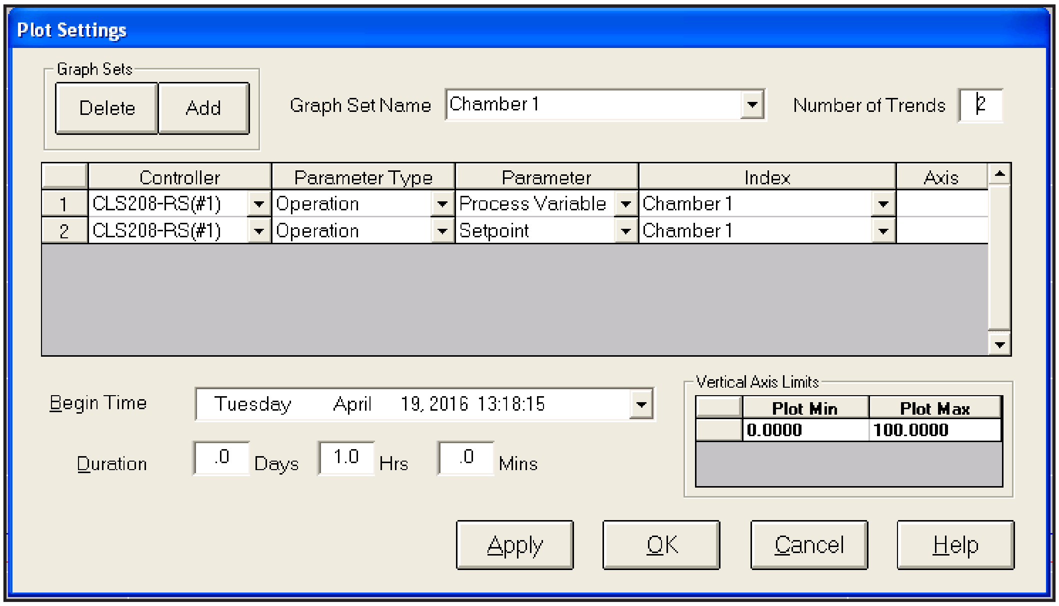
Trend plot data is used to populate the trend plot graph. All system data is exported daily in a format viewable only in the WatView and WatPlot trend plot graph application. From the trend plot graph, the user selects the specific data parameters and record times to view. The data is stored in a proprietary format, however, it can be easily exported from the trend plot graph in a Microsoft Excel format to any location specified by the user. Although all system data is exported daily, it can also be exported manually into a preferred document.

An example of the flexibility of trend plot data
A production lot was run last week, it was started on Monday and completed on Wednesday, grown in Chamber 1. Using the trend plot graph, it is possible to view and export all data associated with Chamber 1 from last Monday to last Wednesday. All data points or specified data points, segmented into any time period (minutes, hours, etc.) can be viewed on the trend plot graph, or exported.

Graphing Process Data with the Trend Plot Database

Graphing features in the *Trend Plot* screen allow you to create multiple graph sets in which you can specify which parameters to graph, over what time period and many other options.

To access the *Plot Settings* window, from the *Trend Plot* graph, click on the **Trend Plot** tab and select **Settings.**



Data for plotting comes from the trend plot database file, which automatically records the values of all process variables and certain other parameters for all the controllers on the network. This data is used to generate graphs on the *Trend Plot* screen. Data can be exported from the database to a text file that can be imported into most spreadsheet or database programs.

Old data is automatically deleted from the trend plot database in order to keep the hard drive from filling up. To set the amount of days to track the data for, this setting must manually changed. *Please refer to the "Setting Data Storage Preferences" section located in the "Trend Plot Database" section of this manual for information on how to store your data for longer than 30 days.*

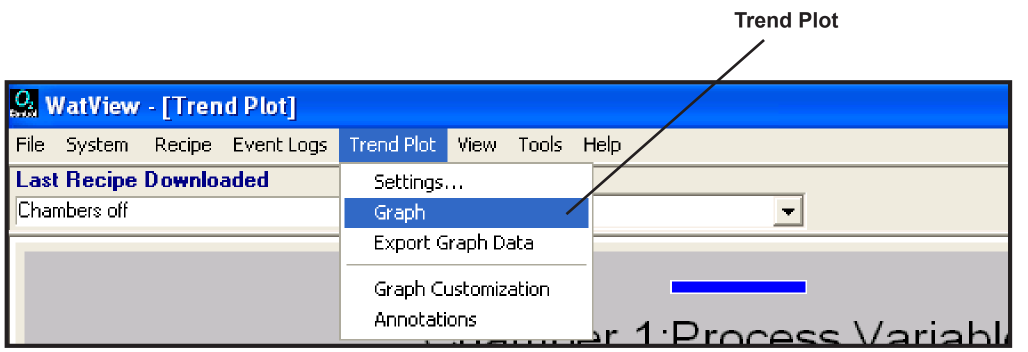
Trend Plot Graph Screen

The *Trend Plot* graph screen allows the operator to view system wide, real-time process readings in graph form. Individual chambers and parameters are designated with different line colors on the graph. The line colors and corresponding variables are defined at the top of the screen.

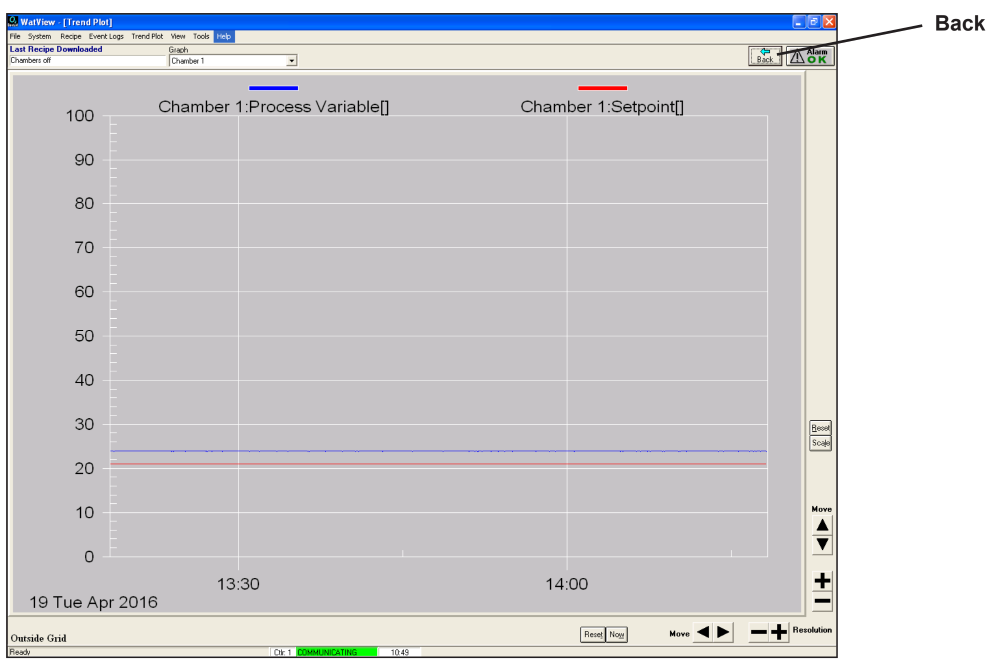
To open the *Trend Plot Graph* screen:

1. Click on the *Trend Plot* tab in the toolbar to expand the *Trend Plot* drop down menu.

2. From the *Trend Plot* drop down menu, select **Graph**. The *Trend Plot* graph screen will open.

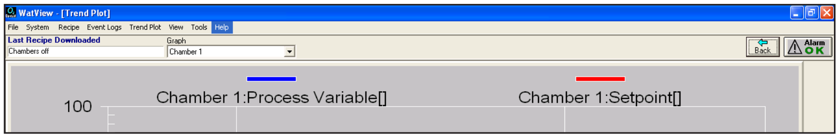


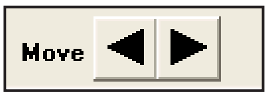
3. Click the **Back** button to return to the last operating menu page.



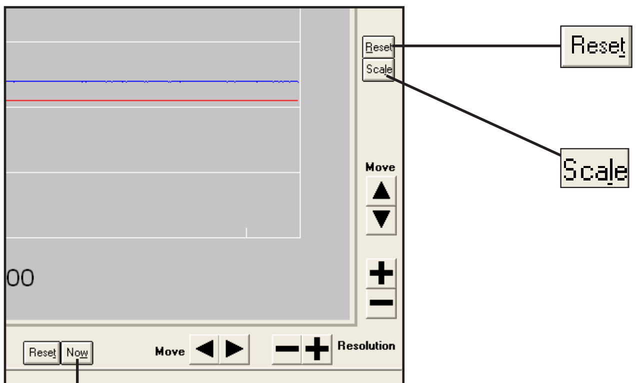
Trend Plot Graph Screen

Legend (top of graph): – Displays the line color that is associated with each Chamber/ Parameter variable. For example: if the line color above *Chamber 1: Process Variable* is blue then the blue line trending on the graph represents the process value for chamber 1.



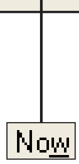


Move < > – These buttons are used in order to navigate around the graph.



Resets the graph view to the original size.

Scales the graph view to show all of the selected process variables.



Resets the graph view to show current readings.

NOTE

To open multiple graph windows, select the Windows **Start** button, select **All Programs,** click on **Watlow**, click on **WatView** and then select **WatPlot**.

Setting Data Storage Preferences

> **NOTE**
>
> Watview must be running and communicating with the controller in order to collect any data.

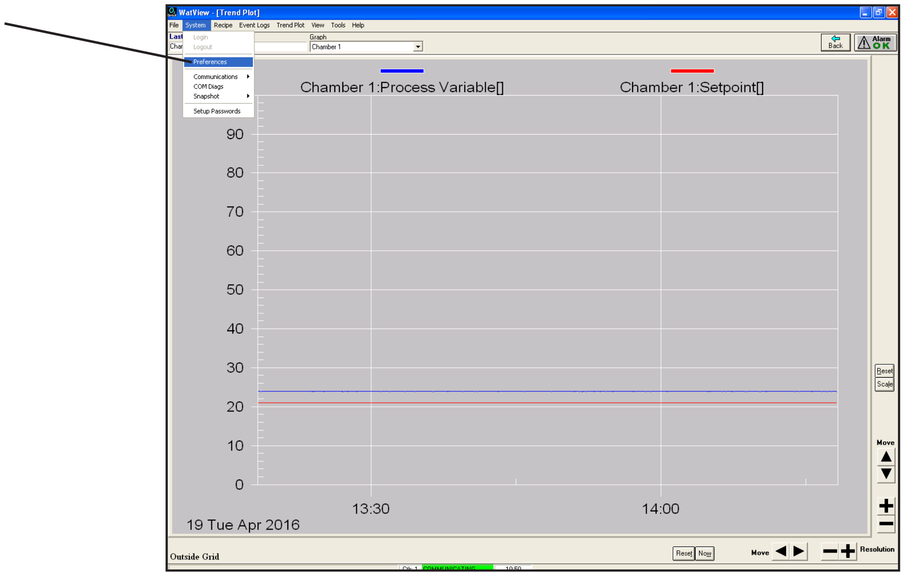
The program is configured at the factory to start storing data automatically. By default, the data will be stored for 30 days. Any data that is older than 30 days will be deleted automatically. Prior to beginning any experiments it is important that the settings are manually changed in order to store the data for more or less than 30 days. **NOTE: It is important that you change this setting before starting your experiment.** If you change the date range while running the unit, there is a potential for data loss. These settings can be changed in the *System Preferences* by selecting the amount of days to store the data for, refer to the steps below.

BioSpherix, Ltd. highly recommends exporting your data immediately once the run is complete. Once exported, verify that the data backed up correctly and save the data using your facilities backup practices. BioSpherix, Ltd. has many customers who set their preferences to track their data for 365 days.

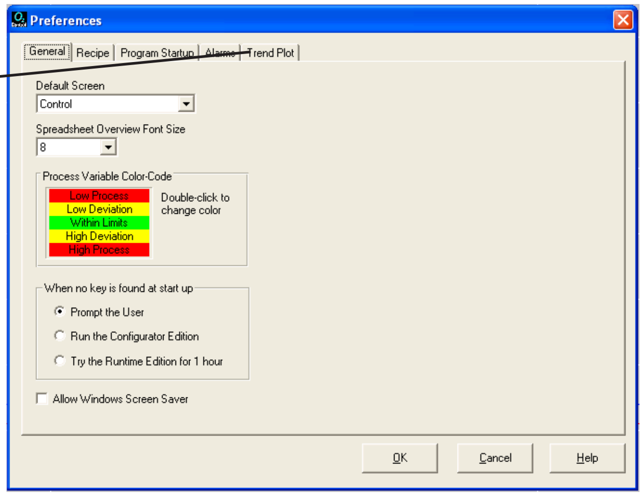
> **NOTE**
>
> BioSpherix, Ltd. strongly recommends routinely backing up all data. *For instructions on how to gather and backup your data for an extended period of time please refer to the "Data Logging" section of this manual.* Trend plotting does not back up your data.

> **NOTE**
>
> You can export from the trend plot, however it will only export what is being currently shown on the *Trend Plot* graph.

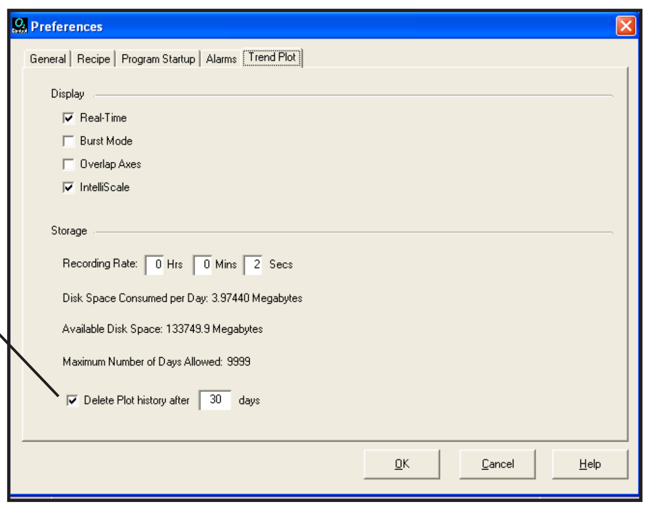
1. On the *Trend Plot* screen click on **System** and then select **Preferences**.



2. The *Preferences* popup window will appear. Click on the **Trend Plot** tab.



3. Check the box next to **Delete Plot history after** and then type in the number of days to track the data for. In the following example, the software is being set up to track the data for 30 days.



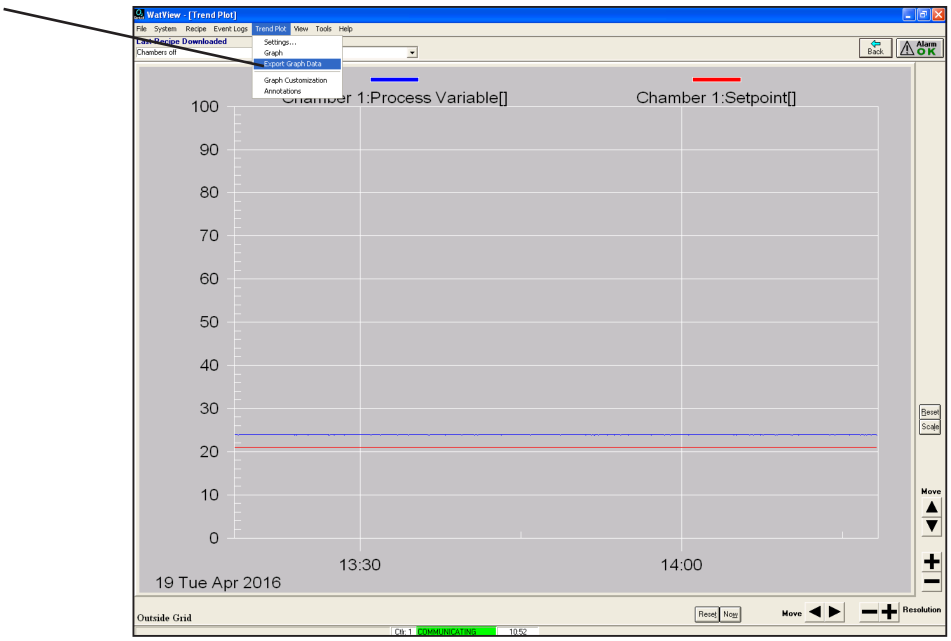
4. Once the amount of days has been selected, click **OK**. The data will now begin tracking.

Exporting Data

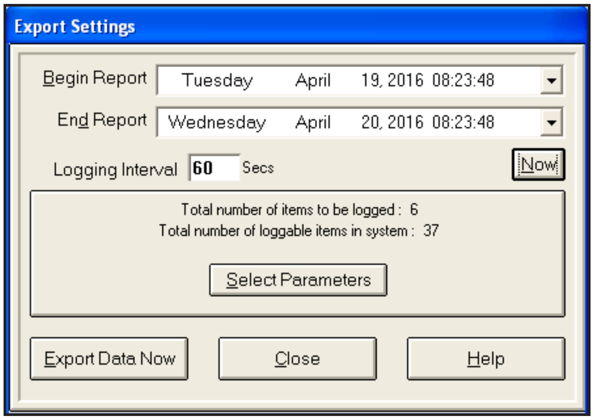
The following procedure will demonstrate how to export all data on the chart into a preferred document, such as a spreadsheet program. Exporting data from the trend plot database will export all graphing parameters into a file. Using the trend plot database also provides the option to track older data by selecting specific dates and times. You can specify how many days you want to track the data for and this setting must be modified prior to beginning your experiments. **It is important that you change this setting before starting your experiment. If you change the date range while running the unit, there is a potential for data loss.** *Please refer to the beginning of the "Setting Data Storage Preferences" section for instructions.*

> **NOTE**
>
> Exporting data from the trend plot graph will **only** export the data that is currently saved within the trend plot graph. This is not the recommended way to get your data for backup purposes.

1. Click on the **Trend Plot** tab located on the toolbar and select **Export Graph Data**.

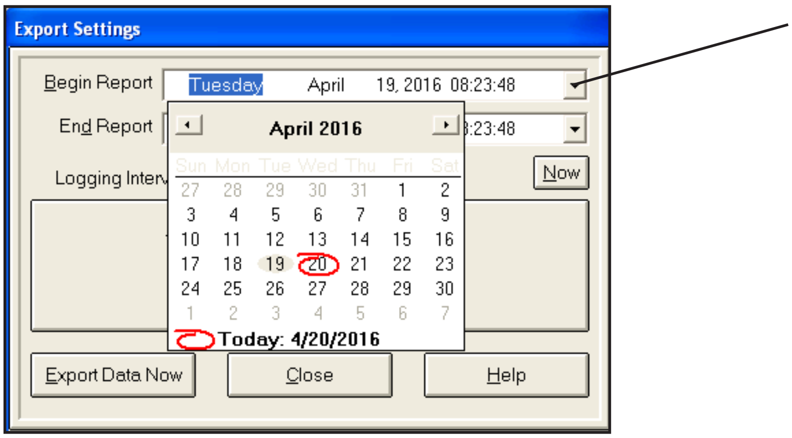


2. The *Export Settings* window will pop up, providing the option to choose what days to track the data for.

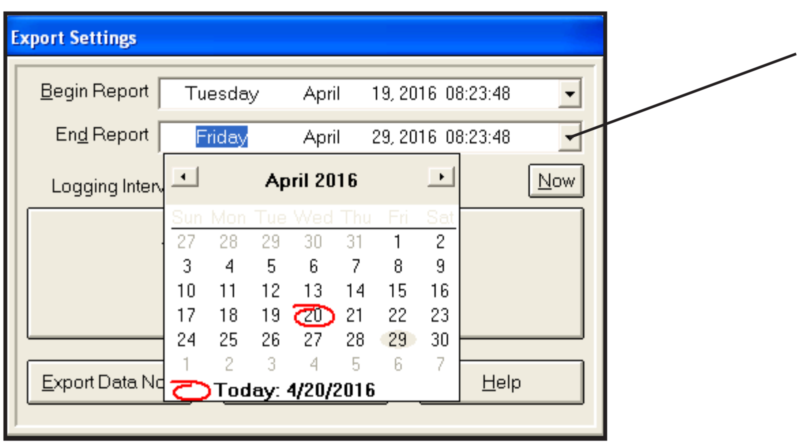


> **NOTE**
>
> This method provides the ability to store and export data that was logged from the past. For example, to log data from two months back, simply click on the left arrow icon on the calendar until the preferred month and day appear. Remember, the amount of days you selected to gather and backup your data for in the "Data Logging" section will affect how far back you can export your data from.

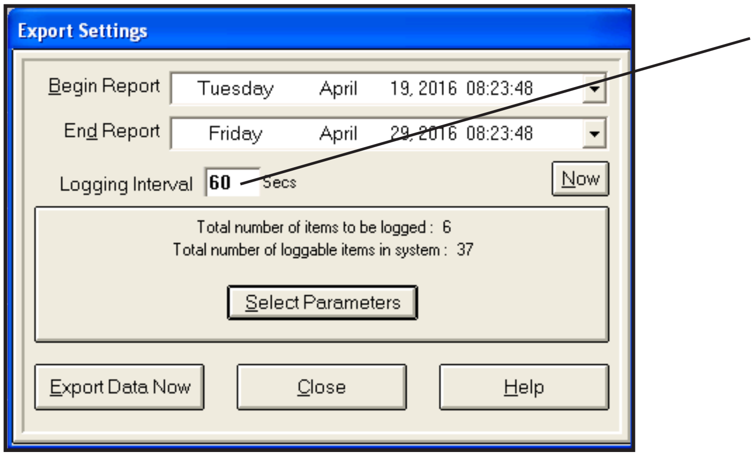
3. Click on the **down arrow** in the *Begin Report* field. Once the calendar appears, select a start date and time for the data to start logging.



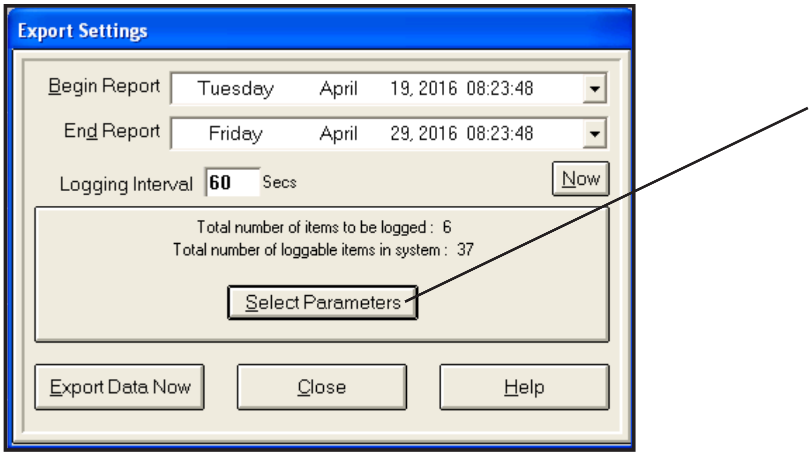
4. Click on the **down arrow** in the *End Report* field and once the calendar appears, select an end date and time for the data to stop logging.



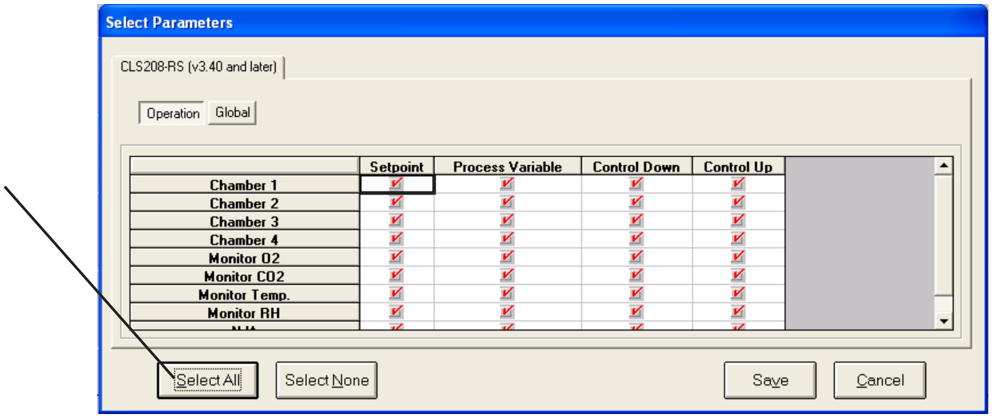
5. The *Logging Interval* field provides the option to select how often the chosen parameters will be logged and exported. The *Logging Interval* has a default of 60 seconds. To change the time of the *Logging Interval*, click in the box next to the **Logging Interval** field and type in a specified time.



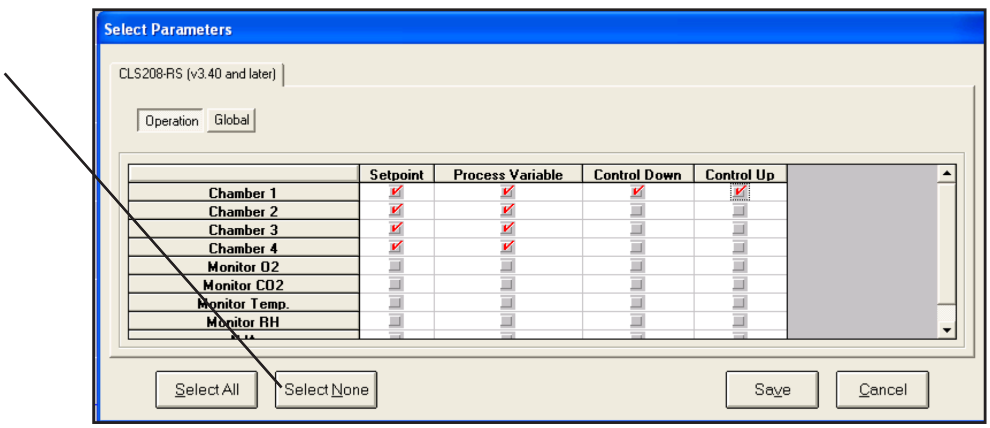
6. Click on **Select Parameters**.



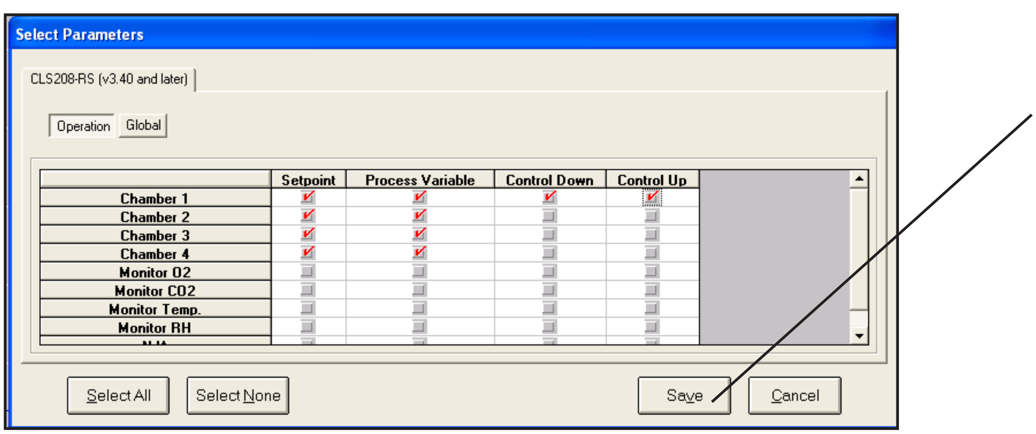
7. The *Select Parameters* popup window will appear, providing a selection of parameters to choose in order to track and export the data. To select all parameters, click on the **Select All** button.



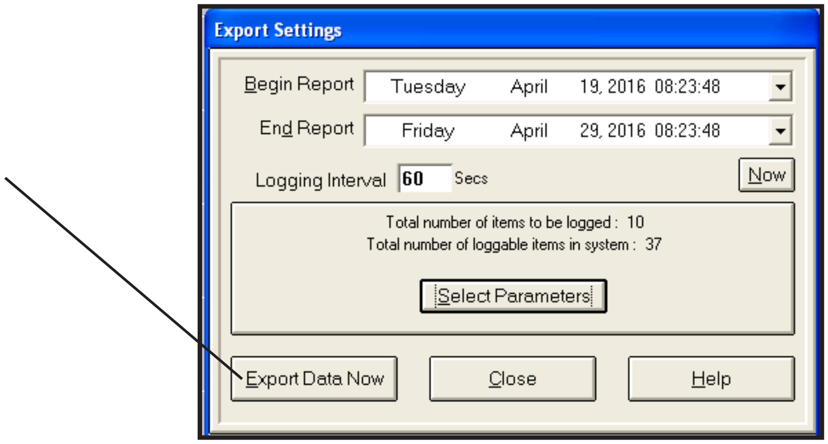
8. To choose specific parameters, click on **Select None** and then manually click on the box of each parameter to track. In the following example, the **Setpoint** and **Process Variable** for **Chambers 1-4** as well as **Control Down** and **Control Up** for **Chamber 1** are being selected to track.



9. Once all preferred parameters have been selected, click **Save**.



10. The *Export Settings* window will appear. Click on **Export Data Now**. The data will now start to track and export.



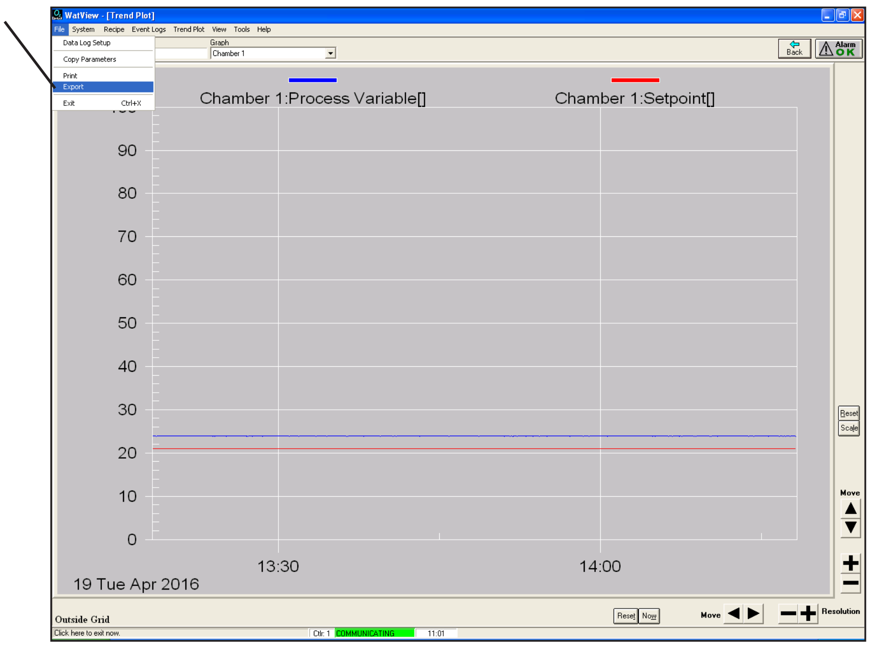
11. The data will load into the **Plot** folder in the Anafaze software. To retrieve this data go to the Program files **Anafaze** folder, click on the **Watview** folder and the data will be stored inside the **Plot** folder.

Exporting an Image

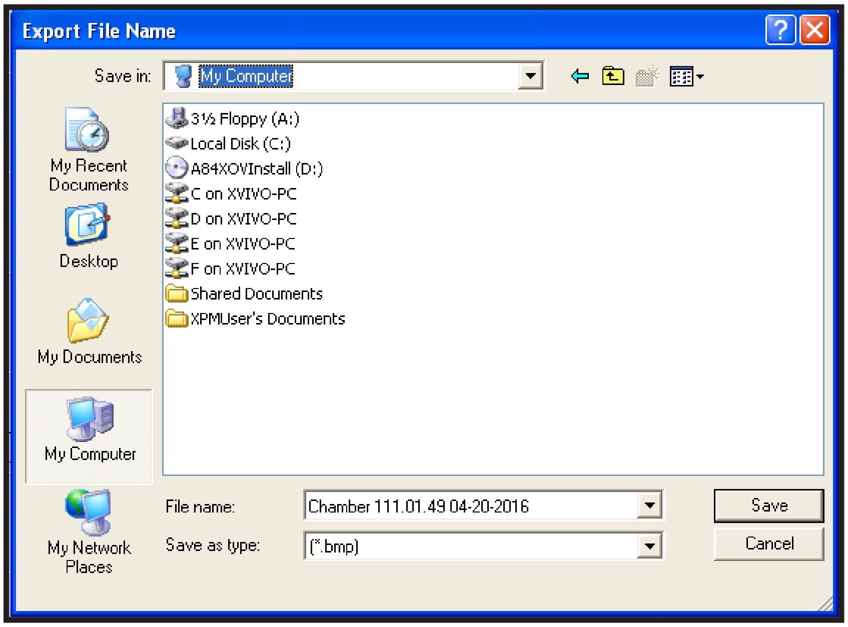
Exporting an image is a good way to get your data if four or less data points are being loaded at a time. This method will take those points and export them immediately.

> **NOTE**
>
> Exporting an image will **only** export the data that is currently shown within the trend plot graph. This is not the recommended way to get your data for backup purposes.

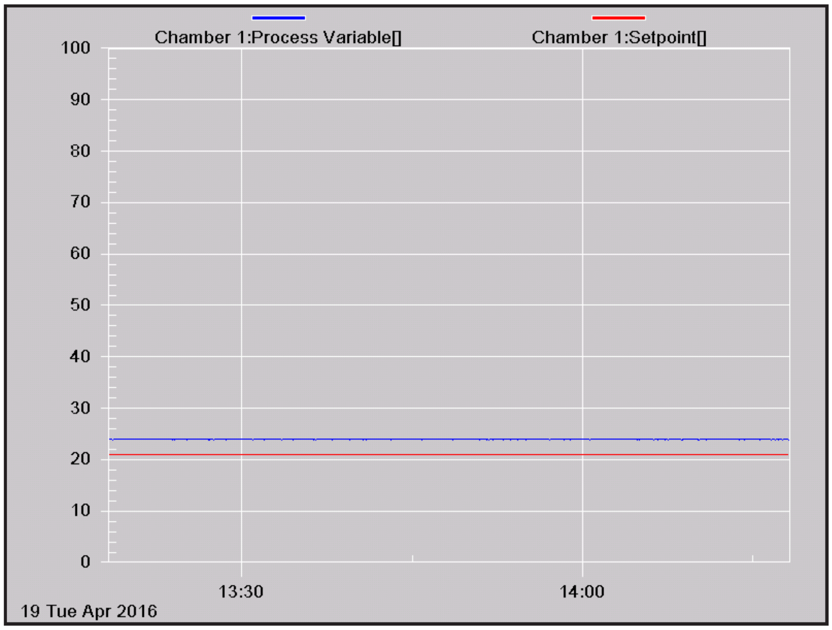
1. Click on the **File** tab located on the toolbar and select **Export**. The data will be saved as an image on the PC.



2. Select a location to save the image to. In the following example, the data is being saved to **My Computer**.



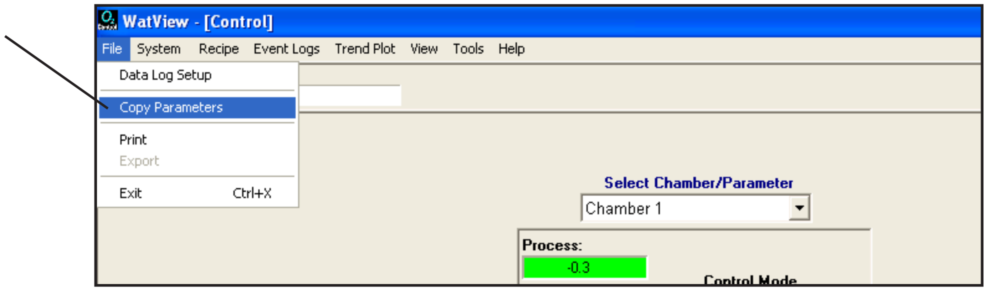
3. This is an example of what the data will look like once the image is opened.

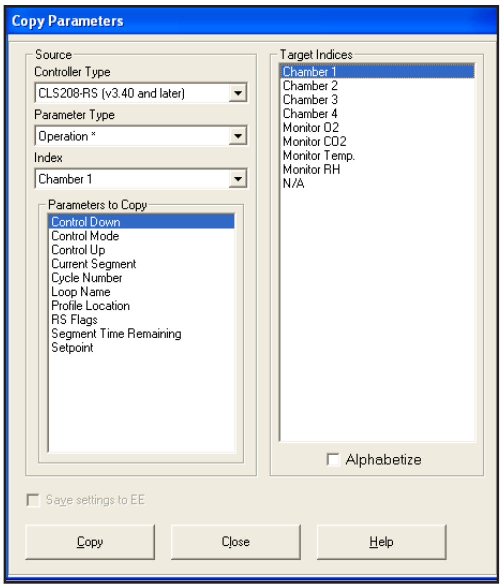


17 Copy Parameters

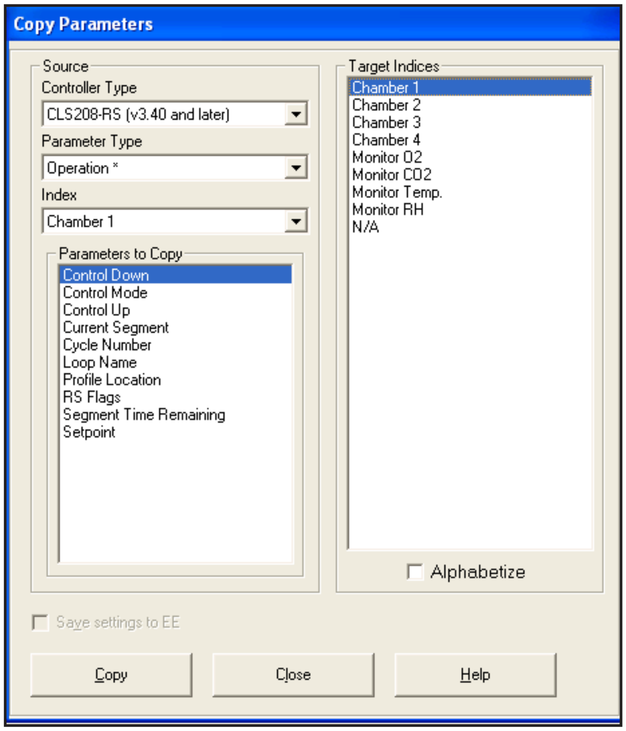
> **NOTE**
>
> This section describes advanced content features for the OxyCycler model A84 System. Prior to accessing these features, please contact BioSpherix, Ltd. Technical Support for assistance.

Parameter settings can be copied from one controller to additional controllers or from one index to additional indexes. In order to launch the *Copy Parameters* window click on **File** and select **Copy Parameters.**





Copy Parameters Window



Copy Parameters Window

Source - Use these items to select the settings you want to duplicate.

Controller Type - Select the controller with the settings you want to copy.

Parameter Type - Select the type of parameter or the group of parameter types you want to copy.

Index - Select an index with the settings you want to copy.

Parameters to Copy - Select the parameters to copy.

Target Indices - Select the index or indices to be updated with the duplicated settings.

Alphabetize - Select this option to list the target indices alphabetically. Uncheck the box to list them in the order they appear in the *Spreadsheet Overview* screen.

Save Settings to EE - Select this option to have the controller save parameter settings in nonvolatile memory. This option is available for controllers that do not automatically save parameter values set via communications.

Copy - Click this button to copy the selected parameters.

NOTE

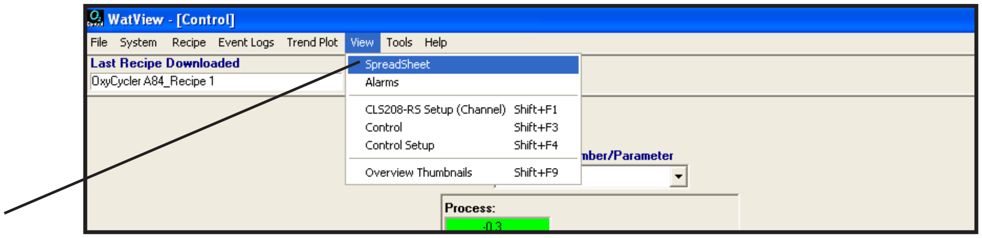
The **copy** option saves the full set of parameters in memory. If you are copying several sets of settings to the same controllers, copy all parameters first before saving the settings. Once all parameters have been copied, click **Save**. Depending on the type of hardware the controller uses for nonvolatile memory, it may be undesirable to perform the *save* too many times.

Close - Click this button to close the dialog box.

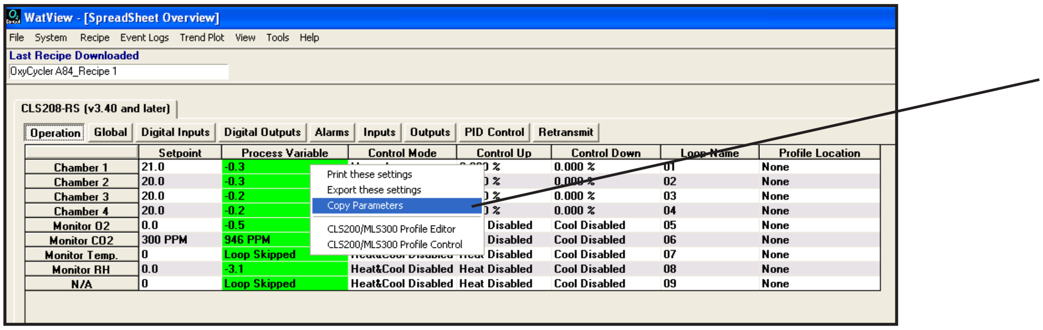
Help - Click this button to open *WatView Help.*

Spreadsheet Overview Screen

The *Copy Parameters* window can also be opened from the *Spreadsheet Overview* screen. The controller tabs and parameter type buttons in the *Spreadsheet Overview* screen provide access to the controller's settings and values. These buttons allow you to view and change the parameters for all the controllers on your network. Each tab on the screen includes parameter settings for a particular type of controller. The buttons on the tabs display the spreadsheets for each type of parameter. In order to launch the *Copy Parameters* window from the *Spreadsheet Overview* screen click on **View** in the toolbar and select **Spreadsheet.**



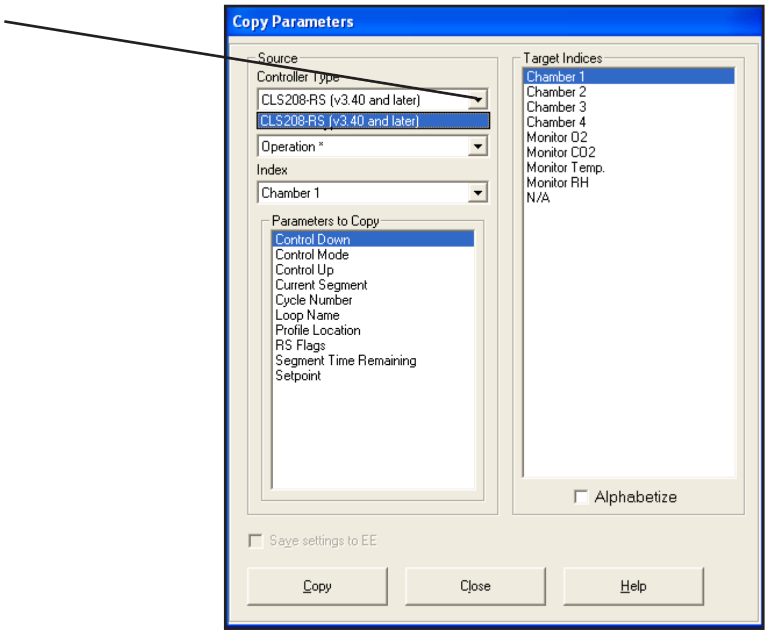
Once the *Spreadsheet Overview* screen opens, right click on the row that contains the settings you want to copy and then select **Copy Parameters**.



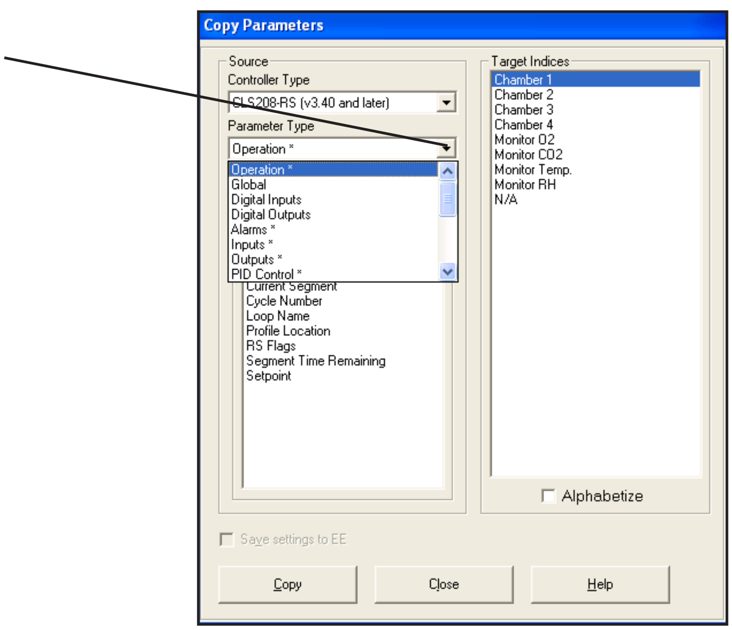
Spreadsheet Overview Screen

Copying Parameters

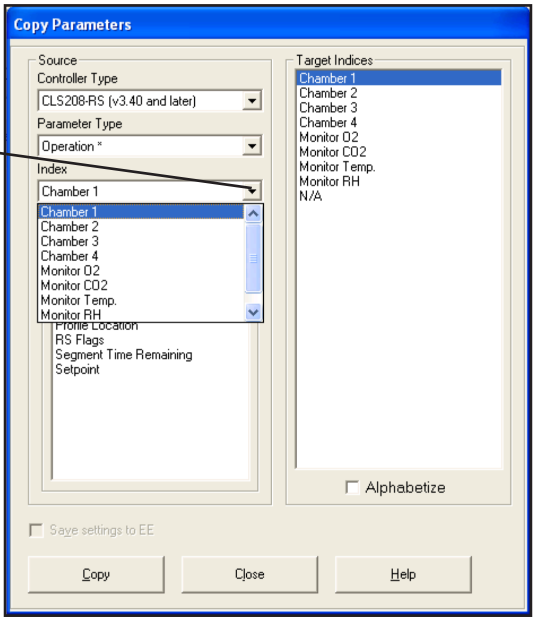
1. Under the **Controller Type** heading, click on the drop down menu and select the desired controller.



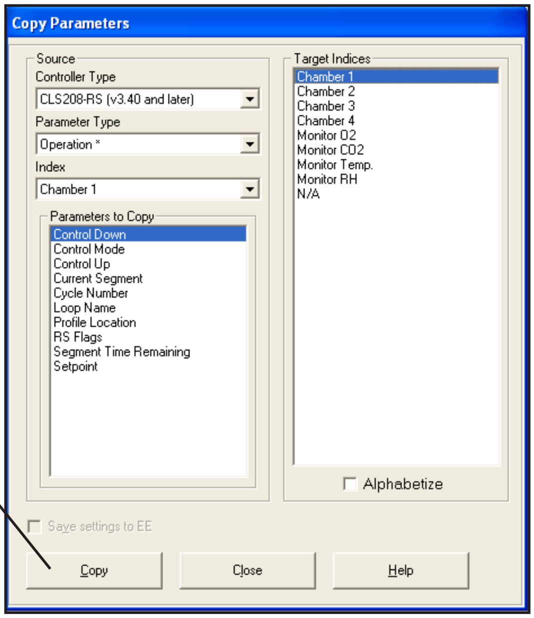
2. Under the **Parameter Type** heading, click on the drop down menu and select the desired parameter.



3. Under the **Index** heading, click on the drop down menu and select the desired index.



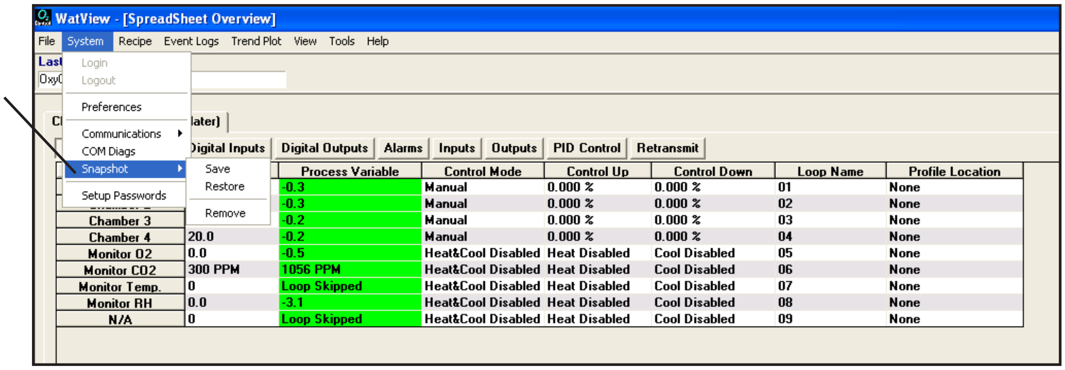
4. Under the **Parameters to Copy** heading and the **Target Indices** heading, click on the parameters and indices you want to copy. Once you have selected all desired parameters and indices, click **Copy.**



18 Snapshots

Overview

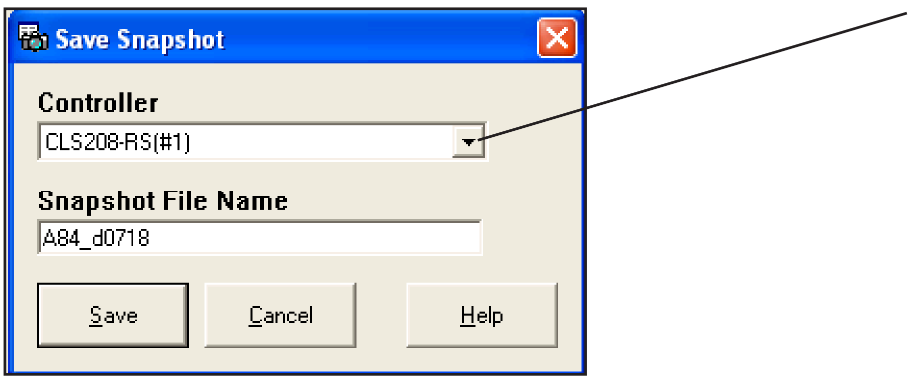
Snapshots provide a quick way to save the complete configuration of a controller and it also provides a good way to backup your settings after you set up a controller. This feature can also be used to copy settings from one controller to another. In the *Spreadsheet Overview* screen, click on **System**, select **Snapshot** and then select whether you want to **Save** the snapshot, **Restore** the snapshot or **Remove** the snapshot.



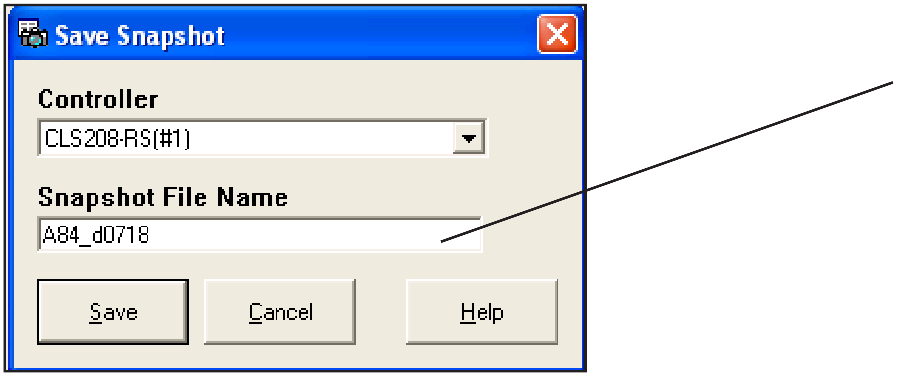
Save a Snapshot

The *Save Snapshot* option is used to save a snapshot from the controller to the software.

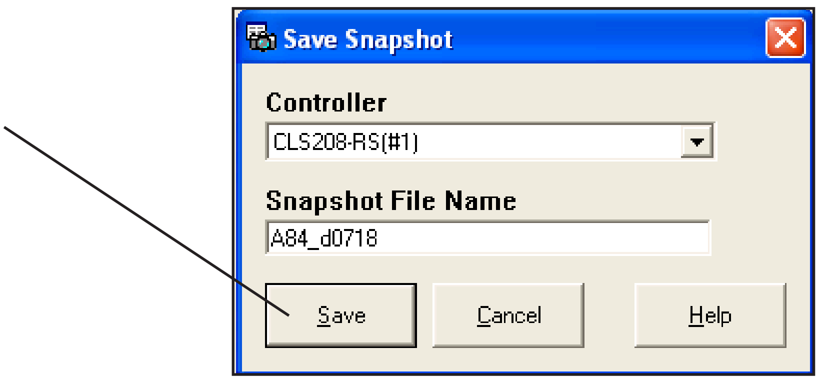
1. If you choose to save the snapshot, the *Save Snapshot* popup window will appear. Under the **Controller** heading, use the drop down menu to select which controller you will be saving the snapshot for.



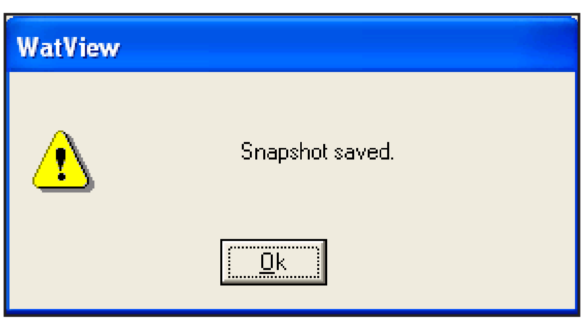
2. Under the **Snapshot File Name** provide a name for the snapshot.



3. Click **Save.**



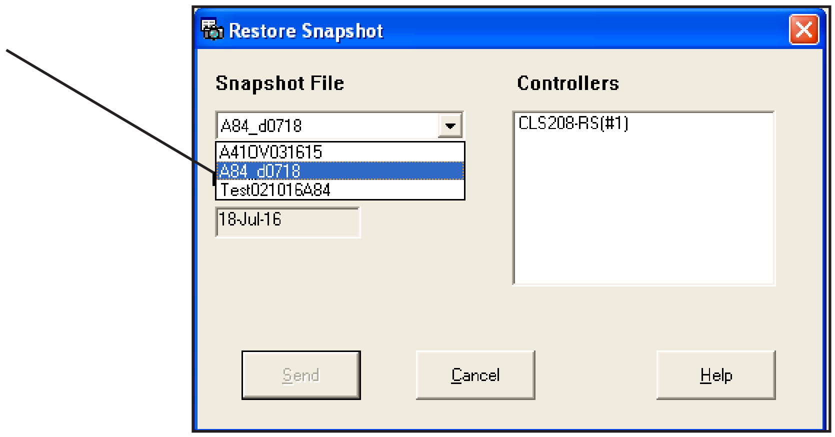
4. The following popup window will appear: *Snapshot saved*. Click **OK**. The snapshot will be saved in the **Snapshots** folder in the **Anafaze** software. To retrieve this snapshot go to the program files **Anafaze** folder, click on the **Watview** folder and the snapshot will be stored inside the **Snapshots** folder.



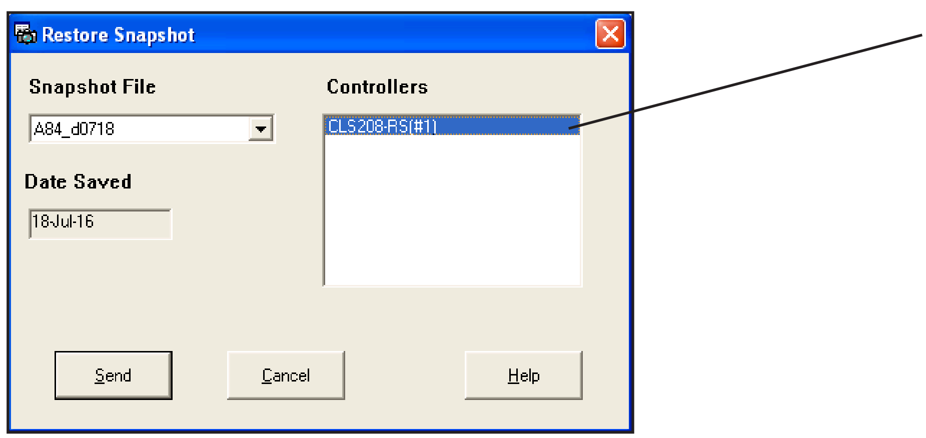
Restore a Snapshot

The *Restore Snapshot* option is used to load a snapshot from the snapshot folder into the controller.

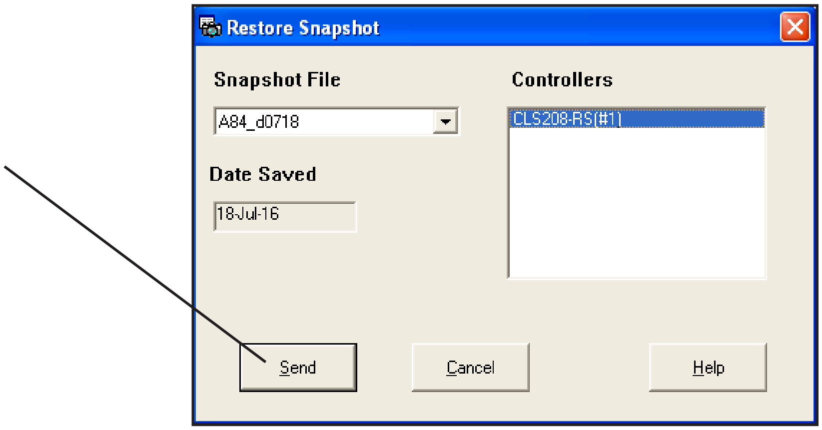
1. If you choose to restore a snapshot, the *Restore Snapshot* popup window will appear. Under the **Snapshot File** heading, use the drop down menu to select which controller you will be restoring the snapshot for.



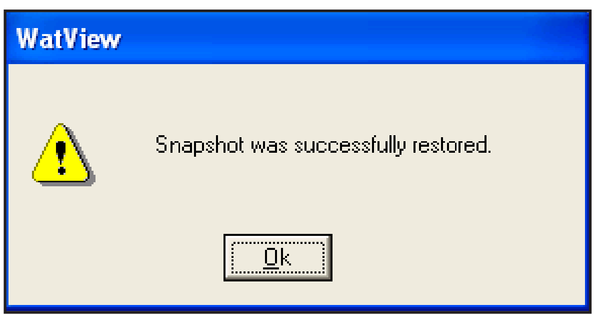
2. Once the snapshot is listed under the *Controllers* heading, you must click on it to highlight it.



3. Once the controller is highlighted, click **Send.**



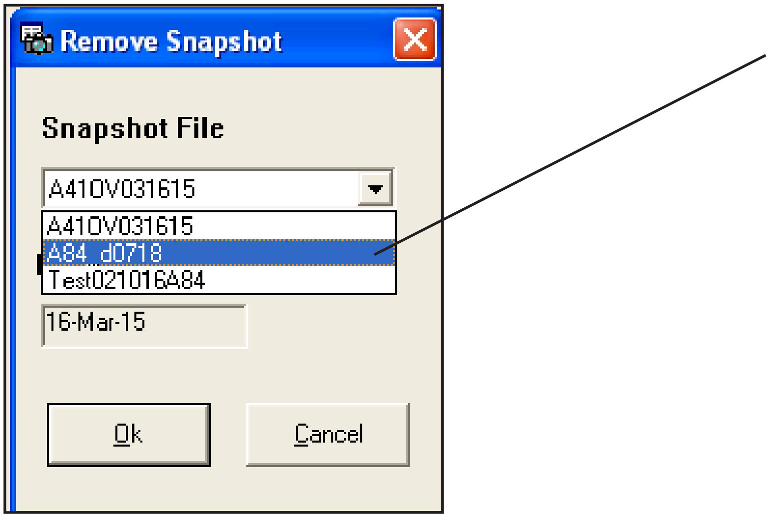
4. The following popup window will appear: *Snapshot was successfully restored*. Click **OK**. The snapshot will be saved in the **Snapshots** folder in the **Anafaze** software. To retrieve this snapshot go to the program files **Anafaze** folder, click on the **Watview** folder and the snapshot will be stored inside the **Snapshots** folder.



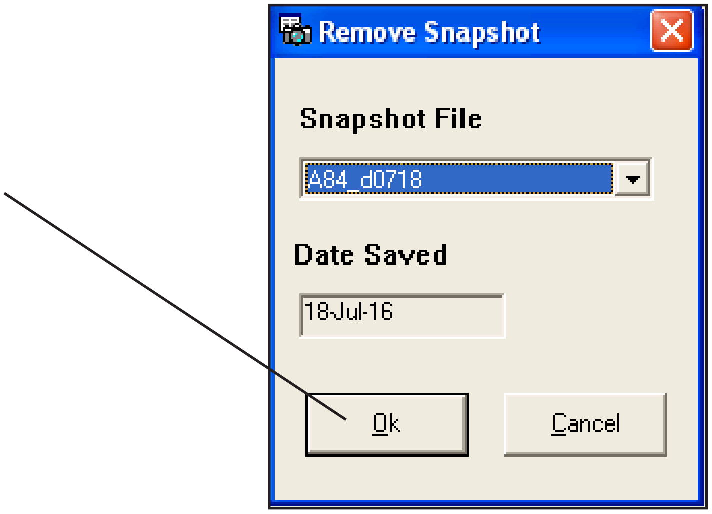
Remove a Snapshot

The *Remove Snapshot* option is used to delete the snapshot file.

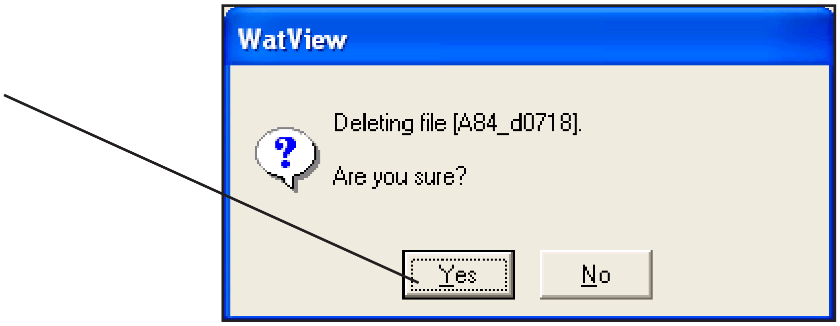
1. If you choose to remove a snapshot, the *Remove Snapshot* popup window will appear. Under the **Snapshot File** heading, use the drop down menu to select which controller you will be removing the snapshot from.



2. Click **OK.**



3. The following popup window will appear: *Deleting File [# # #] Are you sure?* Click **Yes**. The snapshot will be deleted.

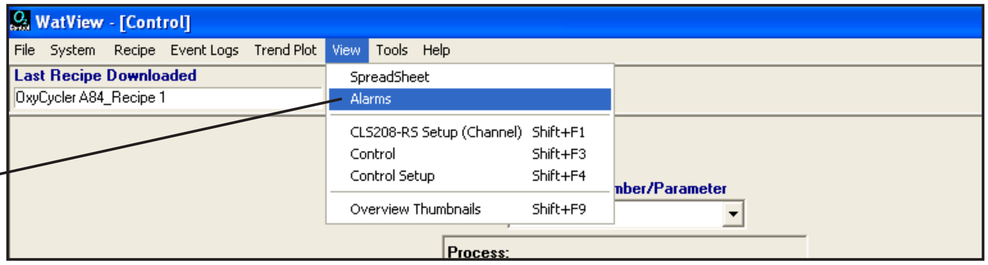


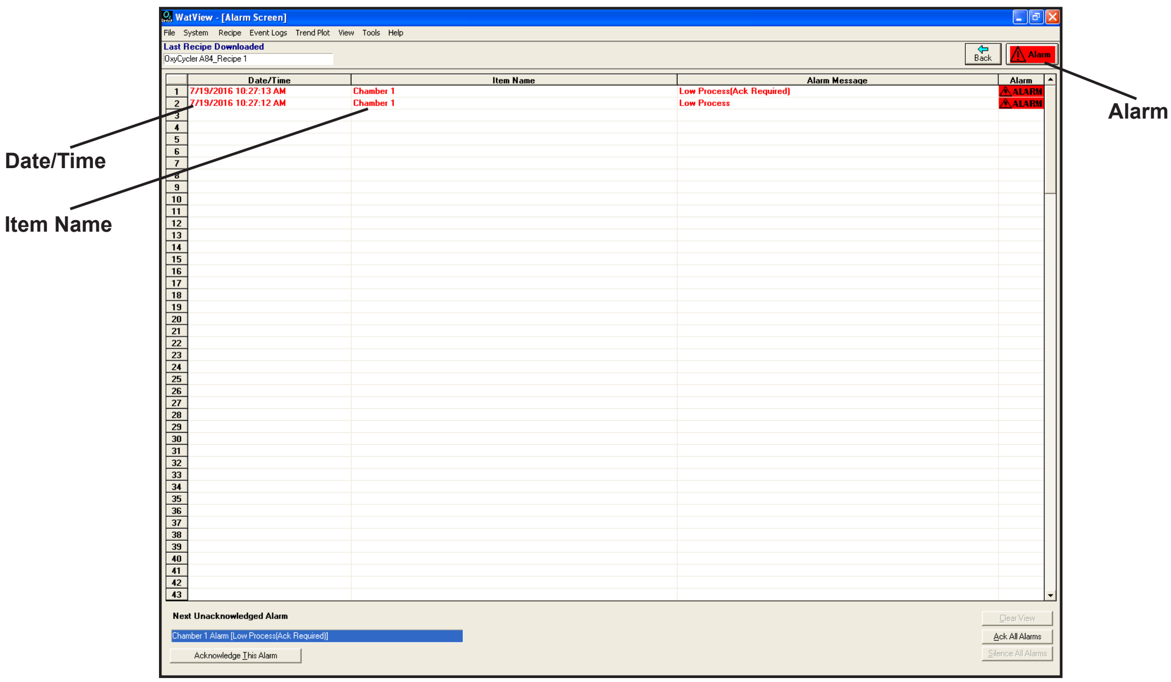
NOTE

When a snapshot is removed it is sent to the recycle bin on your desktop. In order to recover a deleted snapshot you must do so prior to emptying your recycle bin.

19 Alarms

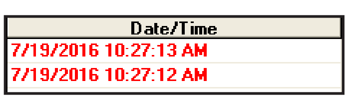
An alarm is triggered when a process value moves beyond limits set by the user. When an alarm occurs, the *Alarm* button located in the upper right of each screen will turn red to indicate an alarm condition and the *Alarm* screen is automatically displayed. The *Alarm* screen displays what alarms are triggered, when the alarm occurred and other alarm information. You must acknowledge the alarm(s) prior to resuming control with the OxyCycler. To get to the *Alarm Screen* click on **View** in the toolbar and select **Alarms.**



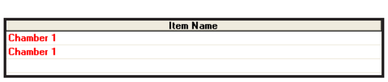


Alarm Screen

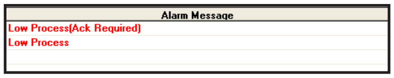
Alarm - Alarm button turns red when an alarm becomes active.



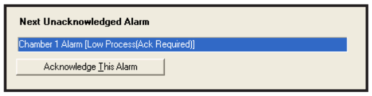
Date/Time - Displays the date and the time that the alarm was triggered.



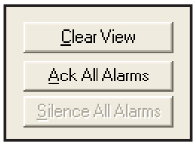
Item Name - Displays the chamber that the alarm was triggered in.



Alarm Message - Displays why the alarm was triggered.



Next Unacknowledged Alarm - This field displays what alarm needs to be acknowledged. Click on the **Acknowledge This Alarm** button.



Clear View - Once an alarm has been acknowledged you can clear it by clicking this button.

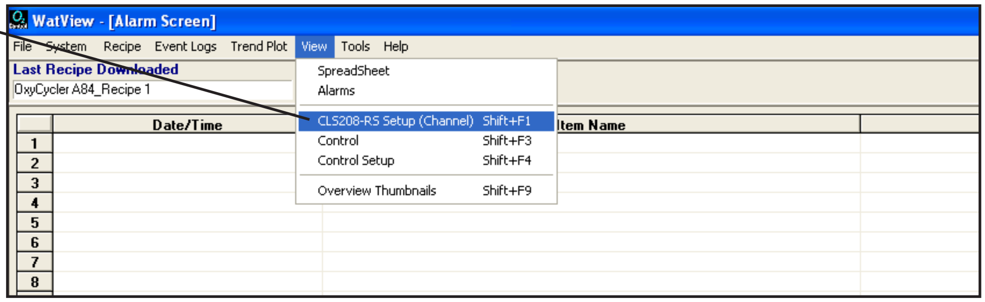
Ack All Alarms - If you have more than one alarm that was triggered you can click this button to acknowledge any alarm that has not yet been acknowledged.

Silence All Alarms - When the silence featured is enabled,you will not receive a sound notification when an alarm is triggered.

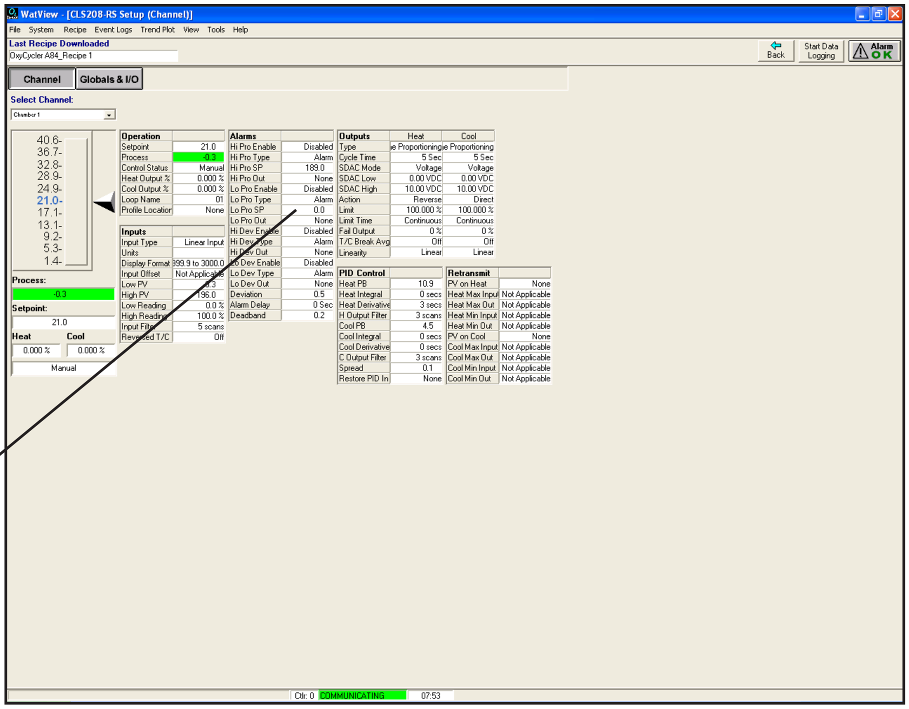
Setting a Tolerance

Sensors vary under normal operations and under some circumstances that variation can activate the alarm. If your alarm is activating inadvertently or unexpectedly then you may need to increase the tolerance. The tolerance can be increased from the controller *Setup* screen.

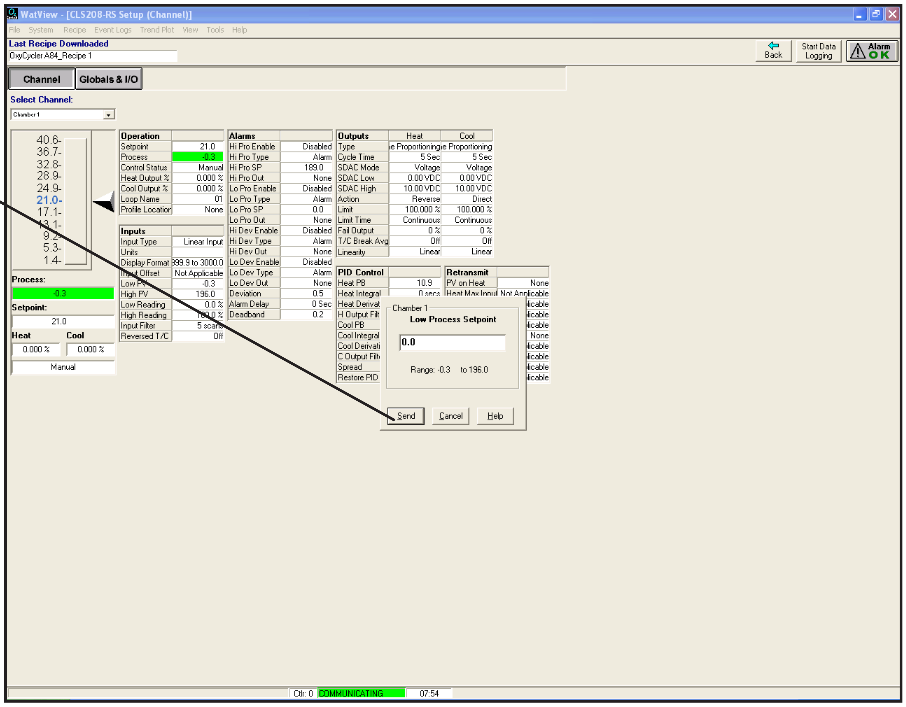
1. In the toolbar click on **View** and select the controller. In the following example, we will be selecting **CLS208-RS.**



2. When the *Setup* screen opens, you can change the tolerance for each parameter. For example, to change the tolerance for the low process setpoint of Chamber 1, double click in the field next to **Lo Pro SP** underneath the **Alarms** column.



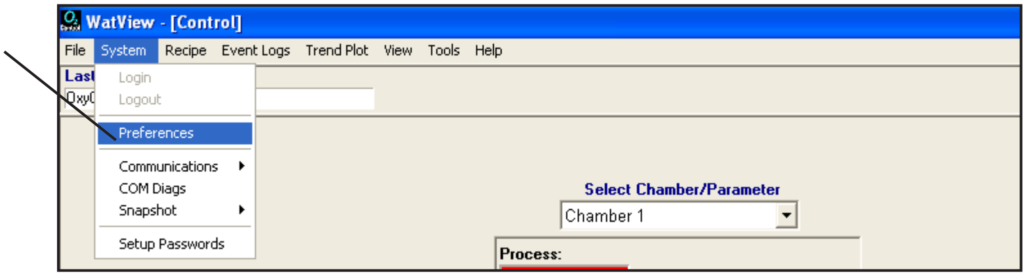
3. The *Chamber 1 Low Process Setpoint* popup screen will appear. Adjust the tolerance for the low process setpoint and then click **Send.**



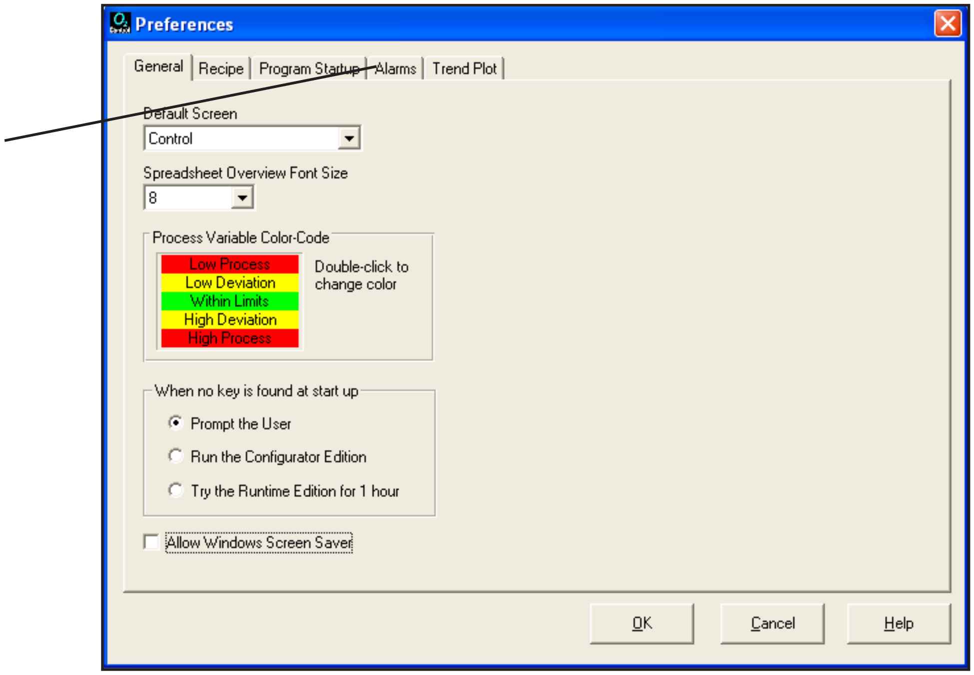
Manage Alarms

By default, when an alarm occurs, the *Alarm* screen is automatically displayed. BioSpherix Ltd. recommends leaving this feature on the default setting, however it can be disabled from the *Alarms Tab.* The alarm tab, in the *Preferences* window allows users to set the conditions that will trigger an alarm.

1. In the toolbar click on **System** and select **Preferences.**

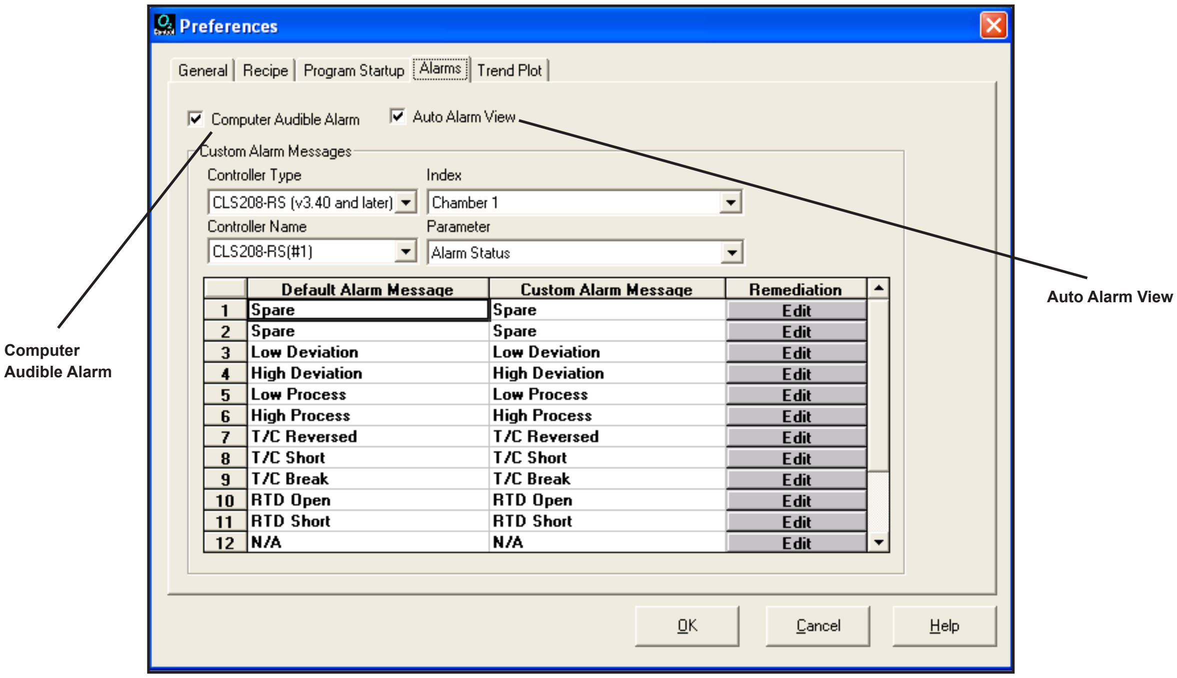


2. When the *Preferences* popup window appear, click on the **Alarms** tab.



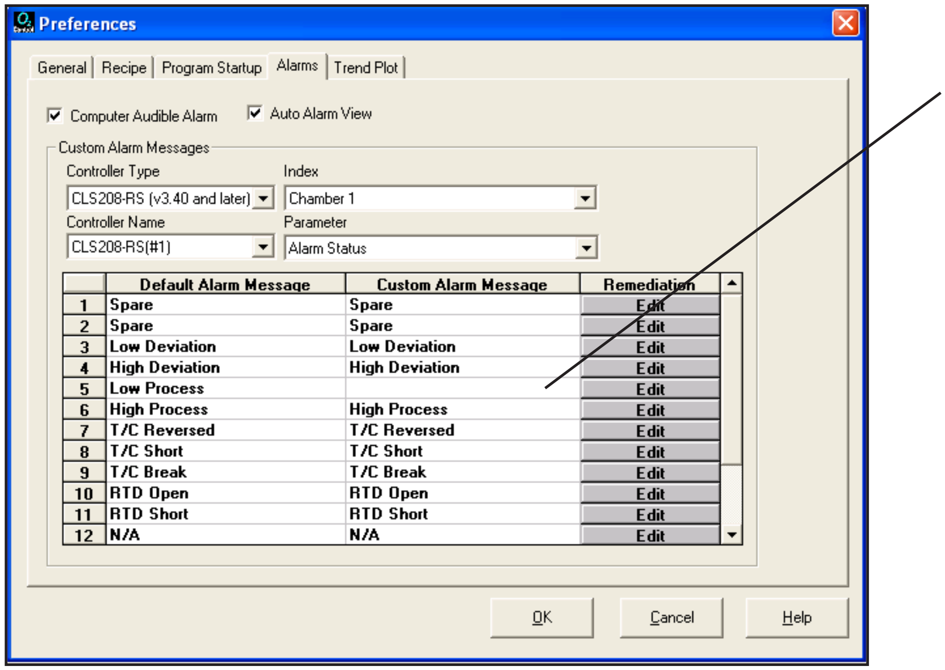
3. In the *Alarms* tab you will see two settings: *Computer Audible Alarm* and *Auto Alarm View.*

- If you remove the checkmark next to **Computer Audible Alarm**, the software will not give off an audible noise when an alarm has been triggered.
- If you remove the check mark next to **Auto Alarm View,** the *Alarm* screen will no longer popup as soon as an alarm has been triggered. The *Alarm* button located in the top right of the screen will still turn red until the alarm has been acknowledged. Navigate to the *Alarm* screen in order to clear the alarm.

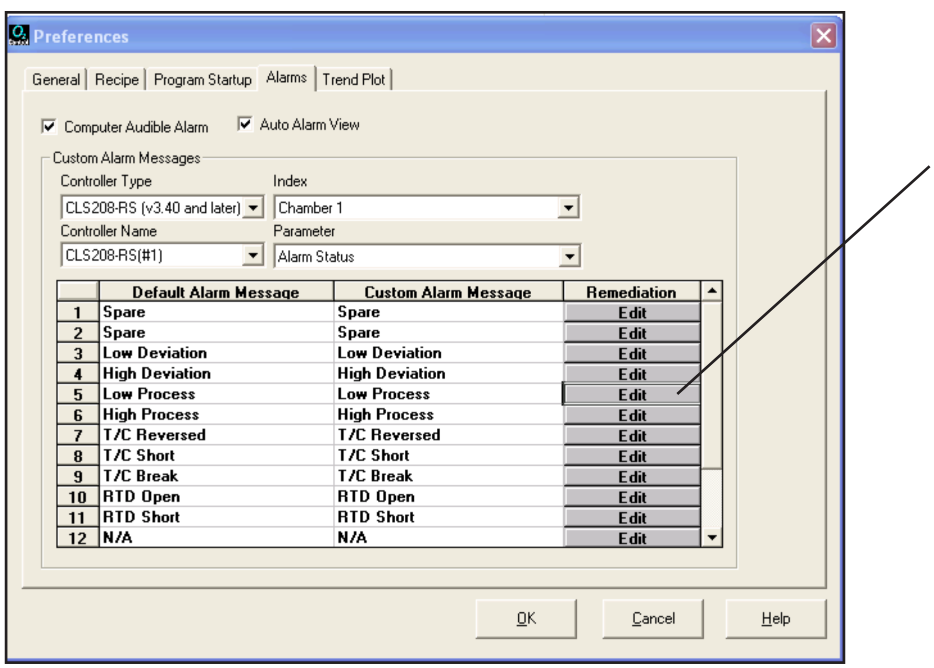


In addition to setting the conditions that will trigger an alarm, Watview software also provides the user the ability to customize each alarm message. You can use WatView to provide the operator with information about the alarm and what action should be taken when an alarm is triggered.

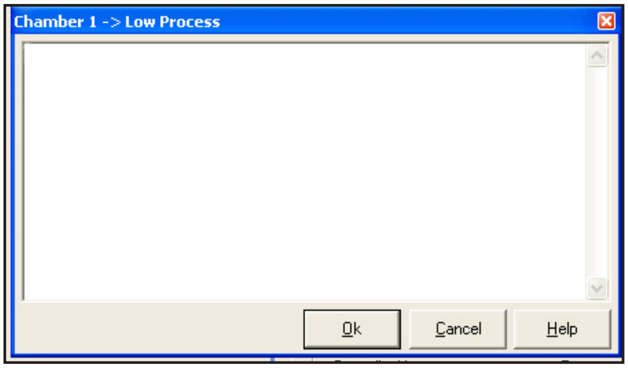
4. The *Custom Alarm Message* screen allows you to customize each alarm message. Click on the alarm you want to customize and type in your custom name/message. In the following example, the *Low Process* alarm is the alarm that is being customized.



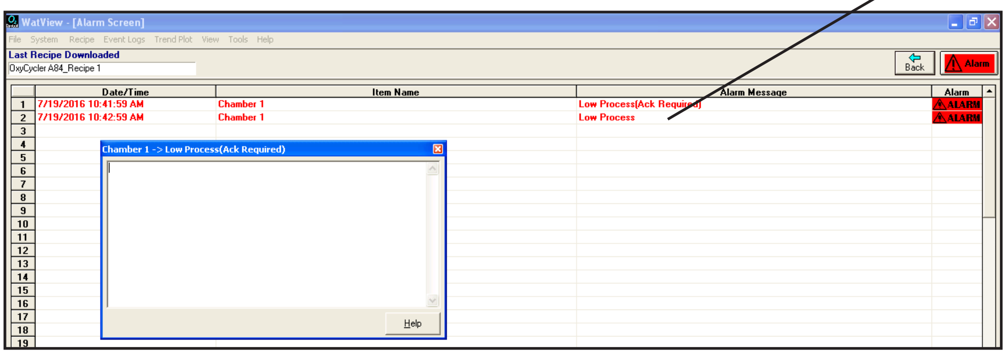
5. Under the *Remediation* column click on **Edit** to open the popup window. In the following example we are going to click in the *Low Process* column to open the *Chamber 1 Low Process Variable* window.



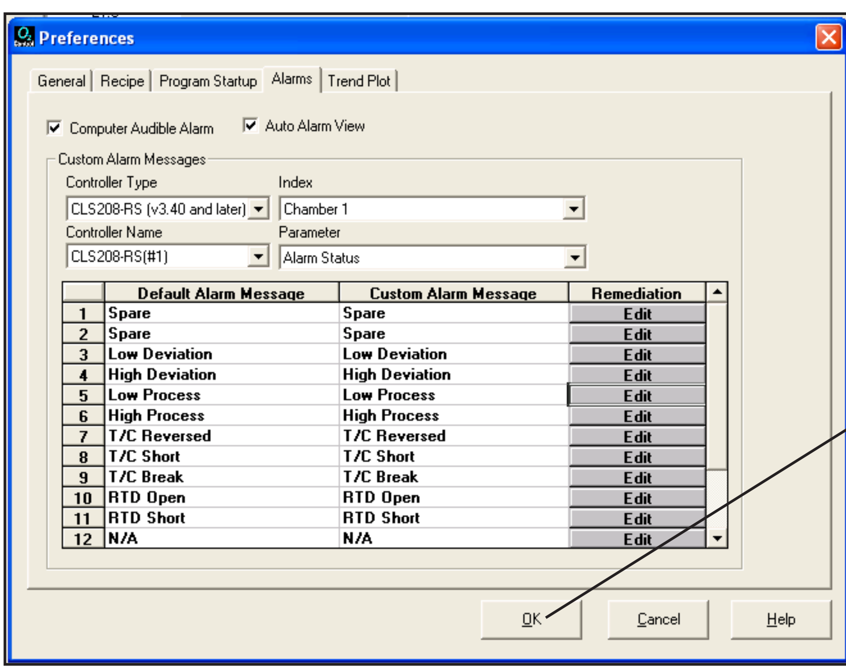
6. When the *Chamber 1 Low Process Variable* window opens, you can provide information about this specific alarm. Now every time that alarm is triggered, the message that you provided in the *Remediation* column will be displayed in the *Alarms* screen. Click **OK** to close this dialog box.
NOTE: In order to see this message in the *Alarms* screen you have to click on the alarm itself.



Click on the Alarm in the Alarms screen in order to bring up the customized message

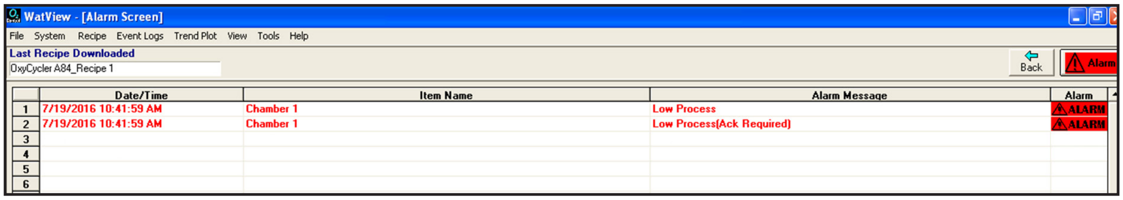


7. Once all settings are set as desired, click **OK** in the *Preferences* window.



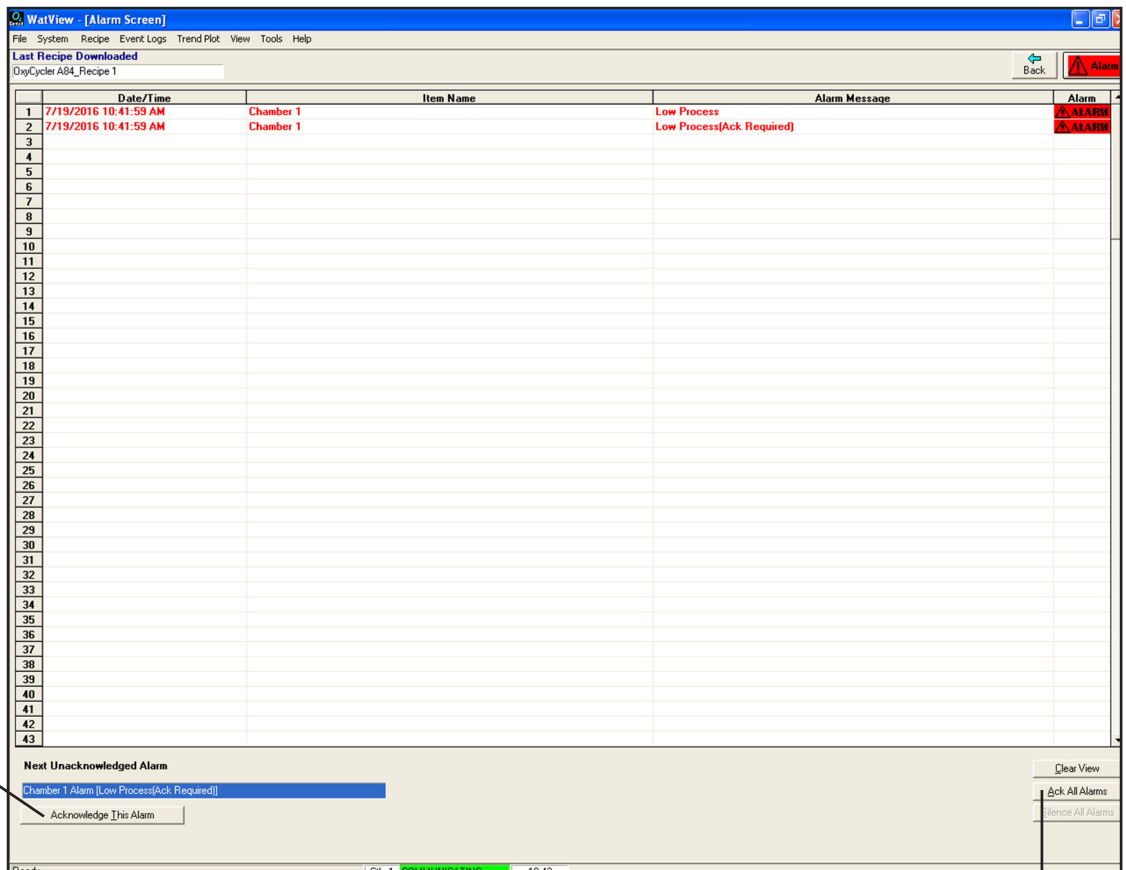
When an Alarm is Triggered

By default, when an alarm occurs, the *Alarm* screen is automatically displayed.



Acknowledging and Clearing an Alarm

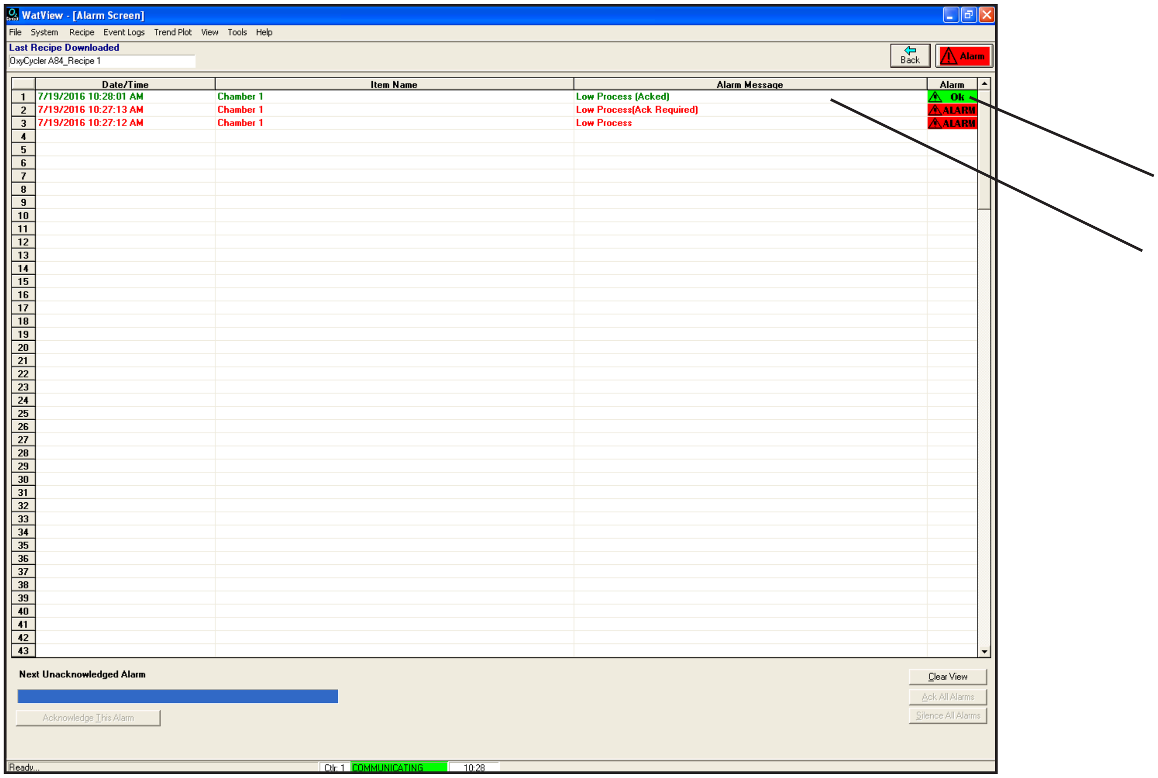
1. If there was only one alarm triggered, click on the **Acknowledge This Alarm** button at the bottom left of the screen. If it was more than one alarm, you can acknowledge all alarms at the same time by clicking on the **Ack All Alarms** button at the bottom right of the screen.



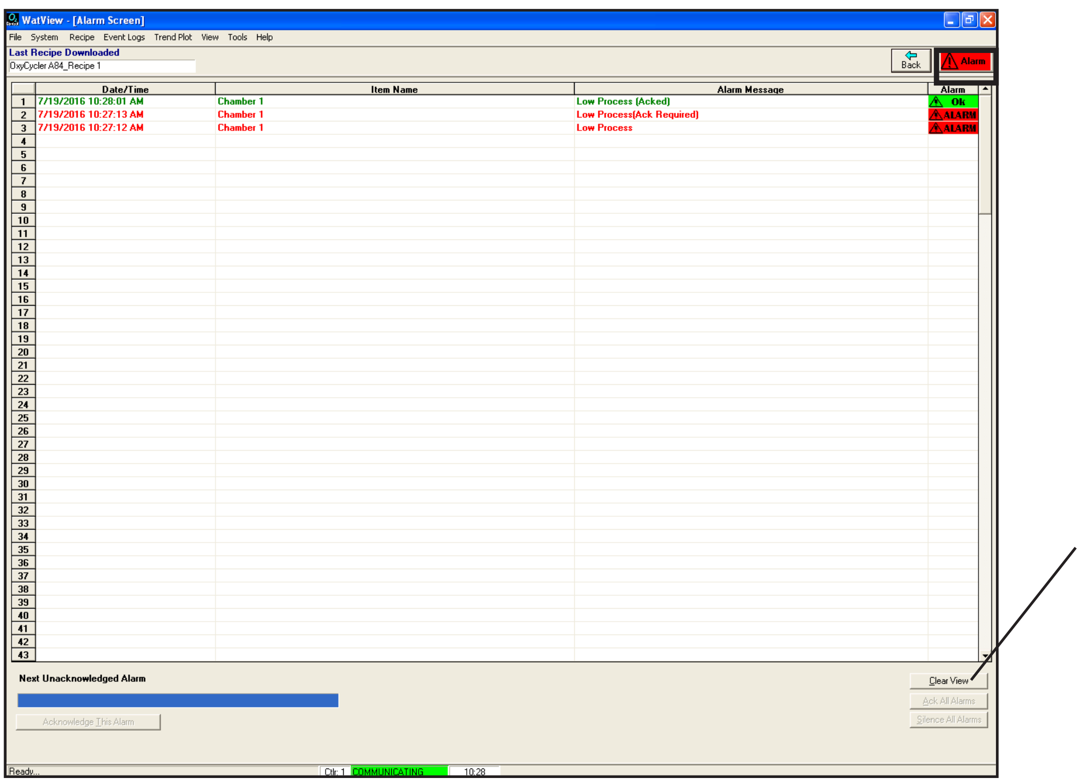
Acknowledge This Alarm

Ack All Alarms

2. Once an alarm has become acknowledged, a new Alarm message will appear in green and the *Alarm* column will display a *green OK.*



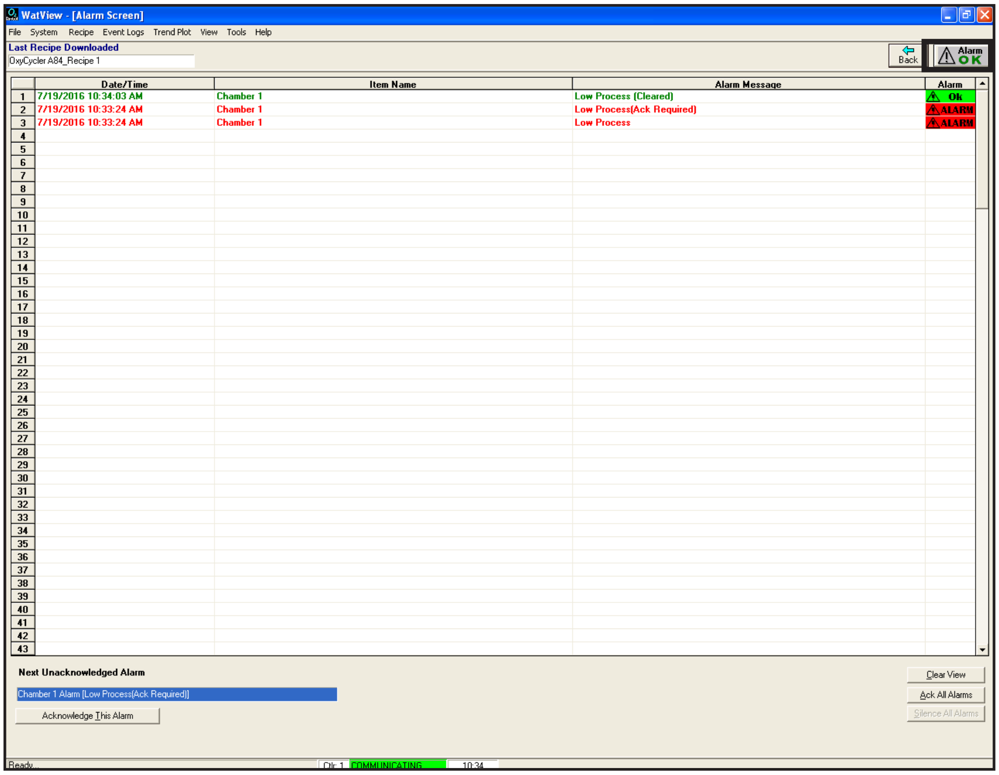
3. Click on **Clear View** in order to turn the red *Alarm* button off.



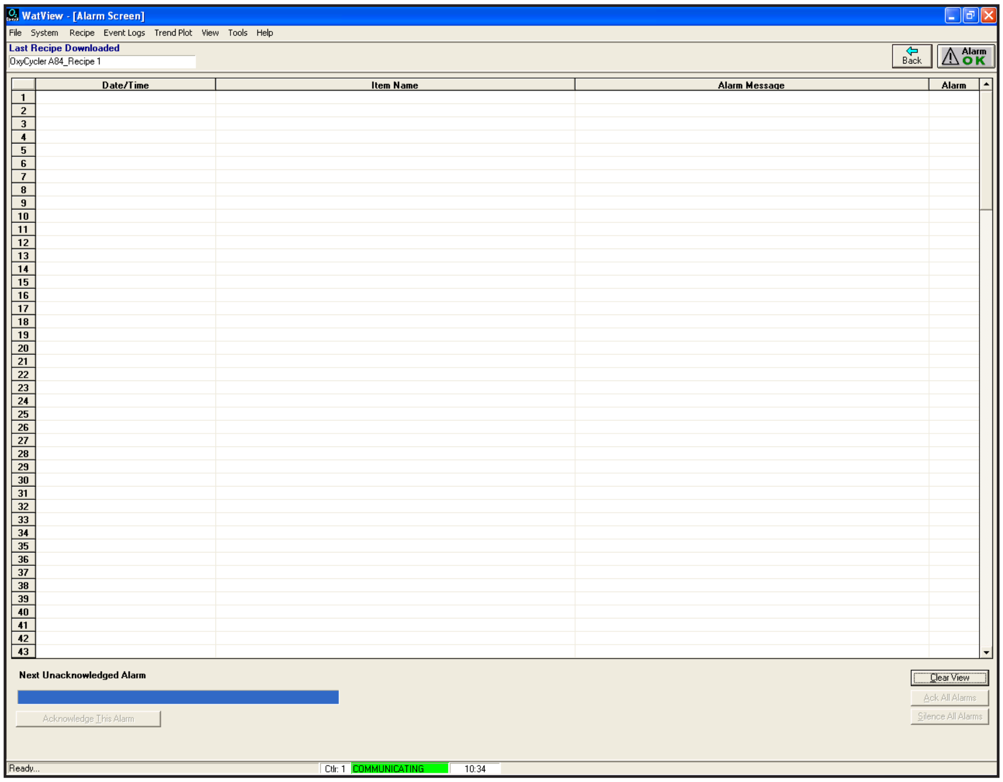
4. Once the alarm had been cleared, the red alarm button will turn back to its original state. The acknowledged alarms will remain in the *Alarm* screen until the problem has been corrected.

NOTE

If your alarm is activating inadvertently or unexpectedly then you may need to increase the tolerance. *Please refer to the System Preferences section for instructions on how to increase the tolerance.*

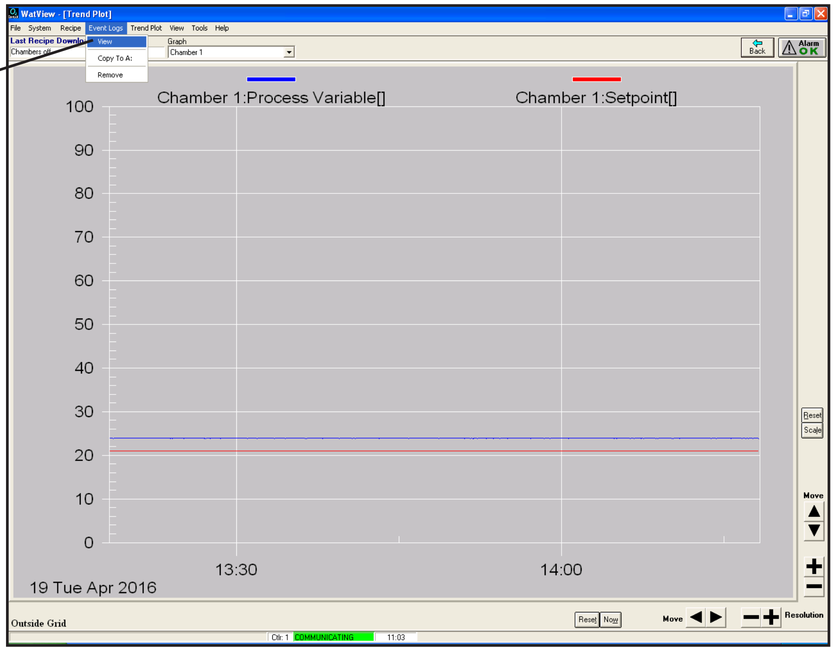


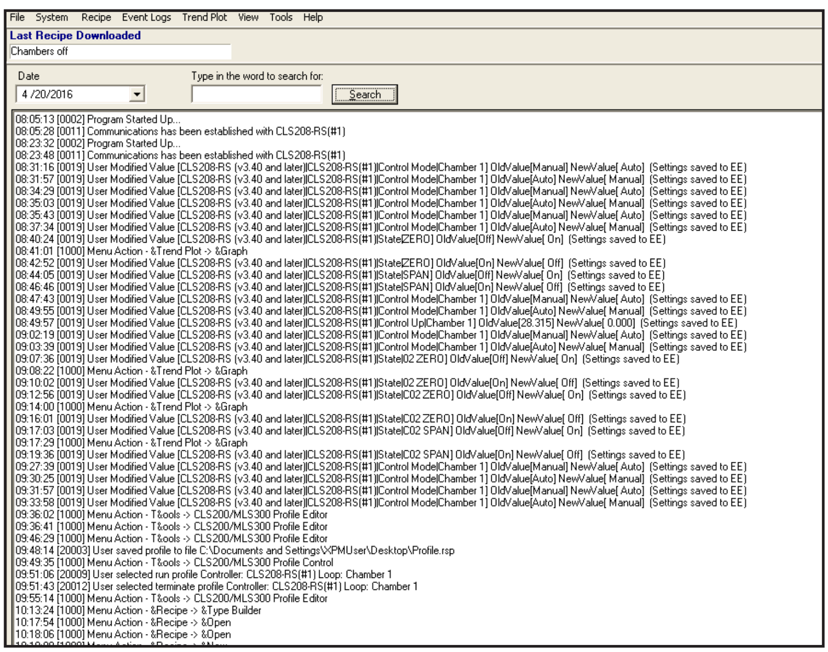
5. Once the problem has been addressed, click on **Clear View** to remove the alarms from the *Alarm* screen.



20 Event Log

The *Event Log* contains a record of user actions, alarms, recipe downloads and other events that occur while WatView is running. This text file can be viewed in WatView or a text editor by clicking on the **Event Log** tab and selecting **View**.





```
File System Recipe Event Logs Trend Plot View Tools Help
Last Recipe Downloaded
Chambers off
Date                 Type in the word to search for:
4 /20/2016                                            Search
08:05:13 [0002] Program Started Up...
08:05:28 [0011] Communications has been established with CLS208-RS(#1)
08:23:32 [0002] Program Started Up...
08:23:48 [0011] Communications has been established with CLS208-RS(#1)
08:31:16 [0019] User Modified Value [CLS208-RS (v3.40 and later)|CLS208-RS(#1)|Control Mode|Chamber 1] OldValue[Manual] NewValue[ Auto]  (Settings saved to EE)
08:31:57 [0019] User Modified Value [CLS208-RS (v3.40 and later)|CLS208-RS(#1)|Control Mode|Chamber 1] OldValue[Auto] NewValue[ Manual]  (Settings saved to EE)
08:34:29 [0019] User Modified Value [CLS208-RS (v3.40 and later)|CLS208-RS(#1)|Control Mode|Chamber 1] OldValue[Manual] NewValue[ Auto]  (Settings saved to EE)
08:35:03 [0019] User Modified Value [CLS208-RS (v3.40 and later)|CLS208-RS(#1)|Control Mode|Chamber 1] OldValue[Auto] NewValue[ Manual]  (Settings saved to EE)
08:35:43 [0019] User Modified Value [CLS208-RS (v3.40 and later)|CLS208-RS(#1)|Control Mode|Chamber 1] OldValue[Manual] NewValue[ Auto]  (Settings saved to EE)
08:37:34 [0019] User Modified Value [CLS208-RS (v3.40 and later)|CLS208-RS(#1)|Control Mode|Chamber 1] OldValue[Auto] NewValue[ Manual]  (Settings saved to EE)
08:40:24 [0019] User Modified Value [CLS208-RS (v3.40 and later)|CLS208-RS(#1)|State|ZERO] OldValue[Off] NewValue[ On]  (Settings saved to EE)
08:41:01 [1000] Menu Action - &Trend Plot -> &Graph
08:42:52 [0019] User Modified Value [CLS208-RS (v3.40 and later)|CLS208-RS(#1)|State|ZERO] OldValue[On] NewValue[ Off]  (Settings saved to EE)
08:44:05 [0019] User Modified Value [CLS208-RS (v3.40 and later)|CLS208-RS(#1)|State|SPAN] OldValue[Off] NewValue[ On]  (Settings saved to EE)
08:46:46 [0019] User Modified Value [CLS208-RS (v3.40 and later)|CLS208-RS(#1)|State|SPAN] OldValue[On] NewValue[ Off]  (Settings saved to EE)
08:47:43 [0019] User Modified Value [CLS208-RS (v3.40 and later)|CLS208-RS(#1)|Control Mode|Chamber 1] OldValue[Manual] NewValue[ Auto]  (Settings saved to EE)
08:49:55 [0019] User Modified Value [CLS208-RS (v3.40 and later)|CLS208-RS(#1)|Control Mode|Chamber 1] OldValue[Auto] NewValue[ Manual]  (Settings saved to EE)
08:49:57 [0019] User Modified Value [CLS208-RS (v3.40 and later)|CLS208-RS(#1)|Control Up|Chamber 1] OldValue[28.315] NewValue[ 0.000]  (Settings saved to EE)
09:02:19 [0019] User Modified Value [CLS208-RS (v3.40 and later)|CLS208-RS(#1)|Control Mode|Chamber 1] OldValue[Manual] NewValue[ Auto]  (Settings saved to EE)
09:03:39 [0019] User Modified Value [CLS208-RS (v3.40 and later)|CLS208-RS(#1)|Control Mode|Chamber 1] OldValue[Auto] NewValue[ Manual]  (Settings saved to EE)
09:07:36 [0019] User Modified Value [CLS208-RS (v3.40 and later)|CLS208-RS(#1)|State|02 ZERO] OldValue[Off] NewValue[ On]  (Settings saved to EE)
09:08:22 [1000] Menu Action - &Trend Plot -> &Graph
09:10:02 [0019] User Modified Value [CLS208-RS (v3.40 and later)|CLS208-RS(#1)|State|02 ZERO] OldValue[On] NewValue[ Off]  (Settings saved to EE)
09:12:56 [0019] User Modified Value [CLS208-RS (v3.40 and later)|CLS208-RS(#1)|State|C02 ZERO] OldValue[Off] NewValue[ On]  (Settings saved to EE)
09:14:00 [1000] Menu Action - &Trend Plot -> &Graph
09:16:01 [0019] User Modified Value [CLS208-RS (v3.40 and later)|CLS208-RS(#1)|State|C02 ZERO] OldValue[On] NewValue[ Off]  (Settings saved to EE)
09:17:03 [0019] User Modified Value [CLS208-RS (v3.40 and later)|CLS208-RS(#1)|State|C02 SPAN] OldValue[Off] NewValue[ On]  (Settings saved to EE)
09:17:29 [1000] Menu Action - &Trend Plot -> &Graph
09:19:36 [0019] User Modified Value [CLS208-RS (v3.40 and later)|CLS208-RS(#1)|State|C02 SPAN] OldValue[On] NewValue[ Off]  (Settings saved to EE)
09:27:39 [0019] User Modified Value [CLS208-RS (v3.40 and later)|CLS208-RS(#1)|Control Mode|Chamber 1] OldValue[Manual] NewValue[ Auto]  (Settings saved to EE)
09:30:25 [0019] User Modified Value [CLS208-RS (v3.40 and later)|CLS208-RS(#1)|Control Mode|Chamber 1] OldValue[Auto] NewValue[ Manual]  (Settings saved to EE)
09:31:57 [0019] User Modified Value [CLS208-RS (v3.40 and later)|CLS208-RS(#1)|Control Mode|Chamber 1] OldValue[Manual] NewValue[ Auto]  (Settings saved to EE)
09:33:58 [0019] User Modified Value [CLS208-RS (v3.40 and later)|CLS208-RS(#1)|Control Mode|Chamber 1] OldValue[Auto] NewValue[ Manual]  (Settings saved to EE)
09:36:02 [1000] Menu Action - T&ools -> CLS200/MLS300 Profile Editor
09:36:41 [1000] Menu Action - T&ools -> CLS200/MLS300 Profile Editor
09:46:29 [1000] Menu Action - T&ools -> CLS200/MLS300 Profile Editor
09:48:14 [20003] User saved profile to file C:\Documents and Settings\XPMUser\Desktop\Profile.rsp
09:49:35 [1000] Menu Action - T&ools -> CLS200/MLS300 Profile Control
09:51:06 [20009] User selected run profile Controller: CLS208-RS(#1) Loop: Chamber 1
09:51:43 [20012] User selected terminate profile Controller: CLS208-RS(#1) Loop: Chamber 1
09:55:14 [1000] Menu Action - T&ools -> CLS200/MLS300 Profile Editor
10:13:24 [1000] Menu Action - &Recipe -> &Type Builder
10:17:54 [1000] Menu Action - &Recipe -> &Open
10:18:06 [1000] Menu Action - &Recipe -> &Open
```

Event Log

21 Maintenance

This section will describe how to:

- **Remove/replace the oxygen sensor inside of the actuator pods**
- **Remove/replace the remote oxygen sensor**
- **Remove/replace actuator pods and monitor pod**
- **Check and re-calibrate the sensors**

WARNING

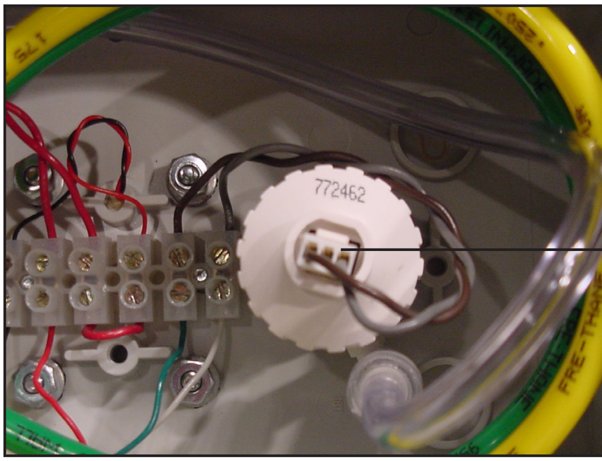
Safety goggles and neoprene gloves are recommended when handling oxygen sensors. The sensors are sealed, and under normal circumstances, the contents of the sensors do not present a health hazard. In case of a leak, respiratory protection and full protective clothing should be worn. The spill should be neutralized with soda ash or lime. Carefully place the material into a clean, dry container and cover; then flush the spill area with water.

Removing/Replacing the Oxygen Sensor Inside of an Actuator Pod:

1. Loosen the four plastic screws on the top of the actuator pod.

Actuator Pod

2. Inside the actuator pod there is a molex connector attached to the sensor. Remove this molex connector by pushing in the tab and pulling out the plug.



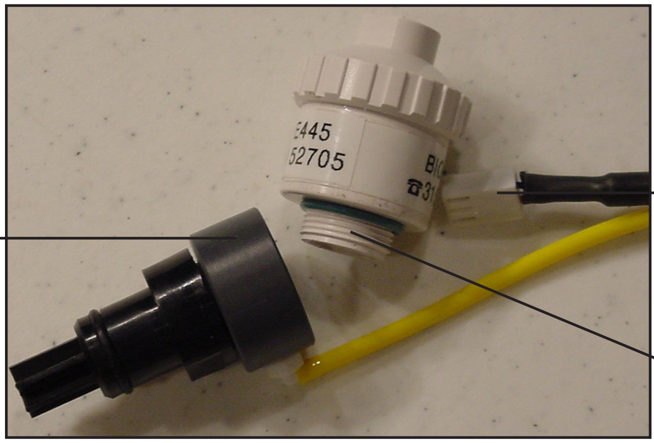
3. Unscrew the oxygen sensor.

> **NOTE**
>
> The BioSpherix, Ltd. phone number and model number are located on the sensor. Call this number to purchase a new sensor.

4. When the new sensor is received, screw it into the base until snug.
5. Plug the molex connector back in with the keyed end of the connector facing the tab.
6. Place the cover back on and screw down the plastic screws.

Removing/Replacing the Remote Oxygen Sensor Attached to a Monitor Pod:

1. Unplug the molex connector from the sensor by pushing in the tab and pulling out the plug.
2. Unscrew the oxygen sensor from its base.
3. The BioSpherix, Ltd. phone number and the model number are located on the sensor. Call this number to purchase a new sensor.



4. Once the new sensor arrives, screw the new sensor into the base.
5. Plug the molex connector back in with the keyed end of the connector facing the tab.

Sensor Disposal

Oxygen sensors should be disposed of in accordance with all applicable federal, state and local environmental regulations, with regards to lead or lead acetate.

WARNING

Please follow your manual instructions on routine calibration of your gas sensor(s). Please also follow your manual guidelines on routine replacement of your gas sensor(s) when they no longer hold calibration. The frequency of calibration and replacement of the gas sensors depends on the exposure levels that the sensors have been immersed in and the type of sensor(s) you are using.

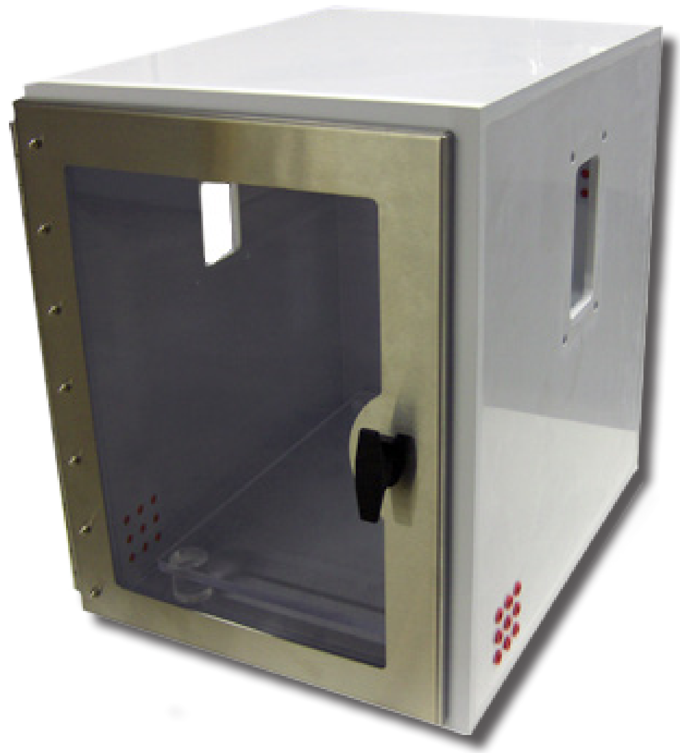
Checking the Calibration and Re-calibrating the Sensors:

1. Use the original calibration procedures to check the calibration of each sensor.
2. The calibration of the sensors should be checked at least once every two weeks.
3. Re-calibrate any sensors that are not accurate (using the original calibration procedures).

A-Chamber Manual

version 0.7 November 2015

This manual is intended to help our customers efficiently setup and operate the equipment. We encourage not only all installers, but also all users to read this manual thoroughly. Keep it handy and refer to it often. Save it for future reference. If you have any problems or questions, please do not hesitate to call. We are here to help.



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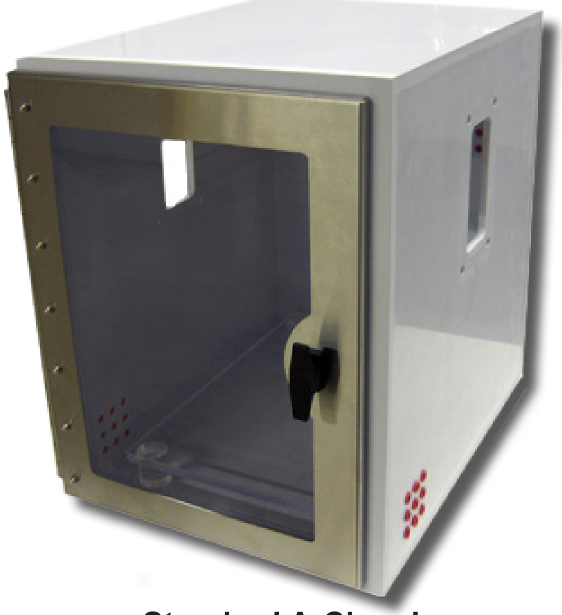
TOLL FREE US/CAN 800-441-3414
www.biospherix.com

! Anyone who has not thoroughly read and understood this manual must never attempt to operate the equipment. !

Table of Contents

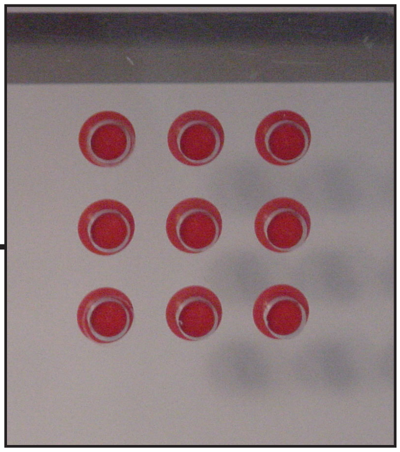
BioSpherix Supplied Parts



Standard A-Chamber
(Size and material may vary)

Plugs for vent holes

Riser



Plugs inside of vent holes

Installation

This section will describe how to install the A-Chamber

1. Place the A-Chamber on a level, secure surface. Make sure the door is facing outward for easy access.
2. Place the riser shelf inside of the chamber.
3. If the gases entering the chamber are air gases such as oxygen, nitrogen or carbon dioxide then the chamber does not need to be inside a fume hood. If the gases are exotic gases then the chamber will need to be inside of a fume hood.
4. It is important that two plugs from the set of holes in the front right, and two plugs from the set of holes in the back left are removed prior to operating the A-Chamber. This allows the gases inside of the chamber to circulate and also allows the off-gases to be released from the chamber. The number of plugs that are removed may need to be adjusted, however two from the front right and two from the back left is a sufficient starting point.

Maintenance

This section will describe how to maintain the A-Chamber.

Clean the inside of the chamber when necessary. Clean the entire chamber periodically, but do not use autoclave or other methods of high heat cleaning which would melt the plastic.

TOUCH KEY OPERATION

version 1.2 September 2015

This chapter consists of pages copied directly from the original generic manual for the cotroller (CLS). CLS is terminology for controller. All pertinent sections on operating the controller from the front panel touchkeys are included. However, as it's read, the controller manual assumed you wanted to control temperature, not oxygen. Therefore, you have to translate from temperature to oxygen. “Heat” means oxygen infusion. “Cool” means nitrogen infusion. There are many other temperature-to-oxygen conversions.

CONTENTS

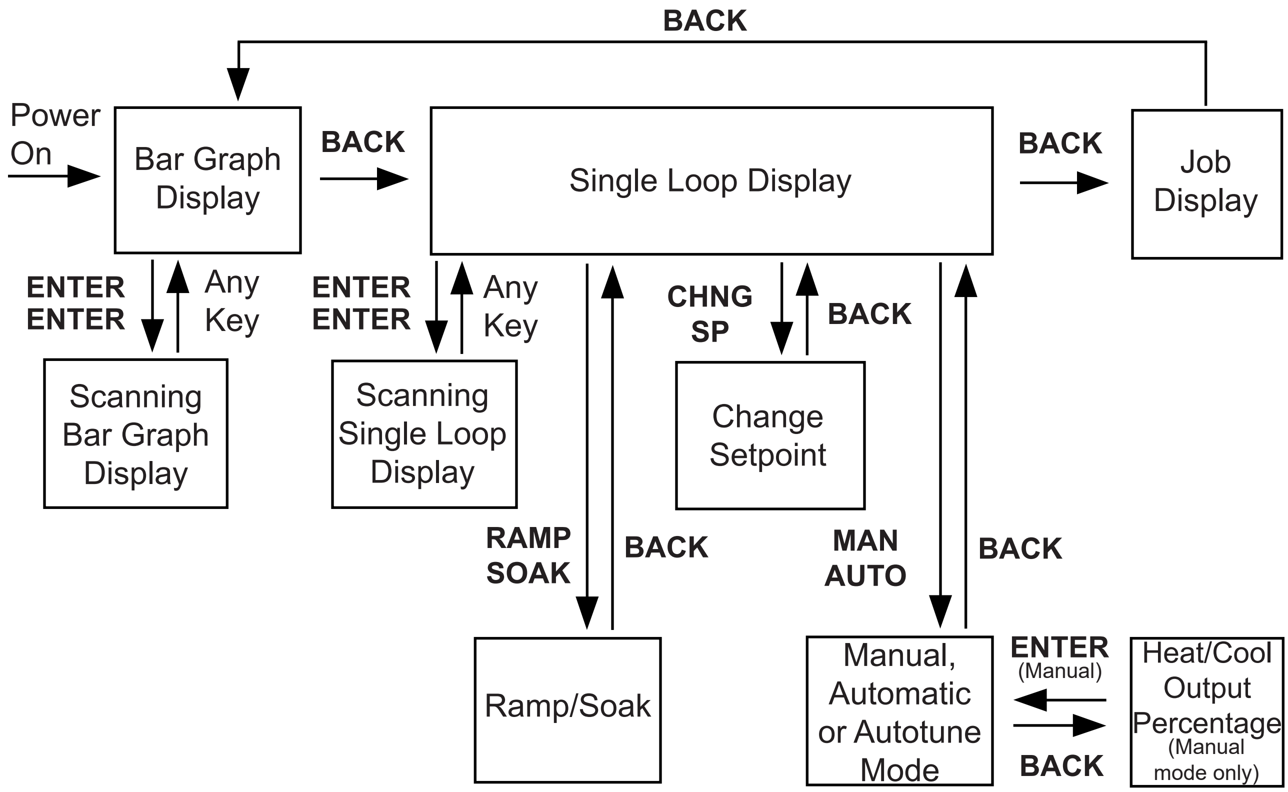
Using the CLS200 Series Controller

This chapter shows you how to use the CLS200 series controller from the front panel. If you re using AnaWin or ANASOFT, please see the related User's Guide.

This chapter covers the following topics:

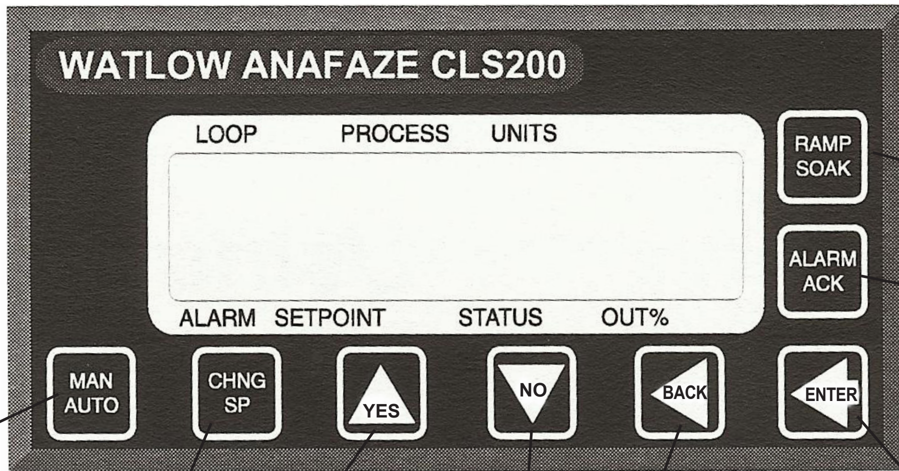
- Front Panel Operation
- Bar Graph Display
- Single Loop Display
- Job Display
- Alarms

The next diagram shows how to reach the operator menus from Single Loop display. (To change global parameters, loop inputs, control parameters, outputs, and alarms from the setup menus, you must enter a special sequence of keys. To learn how, see the next chapter: *Setup*.)



Front Panel

The front panel provides a convenient interlace with the controller. You can program and operate the controller with the front panel keys shown below, or you can use AnaWin or ANASOFT to directly interface with the controller.



RAMP SOAK
- Assigns and monitors profiles

ALARM ACK
- Acknowledges alarms

MAN/AUTO
- Changes loop output control from automatic to manual or tune
- Assigns output power level of manual loops

CHNG SP
- changes process setpoint

YES
- Selects a menu or parameter
- Answers YES to YES/NO prompts
- Increases a value or choice

NO
- Skips a menu or parameter
- Answers NO to YES/NO prompts
- Decreases a value or choice

BACK
- Cancels editing and returns to a previous menu

ENTER
- Stores data or settings and advances to the next parameter
- Starts scanning mode (if pressed twice)

Front Panel Keys

YES (up)

Press **YES** to:
- Select a menu or parameter
- Answer **YES** to the flashing ? prompts
- Increase a value or choice when editing
- Stop scanning mode

NO (down)

Press **NO** to:
- Skip a menu or parameter when the prompt is blinking
- Answer **NO** to the flashing ? prompts
- Decrease a value or choice when editing
- Stop scanning mode
- Perform a **NO**-key reset

NOTE!

Pressing the NO key on power up performs a NO-key reset. This procedure clears the RAM and sets the controller's parameters to their default values. See NO-Key Reset on page XX.

BACK

Press **BACK** to:
- Cancel editing
- Return to a previous menu
- Switch between bar graph, single loop and job displays
- Stop scanning mode

ENTER

Press **ENTER** to:
- Store data or a parameter choice after editing and go to the next parameter.
- Start scanning mode (if pressed twice)

CHNG SP

Press **CHNG SP** to change the loop setpoint

MAN AUTO

Press MAN/AUTO to:
- Toggle a loop between manual and automatic control
- Adjust the output power level of manual loops
- Automatically tune the loop

RAMP SOAK

If your controller has the ramp/soak option, press **RAMP/SOAK** to:
- Assign a ramp/soak profile to the current loop
- Select the ramp/soak mode
- See the status of a running profile

Your controller may not have the ramp/soak option. If it does not, pressing the **RAMP/SOAK** key displays the message:

ALARM ACK

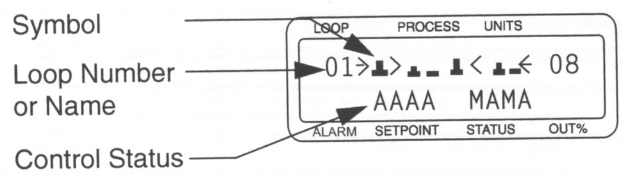
Press **ALARM ACK** to:
- Acknowledge an alarm condition
- Reset the global alarm output

Displays

This section discusses the controller's main displays: Bar Graph, Single Loop and Job.

Bar Graph Display

On power up, the controller displays general symbolic information for up to eight loops. This screen is called the bar graph display. The diagram below shows the symbols used in the bar graph display.



The next table explains the symbols you see on the top line of the Bar Graph display. These symbols appear when the controller is in dual output mode (heat and cool outputs enabled) and single output mode (heat or cool outputs enabled, but not both).

Symbol	Symbol's Meaning
<	Loop is in low process or low deviation alarm.
>	Loop is in high process or high deviation alarm.
	Loop is above setpoint. If you enable the high or low deviation alarm, this symbol is scaled to it. If you don't enable these alarms, these symbols are scaled to the setpoint +5% of the sensor's range.
	Loop is at setpoint. If you enable the high or low deviation alarm, this symbol is scaled to it. If you don't enable these alarms, these symbols are scaled to the setpoint +5% of the sensor's range.
	Loop is below setpoint. If you enable the high or low deviation alarm, this symbol is scaled to it. If you don't enable these alarms, these symbols are scaled to the setpoint +5% of the sensor's range.
(Blank)	Loop is set to SKIP.
F	Sensor has failed.
O	Open RTD
S	Shorted T/C or RTD
B	Broken T/C
R	Reversed T/C

The next table explains the symbols you see on the bottom line of the Bar Graph display. These symbols appear when the controller is in both dual output mode and single output mode. If an alarm occurs, the controller automatically switches to Single Loop display and shows an alarm code.

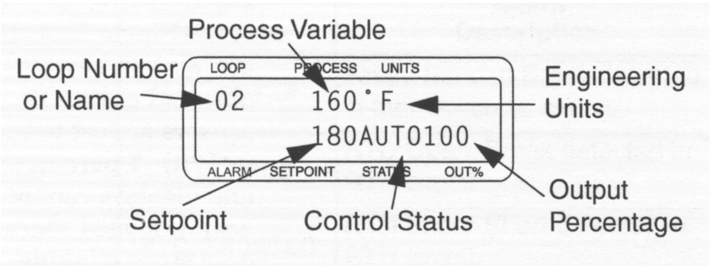
Symbol	Symbol's Meaning
M	One or both outputs enabled. Loop is in manual control.
A	Only one output (heat or cool, but not both) is enabled. Loop is in automatic control.
T	Loop is in Autotune mode.
H T	Both heat and cool outputs are enabled. Loop is in Automatic control and heating.
C L	Both heat and cool outputs are enabled. Loop is in Automatic control and heating.
(Blank)	Loop is set to SKIP.

Navigating in Bar Graph Display:

- Press **YES** (up) or **NO** (down) to see Bar Graph Display for remaining loops.
- Press **ENTER** twice to start Bar Graph scanning mode. In scanning mode, the controller alternately shows each bar graph display.
- Press any key to stop scanning mode.
- From Bar Graph Display, press **BACK** once to go to Single Loop display.

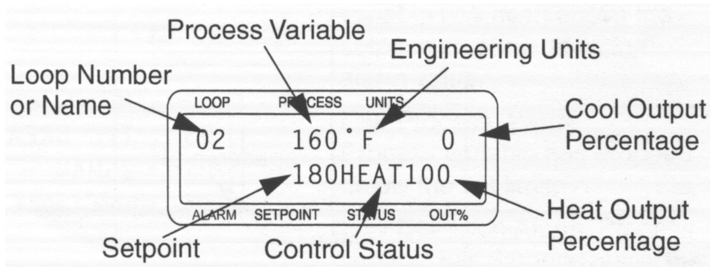
Single Loop Display

Single Loop display (below) shows detailed information for one loop at a time. The Single Loop display is shown below:



The control status indicator shows MAN, AUTO or TUNE modes.

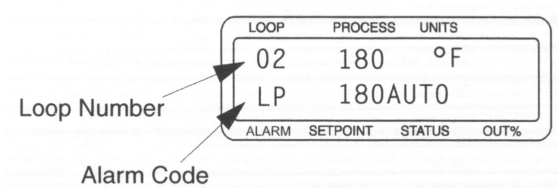
An alternate Single Loop display (below) shows HEAT or COOL if the loop is in automatic control and both outputs are enabled:



From Single Loop Display:
- Press **YES** to go to the next loop.
- Press **NO** to go to the previous loop.
- Press the **BACK** key once to go to Job display (if enabled) or Bar Graph display.
- Press **ENTER** twice to start single loop scanning display. (The single loop scanning display show information for each loop in sequence. Data for each loop displays for one second.)
- Press any key to stop scanning mode.

Alarms

If an alarm occurs, a two-character alarm code appears in the lower left corner of the display (below). If a Failed Sensor alarm occurs, the controller also displays a short alarm



message:

These alarm codes and messages are shown in the table below.

Symbol	Alarm Message	Alarm Type
FS	Failed T/C	Thermocouple Break
RO	RTD Open	RTD Break
RS	RTD Shorted	RTD Short
RT	Reversed T/C	
ST	T/C Shorted	T/C Short
HP	No Message	High Process Alarm
HD	No Message	High Deviation Alarm
LD	No Message	Low Deviation Alarm
LP	No Message	Low Process Alarm

Acknowledging An Alarm:

If an alarm occurs, the controller switches to Single Loop Display.

Press ALARM ACK to acknowledge the alarm. If there are other loops with alarm conditions, the Alarm display switches to the next loop in alarm. Acknowledge all alarms to clear the global alarm digital output. (You must acknowledge each alarm before displays and keyboard operation will resume.)

NOTE!

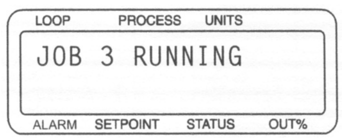
In the CLS204 and CLS208, the controller cannot detect all RTD open and RTD short failures. Detection of open or shorted RTDs depend on which wires are open or shorted.

Job Display

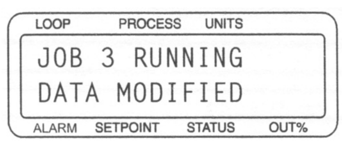
Job display appears only if either:

- You have turned on the Job Select digital inputs.
- You have selected a job from the job load menu.

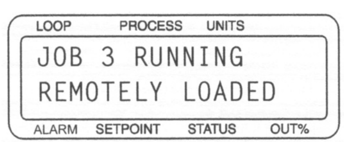
When you load a job, the following screen is displayed:



If you loaded the job using digital inputs, the controller displays the following screen:



If you modify a job's parameters while the job is running, you'll see this job message:

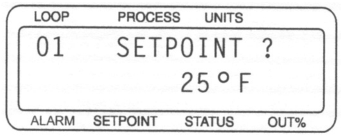


Operator Menus

You can reach the following operator menus from single loop display.

Change Setpoint

To change the setpoint, go to single loop display of the loop you wish to change, and then press the change setpoint key. You should see a display like this:



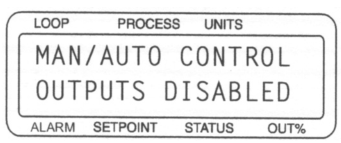
- Press **YES** to change the setpoint.
- The press **YES** or **NO** to change the setpoint value.
- When you are satisfied with the setpoint value you have chosen, press **ENTER** to save your changes and return to Single Loop Display; or
- To return to Single Loop Display without saving your changes, press **NO** or **BACK**.

Manual/Automatic Control

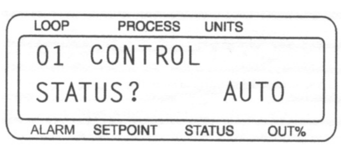
Press the **MAN/AUTO** key to set a loop's control mode, set manual output levels, or automatically tune a loop. The control mode determines whether the controller automatically controls the process according to the configuration information you give it (Automatic control), or you set the output to a constant level (Manual control).

In the third mode, tune, the controller ramps toward a setpoint and attempts to set the best PID parameters for automatic control.

If both heat and cool output are disabled when you press the **MAN/AUTO** key, you'll see the following display:



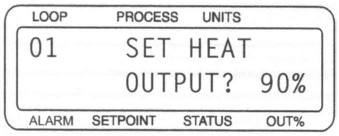
Press any key to exit this display. If at least one control output (heat or cool) is enabled, you'll see the following display:



- Press **YES** to change the mode.
- Press **YES** or **NO** to switch between Manual, Automatic, and Tune.
- To exit this menu and return to the Single Loop Display without saving your changes, press **BACK**.
- Press **ENTER** to save your changes. If you have set the mode to Manual, you can set the manual heat or cool output level.

Manual Output Levels:

The Manual Output Levels menu only appears if you have set the current loop to Manual control. This menu lets you set the manual output levels for the enabled outputs. The cool output menu is just like the heat output menu, except that the word COOL replaces the word HEAT in the display. You should see a display like the one below:



- Press **YES** to change the output power.
- The press **YES** or **NO** to select a new output power level.
- When you are satisfied with the power level you have chosen, press **ENTER** to store your changes. The output is immediately set at the value you have entered.
- To discard your changes and return to Single Loop display, press **BACK**.

Autotune:

If you set the current loop's control status to tune and press **ENTER**, the controller automatically sets the loop to 100% output. (If you selected a continuous output limit, the controller sets the loop to the output limit.) The autotune function then calculates the appropriate PID constants for the loop and puts the loop in automatic control with the calculated PID values.

The Autotune function will abort if:

- Process variable goes over 75% of the setpoint. Remember, the controller is at 100% output or at the output limit you set.
- It has not calculated PID constants after 10 minutes (due to heater failure, sensor failure, etc.).

If the autotune function aborts, it puts the loop into its previous control state (Automatic control or Manual control at the previous output percentages).

To automatically tune a loop, follow these steps:

1. Make sure the process is cold (or stable and well below setpoint).
2. Initiate Autotune:
   a. Use the front panel keypad to go to Single Loop Display.
   b. Press the **MAN/AUTO** key.
   c. Choose tune.
   d. Press **ENTER**.

The tune indicator flashes and the controller goes back to Single Loop Display. The tune indicator flashes as long as the loop is tuning.

Ramp/Soak

If you have a controller without the Ramp/Soak option, pressing the Ramp/Soak key has no effect. If you have a controller with the Ramp/Soak installed, please refer to the Ramp/Soak Appendix at the end of this manual.

Setup

The setup menus let you change the controller's detailed configuration information. This section describes how to setup the controller from menus in the controller firmware.

This chapter covers the following topics:

- Accessing the Setup Menus
- Changing Menu Items
- Description of Controller Parameters

NOTE!

If you have not set up a CLS200 series controller before, or if you don't know what values to enter, please read the *Tuning and Control* chapter, which contains PID tuning constants and useful starting values.

How to Access the Setup Menus

1. Select the Single Loop Display for the loop you wish to edit.
2. Enter the three-key sequence: ENTER, ALARM ACK, CHNG SP to access the setup menus.

3. The first setup menu appears.

NOTE!
To prevent unauthorized personnel from accessing setup parameters, the controller reverts to Single Loop Display if you don't press any keys for three minutes.

How to Change a Menu Item

When you enter the setup menus, you see the name of the first menu displayed, "Setup Global Parameters". Press YES to use the current menu or NO to move to the next menu group.

- Press YES to select this menu or NO to advance to the next menu.
- Press YES or NO to see the selection on a menu.
- Press ENTER to store the value you have selected.
- If you decide not to edit the menu, press Back to stop editing and return to the main menu.

Each display contains the default value for that specific menu, and below each display you will see the range of choices for that menu.

The following sections tell more about the submenus for each of the six main menus. If you have a controller with the Ramp/Soak option, there will also be a Ramp/Soak menu. (Please refer to the Ramp/Soak documentation included with your controller for instructions on use.) The next page show the setup menus accessible from Single Loop Display.

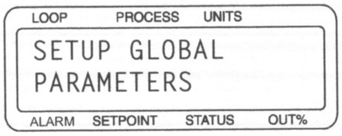
CLS200 Series Menu Structure

SETUP GLOBAL PARAMETERS	SETUP LOOP INPUT?	SETUP LOOP CONTROL PARAMS?	SETUP LOOP OUTPUTS?	SETUP LOOP ALARMS?	MANUAL I/O TEST
LOAD SETUP FROM JOB?	INPUT TYPE?	HEAT CONTROL PB?	HEAT CONTROL OUTPUT?	HI PROC ALARM SETPT?	DIGITAL INPUTS
SAVE SETUP TO JOB?	LOOP NAME?	HEAT CONTROL TI?	HEAT CONTROL TYPE?	HI PROC ALARM TYPE?	TEST DIGITAL OUTPUT?
JOB SELECT DIG INPUTS?	INPUT UNITS?	HEAT CONTROL TD?	HEAT OUTPUT CYCLE TIME? (**TP**)	HI PROC ALARM OUTPUT?	DIGITAL OUTPUT NUMBER XX
JOB SEL DIG INS ACTIVE?	INPUT READING OFFSET?	HEAT CONTROL FILTER?	SDAC PARAMETERS (**SDAC**)	DEV ALARM VALUE?	KEYPAD TEST
OUTPUT OVERRIDE DIG INPUT?	REVERSED T/C DETECT?	COOL CONTROL PB?	HEAT OUTPUT ACTION?	HI DEV ALARM TYPE?	DISPLAY TEST
OVERRIDE DIG IN ACTIVE?	INPUT PULSE SAMPLE TIME? (**Pulse Input**)	COOL CONTROL TI?	HEAT OUTPUT LIMIT?	HI DEV ALARM OUTPUT?	
STARTUP ALARM DELAY?	DISP FORMAT? **(Linear and Pulse)**	COOL CONTROL TD?	HEAT OUTPUT LIMIT TIME?	LO DEV ALARM TYPE?	
RAMP/SOAK TIME BASE? (**Ramp/Soak**)	INPUT SCALING HI PV? (**Linear and Pulse**)	COOL CONTROL FILTER?	SENSOR FAIL HT OUTPUT?	LO DEV ALARM OUTPUT?	
KEYBOARD LOCK STATUS?	INPUT SCALING HI RDG? (**Linear and Pulse**)	SPREAD?	HEAT T/C BRK OUT AVG?	LO PROC ALARM SETPT?	
POWER UP OUTPUT STATUS?	INPUT SCALING LO PV? (**Linear and Pulse**)	RESTORE PID DIGIN?	HEAT OUTPUT?	LO PROC ALARM TYPE?	
PROCESS POWER DIGIN?	INPUT SCALING LO RDG? (**Linear and Pulse**)		COOL CONTROL OUTPUT?	LO PROC ALARM OUTPUT?	
CONTROLLER ADDRESS?	INPUT FILTER		COOL OUTPUT TYPE?	ALARM DEADBAND?	
COMMUNICATIONS BAUD RATE?			COOL OUTPUT CYCLE TIME? (**TP**)	ALARM DELAY?	
COMMUNICATIONS PROTOCOL?			SDAC PARAMETERS (**SDAC**)		
COMMUNICATIONS ERR CHECK?			COOL OUTPUT ACTION?		
AC LINE FREQ?			COOL OUTPUT LIMIT?		
DIG OUT POLARITY ON ALARM?			COOL OUTPUT LIMIT TIME?		
CLS200 (FIRMWARE INFO)			SENSOR FAIL CL OUTPUT?		
			COOL T/C BRK OUT AVG?		
			COOL OUTPUT		

• If Ramp/Soak or the Enhanced Features Option are installed, refer to their respective appendices for specific menu structures for those options.

Setup Global Parameters Menu

The Setup Global Parameters menu looks like this:



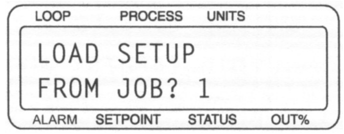
Below is the setup global parameters menu tree. Notice the default values:

Parameter	Default Value
LOAD SETUP FROM JOB?	1
SAVE SETUP TO JOB?	1
JOB SELECT DIG INPUTS?	NONE
JOB SEL DIG INS ACTIVE?	LOW
OUTPUT OVERRIDE DIG INPUT?	NONE
OVERRID DIG IN ACTIVE?	LOW
STARTUP ALARM DELAY?	0 MINS
RAMP/SOAK TIME BASE?*	HOURS/MINS
KEYBOARD LOCK STATUS?	OFF
POWER UP OUTPUT STATUS?	OFF
PROCESS POWER DIGIN?	NONE
CONTROLLER ADDRESS?	1
COMMUNICATIONS BAUD RATE?	9600
COMMUNICATION PROTOCOL?	ANA
COMMUNICATION ERR CHECK?	BCC
AC LINE FREQ?	60 HERTZ
DIG OUT POLARITY ON ALARM?	LOW
CLS200 (model no., firmware rev.)	

* The RAMP/SOAK TIME BASE parameter appears only if the ramp/soak feature is installed.

Load Setup From Job

Use this menu to load any one of 8 jobs saved in battery backed RAM from the controller's front panel.



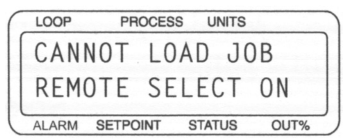
The following parameters are loaded as part of a job:

- PID constants, filter settings, setpoints and spread values.
- Loop control status (Automatic or Manual) and output values (if the loop is in Manual control).
- Alarm functions (Off, Alarm, Control), setpoints, high/low process setpoints, high/low deviation setpoints and deadband settings, and loop alarm delay.
- Ramp/Soak profile and status (Start, Run).

WARNING!

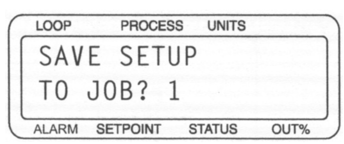
All current job settings are overwritten when you select a job from memory. Save your current settings to another job number if you want to keep them.

If you have enabled the remote job select function, this menu is disabled; you cannot load a job from the front panel. If you try it, you see the message below:

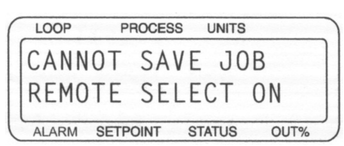


Save Setup To Job

Use this menu to save the job information for every loop to one of 8 jobs in the controller's battery-backed RAM.

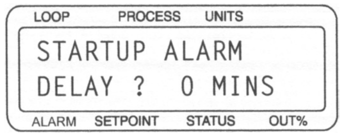


If you have enabled the remote job control function, you cannot save a job. If you try it, you see this message:



Start-up Alarm Delay

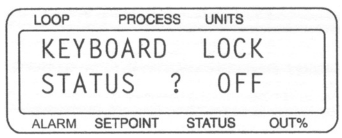
Use this menu to set a start-up delay for process and deviation alarms for all loops. The controller does not report these alarm conditions for the specified number of minutes after the controller powers up. This feature does not delay failed sensor alarms.



Selectable values: 0-60 minutes.

Keyboard Lock Status

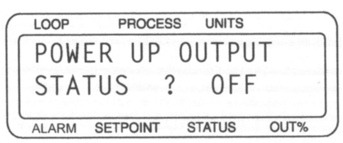
Use this menu to lock the front panel operator function keys Change SP, Man/Auto, and Ramp/Soak so that pressing these keys has no effect. If you want to use these functions, turn off the Keyboard Lock.



Selectable values: On or Off.

Power-up Output Status

Use this menu to set the initial power-up state of the control outputs. If you choose Off, all control outputs are initially set to Manual mode at 0% output level. If you choose Memory, the outputs are restored to the last output state stored in memory.



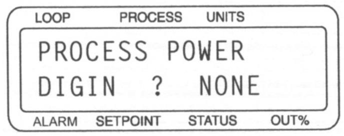
WARNING!

Do not set the controller to start from memory if it is unsafe for your process to have outputs on upon power-up.

Selectable values: Off or Memory.

Process Power Dig In

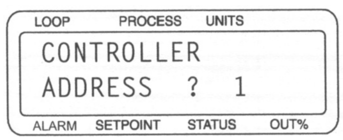
Use this menu to select one of the digital inputs for notifying the controller that the process power is on when a T/C short is detected. Select a single input (1 to 8). Selecting an input enables the shorted T/C detection. When the controller determines that there is a T/C short, the loop is set to manual mode at the power level set from the Sensor Fail Output screen in the Setup Loop Outputs menu. The controller must know the process power (e.g. heater power) is on to detect a T/C short. A T/C short is detected when the process power is on and the temperature doesn't rise as expected.



Selectable values: 1-8, or NONE.

Controller Address

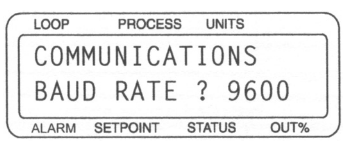
Use this menu to set the controller's address. The controller address is used for multiple controller communications. On a 485 communication loop, each controller must have a unique address. Begin with address 1 for the first controller and assign each subsequent controller the next higher address.



Selectable values: 1-32 for ModBus protocol, 1-16 for A/B and Anafaze protocols.

Communications Baud Rate

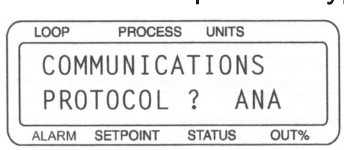
Use this menu to set the communications baud rate.



Selectable values: 2400 or 9600.

Communications Protocol

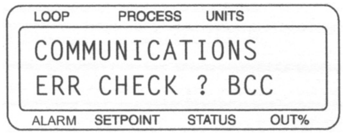
Use this menu to set the communications protocol type.



Selectable values: ANA (Watlow Anafaze's protocol), AB (Allen Bradley's), MOD (Modbus).

Communications Error Checking

This menu appears only when you choose ANA or AB as your communications protocol. Use it to set the data check algorithm used in CLS200 communications to Block Check Character (BCC) or to Cyclic Redundancy Check (CRC).



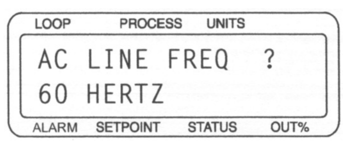
Selectable values: BCC or CRC.

CRC is a more secure error checking algorithm than BCC, but it requires more calculation time and slows the CLS200 communications. BCC ensures a high degree of communications integrity, so Watlow Anafaze recommends that you use BCC unless your application specifically requires CRC.

NOTE!
If you are using ANASOFT, be sure to configure it with ANAINSTL for the same Error Checking method and the same Baud Rate that you set in the controller.

AC Line Frequency

Use this menu to configure the controller to match the AC line frequency. This function is provided for international users who use 50Hz power. Since the controller reduces the effect of power line noise on the analog measurement by integrating the signal over the period of the AC line frequency, the controller must know the frequency of power in use.

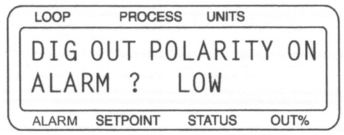


Selectable values: 50Hz or 60Hz.

NOTE!
You must switch power to the controller off and on for a change in AC line frequency to take effect.

Digital Output Polarity

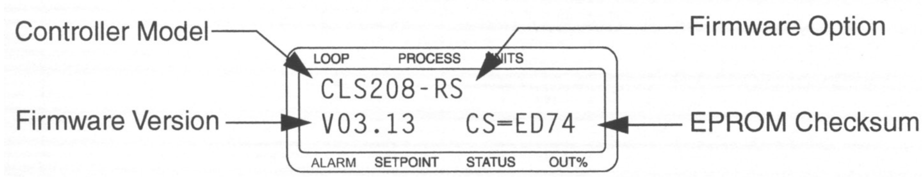
Use this menu to set the polarity of the digital outputs used for alarms. When the default, low, is selected and an alarm occurs, the output sinks to analog common. When set to high, the outputs sink to common when no alarm is active and go high when an alarm occurs.



Selectable values: High or Low.

EPROM Information

This is a view-only display. It shows the controller's EPROM version, firmware options and checksum.



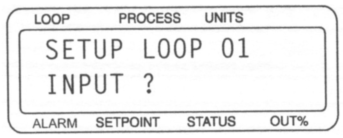
Press any key to return to the Setup Global Parameters menu.

Setup Loop Input

The Setup Loop Input main menu lets you access menus which change parameters related to the loop input:

- Input type
- Input units
- Input scaling and calibration
- Input filtering

The next section explains how to use the Input menus to configure your controller.



Below is the setup inputs menu tree. Notice the default values.

Parameter	Default Value
INPUT TYPE?	J
LOOP NAME?	01
INPUT UNITS?	°F
INPUT READING OFFSET?	0° F
REVERSED T/C DETECT?[3]	OFF
INPUT PULSE SAMPLE TIME?[1]	1
DISP FORMAT?[2]	-999 TO 3000
INPUT SCALING HI PV?[2]	1000
INPUT SCALING HI RDG?[2]	100.0% FS
INPUT SCALING LO PV?[2]	0
INPUT SCALING LO RDG?[2]	0.0% FS
INPUT FILTER?	3 SCANS

[1] This parameter is available only for the pulse loop (loop 5 on CLS204, loop 9 on CLS208, loop 17 on CLS216).

[2] These parameters are available only if LINEAR is selected for INPUT TYPE.

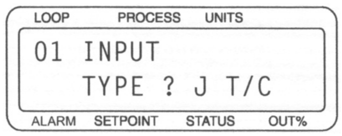
[3] This parameter is available only if INPUT TYPE is set to one of the thermocouple or RTD options.

Input Type

Use this menu to configure the input sensor for each loop as one of these input types:

- Thermocouple types (J, K, T, S, R, B and E).
- RTD (CLS204 and CLS208). Two ranges: RTD1 (Platinum Class A) and RTD2 (Platinum Class B).
- Linear inputs.
- Skip (an input type available for unused channels). The scanning display doesn't show loops you've set to Skip.

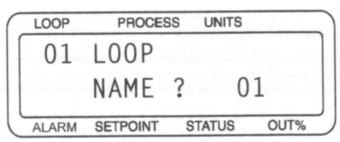
The following tables show the input types and ranges.



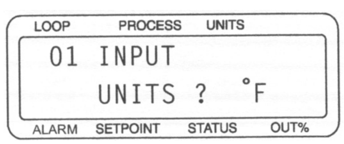
Loop Name

Use this menu to name your loop using two-characters. After specifying a new name, it is shown on the single loop display instead of the loop's number.

Input Units



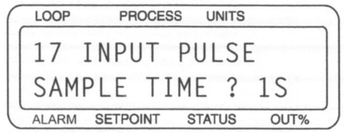
Use this menu to choose a three-character description of the loop's engineering units. Selectable values: The table below shows the character set for input units.



Input	Character Sets for Units
Thermocouple, and RTD	°F or °C
Linear and Pulse	0 to 9, A to Z, %, /, degrees, space

Pulse Sample Time

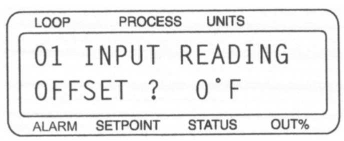
You can connect a digital pulse signal of up to 2 KHz to the controller's pulse input. In this menu, you specify the pulse sample period. Every sample period, the number of pulses the controller receives is divided by the sample time. The controller scales this number and uses it as the pulse loop's process variable.



Selectable range: 1-20 seconds.

Input Reading Offset

This menu does not appear if the input type is linear, pulse, or skip. Use it to make up for the input signal's inaccuracy at any given point. For example, at temperatures below 400°F, a type J thermocouple may be inaccurate ("offset") by several degrees F. Use an independent thermocouple or your own calibration equipment to find the offset for your equipment. To correct for offset errors, change the factory default setting to a positive or negative value for the loop you are editing. (A positive value increases the reading and a negative value decreases it.)

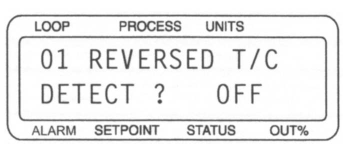


Selectable range: For thermocouples and RTD2s, the offset correction ranges from -300 to +300.

For RTD1 the offset range is -300.0 to +300.0.

Reversed T/C Detection

This selection detects when the polarity of the thermocouple is reversed. If a reversed T/C alarm occurs, the controller sets the loop to Manual control at the sensor fail output power level and displays the alarm.



Selectable range: ON or OFF.

Linear Scaling Menus

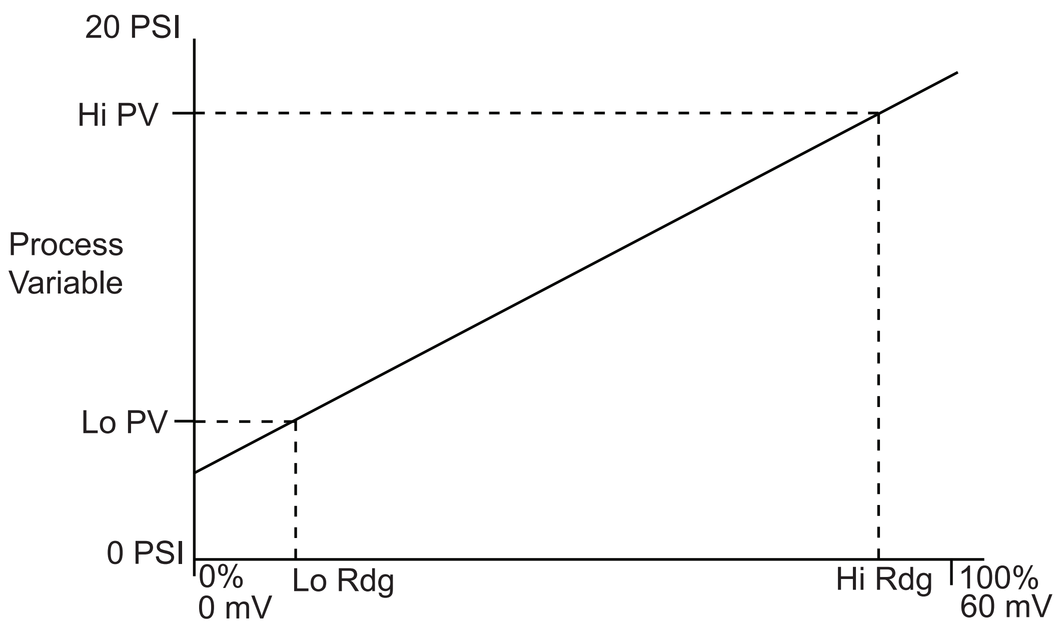
The linear scaling menus appear under the Setup Loop Inputs main menu. It lets you scale the “raw” input readings (readings in millivolts or Hertz) to the engineering units of the process variable.

NOTE!

Linear scaling menus appear only if the loop’s input type is set to Linear (or, for some menus, to Pulse). Linear scaling is available for linear and pulse inputs only.

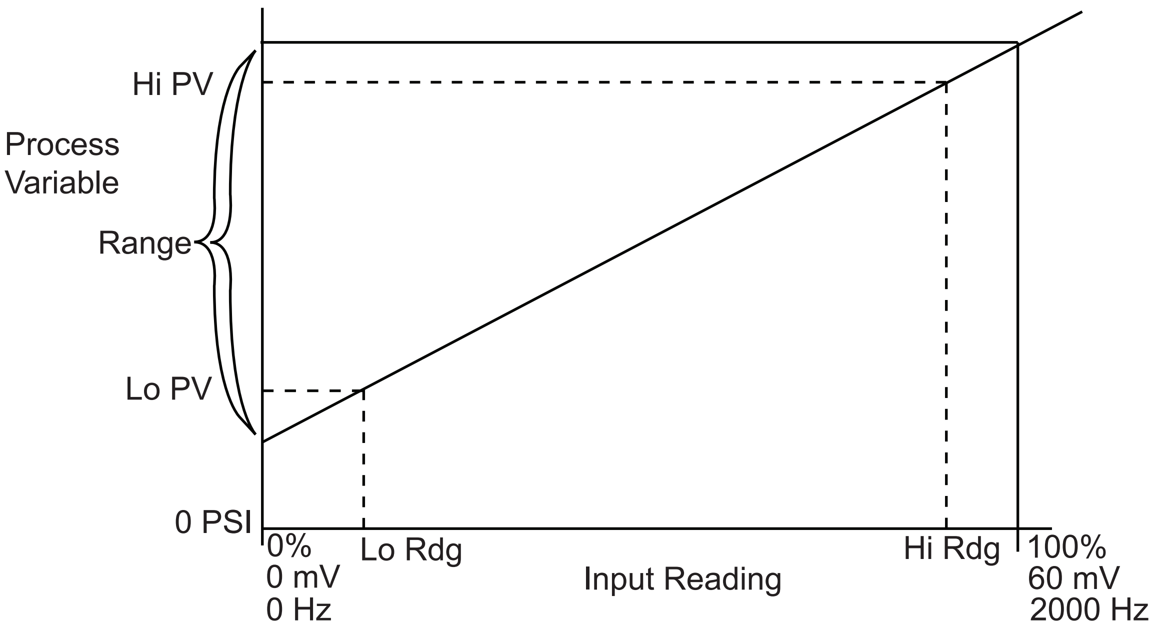
For linear inputs, the input reading is in percent (0 to 100%) representing the 0-60 mV input range of the controller. For pulse inputs, the input reading is in Hertz (cycles per second).

The scaling function is defined by two points on a conversion line. This line relates the PV to the input signal. The engineering units of the process variable can be any arbitrary units. The graph below shows PSI as an example.



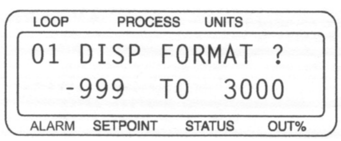
Before you enter the value determining the two points for the conversion line, you must choose an appropriate display format. The controller has six characters available for process variable display; select the setting with the desired number of decimal places. Use a display format that matches the range of the process variable and resolution of the sensor. The display format you choose is used for the setpoint, alarms, deadband, spread, and proportional band.

The PV (Process Variable) range for the scaled input is between the PV values that correspond to the 0% and 100% input readings. For the pulse input, it is between the 0 Hz and 2000 Hz readings. This PV range defines the limits for the setpoint and alarms, as shown here.



Display Format

This menu lets you select a display format for a linear input. Choose a format appropriate for your input range and sensor accuracy. You only see the Display Format menu when editing a linear input.

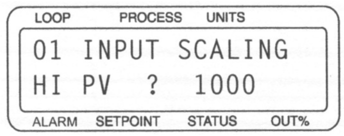


Selectable values: The controller has several available display formats, as shown below. This table also shows the high and low PV values.

Display Format	Default High PV	Default High PV
-9999 to +30000	10000	0
-999 to +3000	1000	0
-999.9 to +3000.0	1000.0	.0
-99.99 to +300.00	100.00	.00
-9.999 to +30.000	10.000	.000
-.9999 to +3.0000	1.0000	.0000

High Process Variable

Use this menu to enter a high process value. The high process value and the high reading value together define one of the points on the linear scaling function's conversion line. Set this menu to the value you want displayed when the signal is at the level set in the High Reading menu.

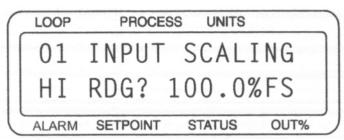


Selectable values: See table on the previous page.

High Reading

Use this menu to enter the input signal level that corresponds to the high process value you entered in the previous menu. For linear inputs, the high reading is a percentage of the full scale input range. For pulse inputs, the high reading is expressed in Hz.

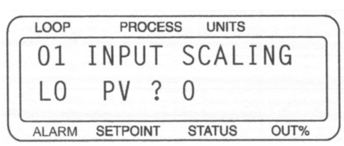
The 100% full scale input value is 60 mV for the linear input type, and 2000 Hz for pulse input type.



Selectable range: Any value between -99.9 and 999.9%. However, you cannot set the high reading to a value less than or equal to the low reading.

Low Process Value

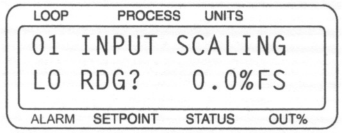
Use this menu to set a low process value for input scaling purposes. The low process value and the low reading value together define one of the points on the linear scaling function's conversion line. Set this menu to the value you want displayed when the signal is at the level set in the Low Reading Menu.



Selectable values: See table under *Display Format*.

Low Reading

Use this menu to enter the input signal level that corresponds to the low process value you selected in the previous menu. For linear inputs, the low reading is a percentage of the full scale input range; for pulse inputs, the low reading is expressed in Hz. The low reading is the signal level corresponding to the low PV in percent of full-scale.



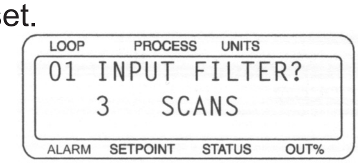
The full scale input value for the linear input type is 60 mV. For pulse inputs, it is 2000 Hz.

Selectable range: -99.9 to 999.9%. You cannot set the low reading to a value greater than or equal to the high reading.

Input Filter

The controller has two types of input filtering:

- The first is a filter that rejects high frequency input signal noise. This filter keeps a “trend log” of input readings. If a reading is outside the filter’s “acceptance band”, and later readings are within the acceptance band, the controller ignores the anomalous reading. The acceptance band for thermocouples is 5 degrees above and 5 degrees below the input reading. If later readings are also outside the acceptance band, the controller accepts the anomalous reading and calculates a new acceptance band. You cannot adjust this input filter.
- A simulated resistor-capacitor (RC) filter dampens the input response if inputs change unrealistically or change faster than the system can respond. If the input filter is enabled, the process variable responds to a step change by going to 2/3 of the actual value within the number of scans you set.

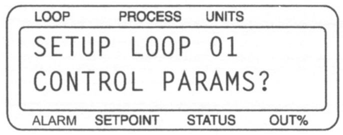


Selectable range: 0-255 scans. 0 disables the filter.

Setup Loop Control Parameters

Use these menus to change control parameters for heat and cool outputs of the selected loop, including:

- Proportional Band (PB or Gain), Integral (TI or Reset), and Derivative (TD or Rate) settings.
- Output Filter.
- Spread between heat and cool outputs.



Below is the setup control parameters menu tree.

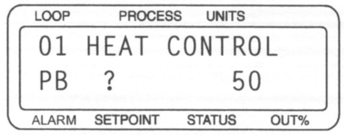
NOTE!

Both heat and cool outputs have the same menus, so only one of each menu is shown here. The controller will show both heat and cool menus even if the heat or cool output is disabled. See Setup Loop Outputs for help enabling or disabling the heat or cool output.

Setup Loop Control Parameters?
Heat/Cool Control PB?
Heat/Cool Control TI?
Heat/Cool Control TD?
Heat/Cool Control Filter?
Heat/Cool Spread?
Restore PID Digin?

Heat or Cool Control PB

This menu allows you to set the Proportional Band (also known as Gain). Larger numbers entered for PB result in lesser proportional action for a given deviation.



Selectable range: Dependent on sensor type.

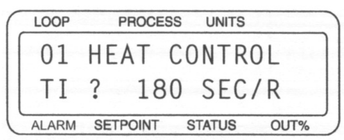
NOTE!
The controller internally represents the proportional band (PB) as a gain value. When you edit the PB, you'll see the values change in predefined steps; small steps for narrow PB values and large steps for wide PB values.

The controller calculates the default PB for each input type according to the following equation:

$$\text{Default PB} = \frac{(\text{High Range - Low Range})}{\text{Gain}}$$

Heat or Cool Control TI

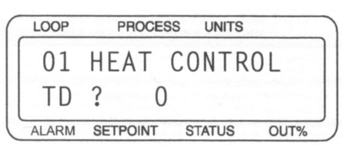
This menu lets you set the Integral term, or Reset. Here a larger number yields a lesser integral action.



Selectable range: 0 (off) - 6000 seconds.

Heat or Cool Control TD

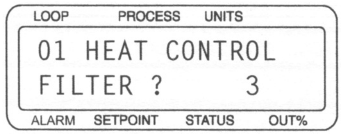
This menu lets you set the derivative constant. Here a larger number yields a greater derivative action.



Selectable range: 0-255 seconds.

Heat or Cool Output Filter

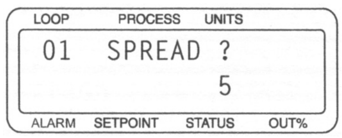
Use this menu to dampen the heat or cool output's response. The output responds to a step change by going to approximately 2/3 of its final value within the number of scans you set here. A larger number set here results in a slower, or more dampened, response to changes in the process variable.



Selectable range: 0-255. Setting the output filter to 0 turns it off.

Heat and Cool Spread

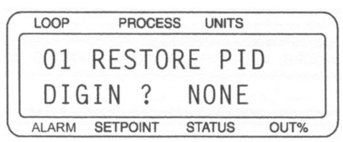
Use this menu to set the spread between the heat and cool output and the spread of the On/Off control action.



Selectable ranges: 0-255, 25.5, 2.55, .255, or .0255, depending on the way you set up the Input menus.

Restore PID Dig In

Selecting a digital input in this menu enables a sensor failure recovery feature. If the specified input is held low, the loop returns to automatic control after a failed sensor is corrected.

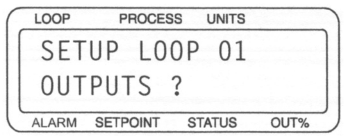


Selectable range: None, 1-8.

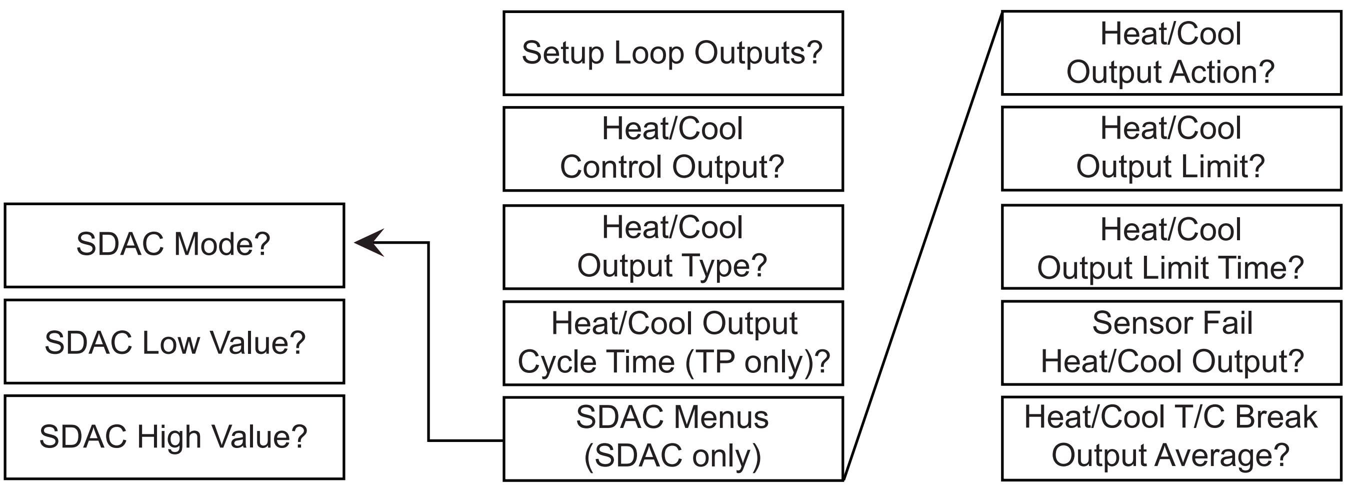
Setup Loop Outputs

Press YES at this prompt to access menus to change loop output parameters for the current loop, including:

- Enable or disable outputs
- Output type
- Cycle time (for TP outputs)
- SDAC parameters (for SDAC outputs)
- Control action
- Output level limit and limit time
- Sensor Fail Output (output override)
- Nonlinear output curve

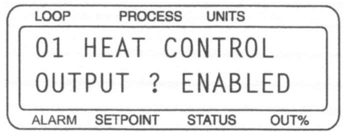


Below is the setup outputs menu tree. Both heat and cool outputs have the same menus, so only one of each menu is shown here.



Enable/Disable Heat or Cool Outputs

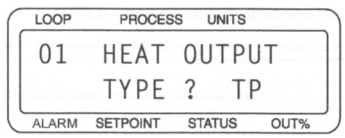
On this menu you can enable or disable the heat or cool output for the current loop. If you want the loop to have a control output, you must enable at least one output. You can also disable a heat or cool control output and use the output pin for something else, such as an alarm.



Selectable values: Enabled or Disabled.

Heat or Cool Output Type

This menu lets you set the output type.



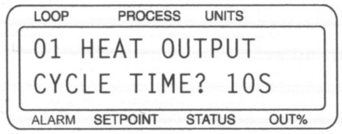
This table shows the available output types.

Display Code	Output Type	Definition
TP	Time Proportioning	Percent output converted to a percent duty cycle over the user-selected fixed time.
DZC	Distributed Zero Crossing	Output on/off state calculated for every AC line cycle.
SDAC	Serial DAC	Output type for optional Serial Digital to Analog Converter.
ON/OFF	On/Off	Output either full ON or full OFF.

For an expanded description of these output types, see *Tuning and Control*.

Heat or Cool Cycle Time

From this menu you can set the Cycle Time for Time Proportioning outputs.



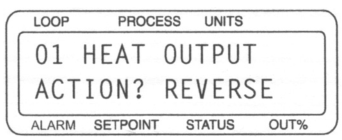
NOTE!

The Cycle Time menu only appears if the output type for the loop is Time Proportioning.

Selectable range: 1-255 seconds.

Heat or Cool Output Action

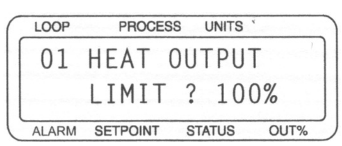
Use this menu to select the control action for the current output. Normally, heat outputs are set to reverse action and cool outputs are set to direct action. When output action is set to revers, the output goes up when the PV goes down. When set to direct, the output goes up when the PV goes up.



Selectable values: Reverse or direct. For heat outputs, set to reverse; for cool outputs, set to direct.

Heat or Cool Output Limit

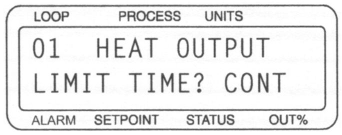
Use this menu to limit the maximum PID control output for a loop's heat and cool outputs. This limit may be continuous, or it may be in effect for a specified number of seconds (see Output Limit Time). If you choose a timed limit, the output limit restarts when the controller powers up and when the loop goes from Manual to Automatic control (via the front panel, when the controller changes jobs, or from ANASOFT). The output limit only affects loops under automatic control. It does not affect loops under manual control.



Selectable range: 0-100%.

Heat or Cool Output Limit Time

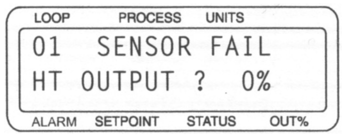
Use this menu to set a time limit for the output limit.



Selectable values: 1-999 seconds (1 seconds to over 16 minutes), or to CONT (continuous).

Sensor Fail Heat or Cool Output

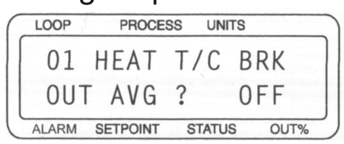
When a sensor fail alarm occurs or when the output override digital input becomes active on a loop that is in automatic control, that loop goes to manual control at the percent power output you set here.



Selectable range: 0-100%.

Heat or Cool T/C Break Output Average

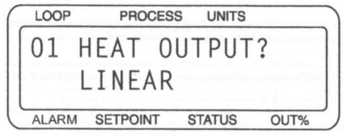
If you set this feature to ON and a T/C break occurs, a loop set to automatic control mode will go to manual mode at a percentage equal to the average output prior to the break.



Selectable range: ON or OFF.

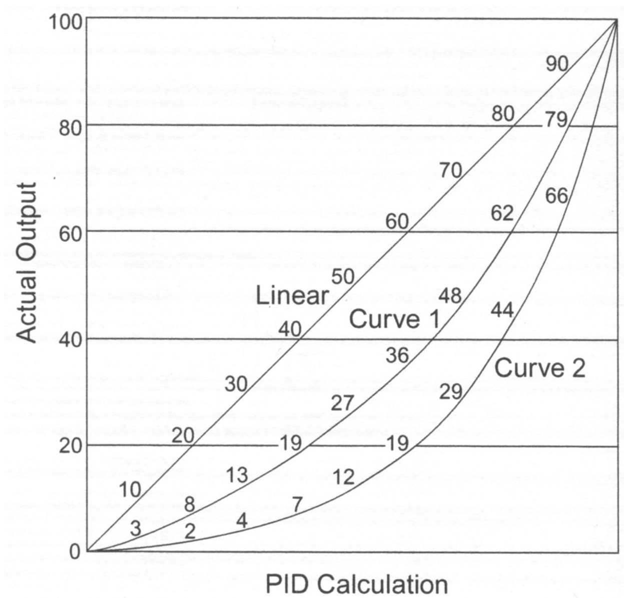
Heat or Cool Nonlinear Output Curve

Use this menu to select one of two nonlinear output curves for nonlinear processes.



Selectable values: Curve 1, Curve 2, or Linear.

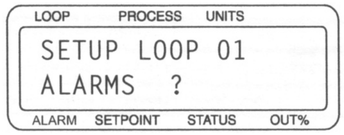
These curves are shown in the figure below.



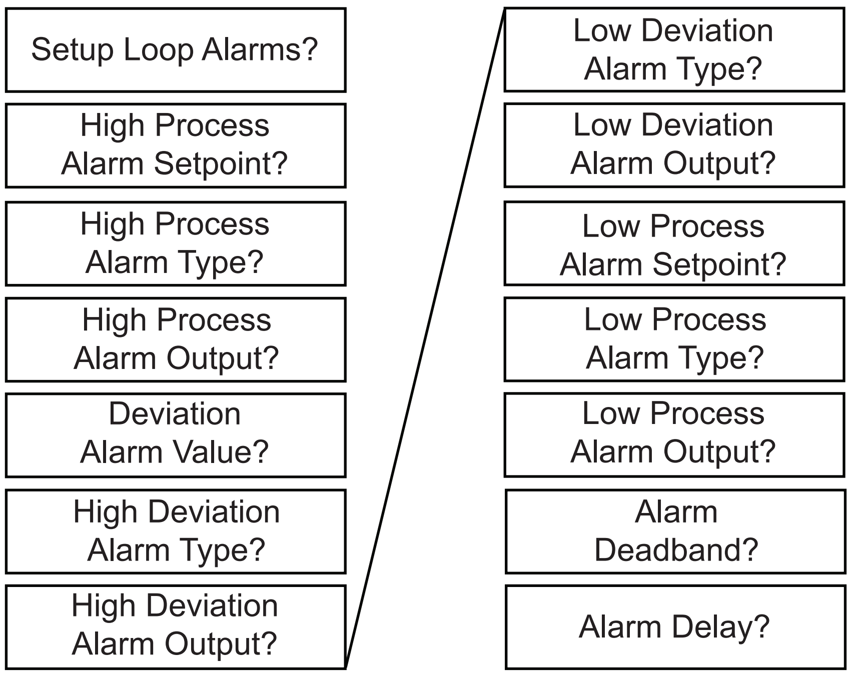
With 1 or 2 selected, a PID calculation results in a lower actual output level than the linear output requires. This output is used when the response of the system to the output device is non-linear.

Setup Loop Alarms

Press YES at the Setup Loop Alarms prompt to access menus which change alarm function parameters for the current loop. The main alarms menu looks like this:



Below is the setup alarms menu tree.



Alarm Types

The controller has three different kinds of alarms: failed sensor alarms, the global alarm, and process alarms.

Failed Sensor Alarms

Failed sensor alarms alert you to T/C breaks, shorted T/Cs, reversed T/Cs, and RTD open or short failures.

- Open + input.
- Open - input.
- Short between + and - input.

When the loop is in Automatic or Tune mode and a failed sensor alarm occurs, the controller sets the loop to Manual control at the sensor fail output percentage you set in the Setup Loop Outputs menus. The T/C break output averaging feature allows you to choose to have the loop go to an average output instead of the sensor fail output.

Global Alarm

The global alarm occurs when a loop alarm set to Alarm (not Control) occurs and is unacknowledged, or when there are any unacknowledged failed sensor alarms. (If an alarm occurs, the front panel displays the corresponding alarm code.) Even if the alarm condition goes away, the global alarm stays on until you use the front panel **Alarm Ack** key (or software) to acknowledge it.

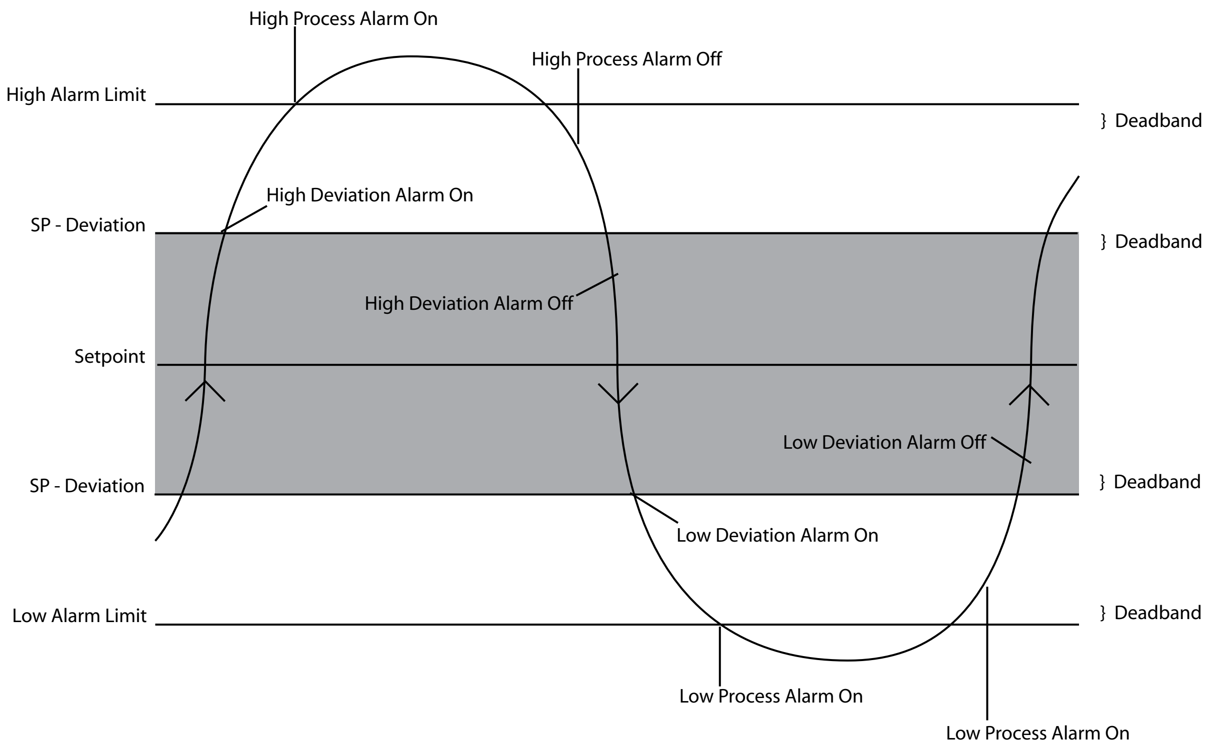
Process Alarms

Process alarms include high and low deviation and high and low process alarms. You can set each of these alarms to Off, Alarm, or Control, as shown here.

Function	Description
Off	No alarm or control function.
Alarm	Standard alarm function. Digital output, if set, activates on alarm, deactivates when loop is not in alarm. Global alarm output activates.
Control	Digital output, if set, activates on alarm, deactivates when loop is not in alarm. Global alarm output does not activate.

- High process and high deviation alarms activate when the process variable goes outside the limit you set. The alarm remains active until the process variable comes within the limits and the deadband.
- Any digital output not used as a control output can be assigned to one or more process alarms. The output is active if any of its alarms are active. All alarm outputs are active Low or active High, depending on the global alarm output polarity setting.
- Low process and low deviation alarms activate when the process variable goes outside the limit you set. They remain active until the process variable comes within the limits and the deadband.

When the controller powers up or the setpoint changes, deviation alarms do not activate until the process variable comes within the deviation alarm band, preventing deviation alarms during a cold start. (High and low process alarms are enabled unless delayed by the startup alarm delay.)



Use menus to set the following process alarm parameters for each loop:

- High and low process alarm type, setpoint, and digital output.
- High and low deviation alarm type, deviation alarm limit, and digital output.
- Alarm deadband.
- Alarm delay.

The setpoints, deviation alarm, values, and deadband all use the same decimal format as the loop's process variable.

Alarm Delay

You can set the controller to delay normal alarm detection and alarm reporting. There are two kinds of alarm delay:

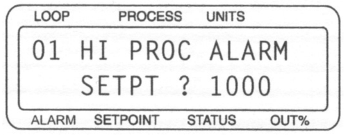
- Start-up alarm delay delays process alarms (but not failed sensor alarms) for all loops for a time period you set in the Setup Global Parameters main menu.
- Loop alarm delay delays failed sensor alarms and process alarms for one loop until the alarm condition as continuously present for longer then the loop alarm delay time you set.

NOTE!

Failed sensor alarms are affected by the loop alarm delay even during the start-up alarm delay time period.

High Process Alarm Setpoint

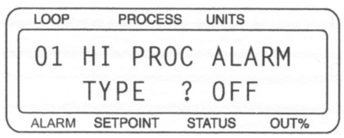
Use this menu to select the value at which the high process alarm activates. The high process alarm activates when the process variable (PV) goes above the high process setpoint. The PV must drop to the alarm setpoint minus the alarm deadband for the alarm to clear.



Selectable range: Any point within the scaled sensor range.

High Process Alarm Type

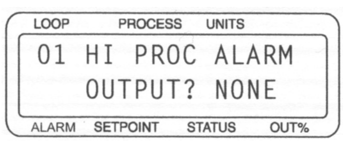
Use this menu to turn off the high process alarm or set it to the alarm or control function. (See previous description for an explanation of these choices.)



Selectable values: Off, Alarm, or Control.

High Process Alarm Output Number

Use this menu to choose a digital output to activate when a high process alarm for the loop occurs. You can use this output to activate an alarm horn or indicator. You can also use it to control your process. For example, you can set the output you have chosen to activate heating or cooling mechanisms, or to turn off the system.



NOTE!

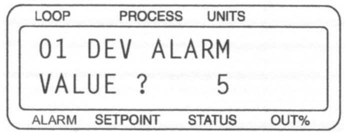
If you assign more than one alarm to the same output number, that output will be ON if any of those alarms is ON.

Selectable values: Any output number between 1 and 34, as long as it's not already used for control or the SDAC clock, or you may select None.

Outputs go off when the process returns to normal whether the alarm has been acknowledged or not. The alarm outputs are non-latching.

Deviation Band Value

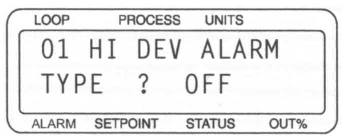
Use this menu to set the deviation band width, a positive and negative alarm or control point relative to the setpoint. If the loop setpoint changes, the deviation band moves with it. You can assign a separate digital output to the high and low deviation alarm/control setpoints, so that, for example, a high deviation alarm turns on a fan and a low deviation alarm turns on a heater.



Selectable values: 0-255, 25.5, 2.55, .255, or .0255, depending on the way you setup the Input menus.

High Deviation Alarm Type

Use this menu to disable the high deviation alarm function or set it to the alarm or control function. (The high deviation alarm activates if the process value (PV) rises above the deviation band value. The PV must drop below the high deviation limit minus the alarm deadband to be reset (cleared).)



NOTE!

If you assign more than one alarm to the same output number, that output is ON if any of those alarms is ON.

Selectable values: Any output number between 1 and 34, as long as that output is not already used for control or the SDAC clock, or you may select None.

Alarm outputs go off when the process returns to normal (within the alarm limit deadband) whether the alarm has been acknowledged or not. The outputs are non-latching.

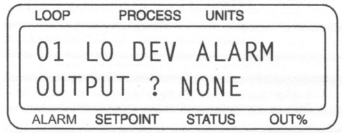
Low Deviation Alarm Type

Use this menu to turn Off the low deviation alarm or set it to Alarm or Control mode.

Selectable values: Off, Alarm, or Control.

Low Deviation Alarm Output Number

Use this menu to assign a digital output that activates when the loop is in low deviation alarm.



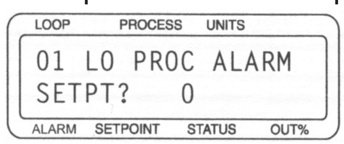
NOTE!

If you assign more than one alarm to the same output number, that output will be ON if any of those alarms is ON.

Selectable values: 1 and 34, as long as that output is not already used for control or the SDAC clock, or you may select None.

Low Process Alarm Setpoint

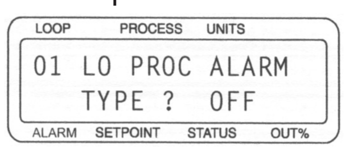
Use this menu to set a low process alarm setpoint. The low process alarm activates when the process variable goes below the low process alarm setpoint. It may be reset when the process variable goes above the low process alarm setpoint plus the alarm deadband.



Selectable range: Any value within the input sensor's range.

Low Process Alarm Type

This menu lets you turn off the low process alarm or set it to the Alarm or Control function.



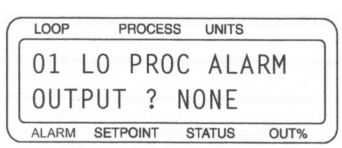
Selectable values: Off, Alarm, or Control.

Low Process Alarm Output Number

Use this menu to assign the digital output that activates when the loop is in low process alarm.

NOTE!

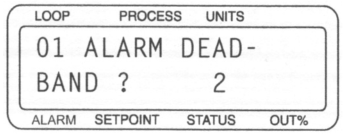
If you assign more than one alarm to the same output number, that output will be ON if any of those alarms is ON.



Selectable values: Any from 1-34 that are not used for control or the SDAC clock.

Alarm Deadband

Use this menu to set an alarm deadband. This deadband value applies to the high process, low process, high deviation, an low deviation alarms for the loop you are editing. Use the Alarm Deadband to avoid repeated alarms as the PV cycles slightly around an alarm value.

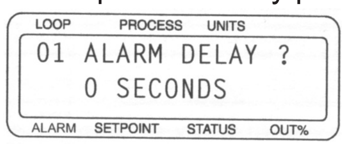


Selectable values: 0-255, 25.5, 2.55, .255, or .0255, depending on the display format set on the input menu.

Alarm Delay

Use this menu to set a loop alarm delay. There are two types of alarm delay: the startup alarm delay and the loop alarm delay. Startup alarm delay is set in the Setup Global Parameters main menu.

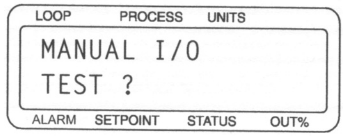
The loop alarm delay is set separately for each loop. It delays failed sensor and process alarms until the alarm condition has been continuously present for longer than the alarm delay time. (Failed sensor alarms are not subject to the startup alarm delay, but they are affected by the loop's alarm delay during the startup alarm delay period.)



Selectable range: 0-255 seconds.

Manual I/O Test

Press YES at this prompt to see menus which can help you test the digital inputs, digital outputs and the controller's keypad.



Below is the manual I/O menu tree.

Manual I/O Test?

Digital Inputs?

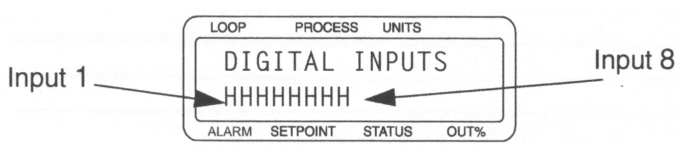
Test Digital Output? 34

Digital Output Number 34? Off

Keypad Test

Digital Input Testing

Use this menu to view the logic state of the 8 digital inputs as H (High) meaning the input is a 5 volts or is not connected, or L (Low) meaning the input is at zero volts. The menu displays inputs 1 to 8 from left to right. Since inputs are pulled High when they are not connected, test an input by shorting it to controller common and making sure this menu shows the correct state for that input.

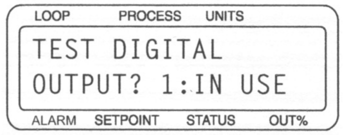


Using This Menu

- Short the digital input you are testing to controller common. When you do that, the input's state should change to L.
- Press **Yes** or **No** to advance to the next menu.
- Press **Back** to return to the Manual I/O test main menu.

Test Digital Output

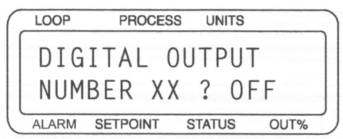
Use this menu to select one of the digital alarm outputs to test in the next menu. You cannot force the state of an output enabled for control.



Selectable values: 1-34 (except outputs enabled for control).

Toggle Digital Output

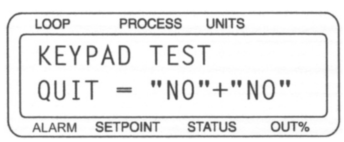
Use this menu to manually toggle a digital output On or Off to test it. (You select the output to test in the previous menu.) On may be Low or High depending on the digital output polarity you set in the Output Polarity menu. All outputs are set to Off when you exit Manual I/O Test menu. Outputs enabled for control cannot be toggled on.



Selectable values: On or Off.

Keypad Test

Use this menu to test the keypad.



- Press any key to test the keypad. The controller will display the name of the key you have pressed.
- Press **No** twice to advance to the next menu.

PID Tuning and Control

This chapter describes the different methods of control available with the controller.

This section covers:

- On/Off Control
- Proportional Control
- Proportional and Integral Control
- PID Control
- Control Outputs
- Tuning PID Loops
- PID Constants by Application

Introduction

This chapter explains PID control and supplies some starting PID values and tuning instructions, so you can use control parameters appropriate for your system. If you would like more information on PID control, consult the Watlow Anafaze Practical Guide to PID.

The control mode dictates how the controller responds to an input signal. The control mode is different from the type of control output signal (like analog or pulsed DC voltage). There are several control modes available: On/Off, Proportional (P), and Proportional with Integral and Derivative (PID). P, PI, or PID control are necessary when process variable (PV) cycling is unacceptable or if the process or setpoint (SP) is variable.

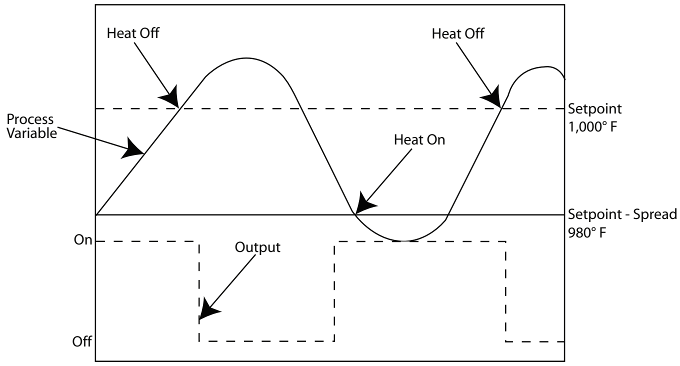
NOTE!
For any of these control modes to function, the loop must be in automatic mode.

Control Modes

The next sections explain the different methods you can use to control a loop.

On/Off Control

On/Off control is the simplest way to control a process; a controller using On/Off control turns an output on or off when the process variable reaches certain limits around the desired setpoint. You can adjust this limit, since Watlow Anafaze controllers use an adjustable spread. For example, if your setpoint is 1000°F, and your limit (spread) is 20°F, the output switches On when the process variable goes below 980°F and Off when the process goes above 1000°F. (The next diagram shows a process under On/Off control.)



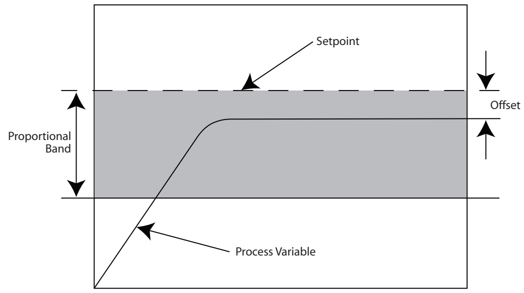
Proportional Control

A process using On/Off control cycles around the setpoint. Proportional control eliminates cycling by increasing or decreasing the output proportional to the process variable's deviation from the setpoint.

The magnitude of proportional response is defined by the Proportional Band (PB); outside this band of control, the output is either 100% or 0%. Within the proportional band the output power is proportional to the PV's difference from the setpoint. For example, using the same values from the example above and a PB of 20°F, the output is:

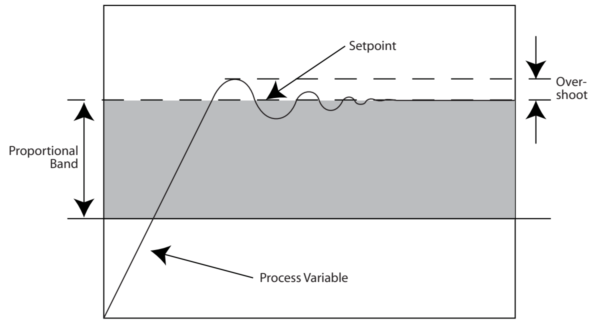
- 50% when the process variable is 990°F.
- 75% when the process variable is 985°F.
- 100% when the process variable is 980°F or below.

However, a process which uses only proportional control may settle at a point above or below the setpoint; it may never reach the setpoint at all. This behavior is known as offset or droop. (This diagram shows a process under proportional control only.)



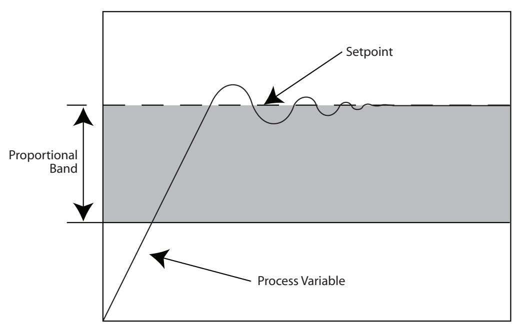
Proportional and Integral Control

In proportional and integral control, the integral term (reset) corrects for offset by repeating the proportional band's error correction until there is no error. For example, if a process tends to settle about 5°F below the setpoint, integral control brings it to the desired setting by increasing the output. (The next diagram shows a process under proportional control.)



Proportional, Integral and Derivative Control

Derivative control corrects for overshoot by anticipating the behavior of the process variable and adjusting the output appropriately. For example, if the process variable is rapidly approaching the setpoint, derivative control reduces the output, anticipating that the process variable will reach setpoint. Use it to eliminate the process variable overshoot common to PI control. (This figure shows a process under full PID (Proportional, Integral and Derivative) control.)



Control Outputs

The controller provides open collector outputs for PID control. These outputs normally control the process using solid state relays. Watlow Anafaze can also provide a Serial Digital to Analog converter (SDAC) for 0-5 Vdc, 0-10 Vdc, or 4-20 mA analog output signals.

Digital Output Control Forms

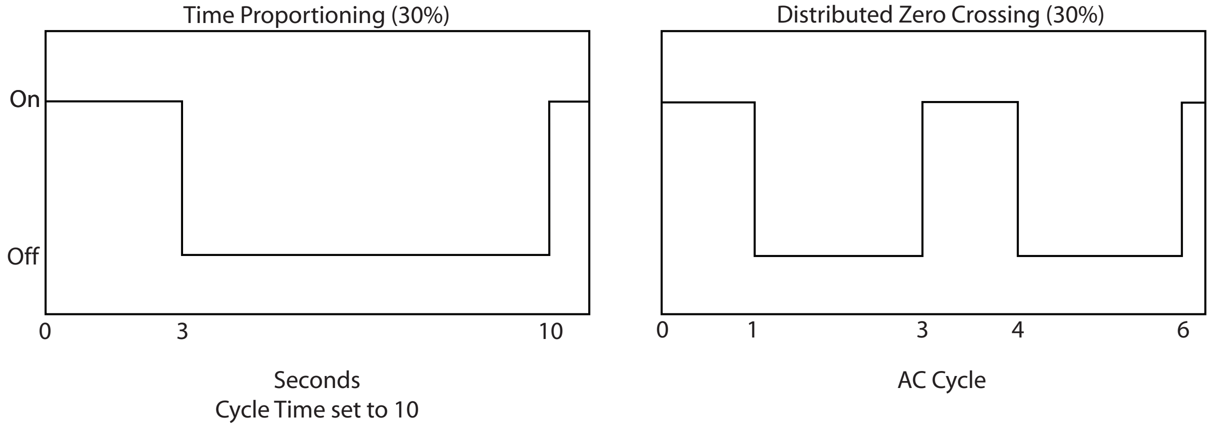
The next section explains different modes for control outputs.

On/Off

On/Off output is very simple: it turns the output on or off depending on the difference between the setpoint and the process variable. PID algorithms are not used with ON/OFF control. The output variable is always off or on.

Time Proportioning (TP)

With time proportioning outputs, the PID algorithm calculates an output between 0 and 100%, which is represented by turning on an output for that percent of a fixed user-selected time base or cycle time. The cycle time is the time over which the output is proportioned, and it can be any value from 1 to 255 seconds. For example, if the output is 30% and the Cycle Time is 10 seconds, then the output will be on for 3 seconds and off for 7 seconds. The figure below shows typical TP and DZC waveforms.



Distributed Zero Crossing (DZC)

With DZC outputs, the PID algorithm also calculates an output between 0 and 100%, but the output is a single cycle variable time base signal. For each AC line cycle the controller decides whether the power should be on or off. There is no fixed cycle time since the decision is made for each line cycle. Since the time period for 60 Hz power is 16.6 ms, the switching interval is very short and the power is applied uniformly. When used in conjunction with a zero crossing device, such as an SSR, switching is done only at the zero crossing of the AC line, which helps reduce electrical noise.

DZC output should extend the life of heaters. It should be used with SSRs. Do not use DZC output for electromechanical relays.

The combination of DZC output and a solid state relay can inexpensively approach the effect of analog phase angle fired control.

Analog Outputs

The Serial Digital to Analog Converter (SDAC) is an optional analog output module for the controller. It lets the controller output precise analog voltages or currents, typically for precision open-loop control, motor or belt speed control, or phase angle fired control. To use it, set the output type for the loop to SDAC.

Output Digital Filter

The output filter digitally smooths PID control output signals. It has a range of 0-255 scans, which gives a time constant of 0-170 seconds for a CLS216. Use the output filter if you need to filter out erratic output swings due to extremely sensitive input signals, like a turbine flow signal or an open air thermocouple in a dry air gas over.

The output filter can also enhance PID control. Some processes are very sensitive and require a large PB, so normal control methods are ineffective. You can use a smaller PB and get better control, if you use the digital filter to reduce the process output swings.

You can also use the filter to reduce output noise when a large derivative is necessary, or to make badly tuned PID loops and poorly designed processes behave properly.

Reverse and Direct Action

With reverse action an increase in the process variable causes a decrease in the output. Conversly, with direct action an increase in the process variable causes an increase in the output. Heating applications normally use reverse action and cooling applications usually use direct action.

Setting Up and Tuning PID Loops

After you have installed your control system, tune each control loop and then set the loop to automatic control. (When you tune a loop, you choose PID parameters that will best control the process.) If you don't mind minor process fluctuations, you can tune the loop in automatic control mode. This section gives PID values for a variety of heating and cooling applications.

If you don't know the PID values that are best for your process, try the Autotune feature. The autotune feature is accessible from the controller's Man/Auto key.

NOTE!

Tuning is a slow process. After you have adjusted a loop, allow about 20 minutes for the change to take effect.

Proportional Band (PB) Settings

The table below shows PB settings for various temperatures in degrees F.

As a general rule, set the PB to 10% of the setpoint below 1000°F and 5% of the setpoint above 1000°F. This setting is useful as a starting value.

Temperature Setpoint	PB
-100 to 99	20
100 to 199	20
200 to 299	30
300 to 399	35
400 to 499	40
500 to 599	45
600 to 699	50
700 to 799	55
800 to 899	60
900 to 999	65
1000 to 1099	70

Temperature Setpoint	PB
1100 to 1199	75
1200 to 1299	80
1300 to 1399	85
1400 to 1499	90
1500 to 1599	95
1600 to 1699	100
1700 to 1799	105
1800 to 1899	110
1900 to 1999	120
2000 to 2099	125
2100 to 2199	130

Temperature Setpoint	PB
2200 to 2299	135
2300 to 2399	140
2400 to 2499	1405
2500 to 2599	150
2600 to 2699	155
2700 to 2799	160
2800 to 2899	165
2900 to 2999	170
3000 to 3099	175
3100 to 3199	180
3200 to 3299	185

Troubleshooting & Maintenance

No-Key Reset

You want to clear all programmed data in a controller by performing a no-key reset. This will return the controller to all its default settings. To perform a no-key reset:

1. Turn off the power to the unit.

2. Press and hold the **NO** key on the front panel while the controller is powering up.

3. When prompted, “reset with defaults?”, press the **YES** key.

NOTE!

If you have a stand-alone system, there is no way to recover your original parameters. If you have a computer-supervised system with AnaWin or ANASOFT, a copy of your parameters can be saved to a job file.

WARNING!

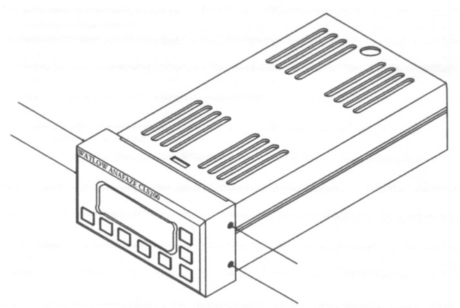
If you suspect your controller has been damaged, you should not attempt to repair it yourself. If the troubleshooting procedures in this chapter do not solve your system’s problems, call the Technical Services department for additional troubleshooting help. If you need to return the unit to Watlow Anafaze for testing and repair, Customer Services will issue you an RMA number. See Returning Your Unit below.

Changing The Firmware

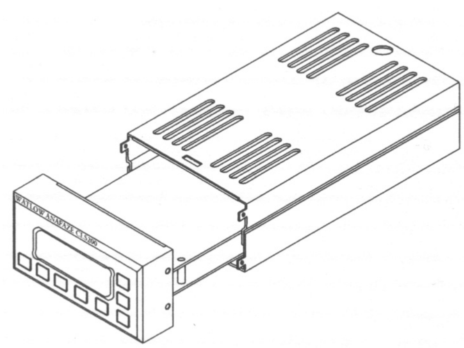
Changing the firmware involves minor mechanical disassembly and reassembly of the controller. You don’t need any soldering or electrical expertise, but appropriate precautions should be taken to prevent damage to electronic components by electrostatic discharge. Wear a grounding strap and place components on static-free grounded surfaces only. The only tools you need are a Phillips head screwdriver and a small Flathead screwdriver.

1. Power down the controller. Be sure to take antistatic precautions.

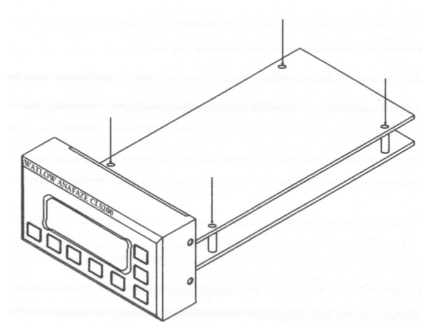
2. Remove two Phillips screws from each side of the bezel.



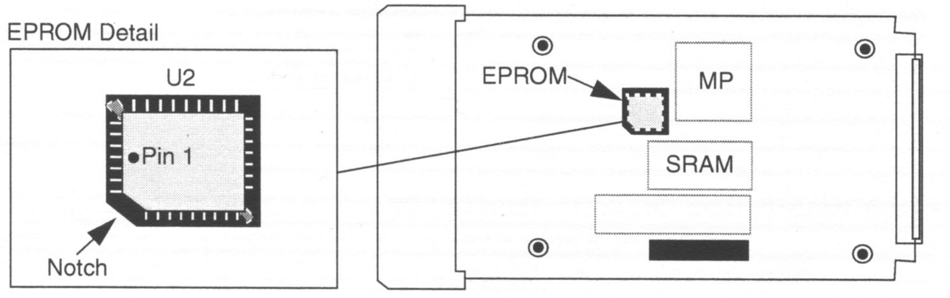
3. Firmly pull the controller electronics from the housing by holding on to the bezel.



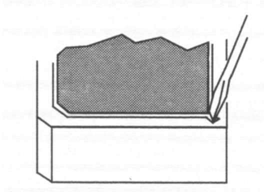
4. Remove the four Phillips screws connecting the analog (top) board to the processor (bottom) board.



5. Carefully lift the analog board off the processor board and set it aside in a static-free area.



6. Use a PROM remover or insert a small flat head screwdriver into one of the notches and gently pry the firmware PROM out of the socket.



7. Install the new firmware PROM into its socket.

8. Reassemble the controller.

9. Power the unit. If it is working properly it will detect that the new EPROM has a different version number and automatically perform a full RAM clear.

10. Do a no-key reset to reinitialize the battery backed RAM. You must perform a no-key reset for the unit to operate properly. Refer to the No-Key Reset section of this chapter.

Appendix: Ramp Soak

This appendix covers setup and operation of Ramp/Soak profiles in CLS200 series controllers.

The Ramp/Soak feature turns your controller into a powerful and flexible batch controller. Ramp/Soak lets you program the controller to change a process setpoint in a preset pattern over time. This preset pattern, or temperature profile, consists of several segments. During a segment, the temperature goes from the previous segment's setpoint to the current segment's setpoint.

- If the current segment's setpoint is higher or lower than the previous segment's setpoint, it is called a **ramp** segment.
- If the current segment's setpoint is the same as the previous segment's setpoint, it is called a **soak** segment.

Each segment can have up to two triggers. If both are set, both must be true before the segment can start. While one or both are not true, the profile waits (this wait state is called **trigger wait**).

Each segment can also have up to four **events** (external signals connected to the digital outputs). Events occur at the end of a segment. You can use any of the digital outputs that are not used for control or for the SDAC clock for events or alarms.

Ramp/Soak Features

- **User-configurable time base:** Watlow Anafaze's Ramp/Soak lets you set your profiles to run for hours and minutes or for minutes and seconds - Whichever is appropriate for your installation.
- **Repeatable profiles:** You can set any profile to repeat from 1 to 99 times or continuously.
- **Fast setup for similar profiles:** You can setup one profile, then copy it and alter it to setup the rest.
- **External reset:** Use the external reset menu to configure a digital input you can use to hold a profile in the Start state and restart it.

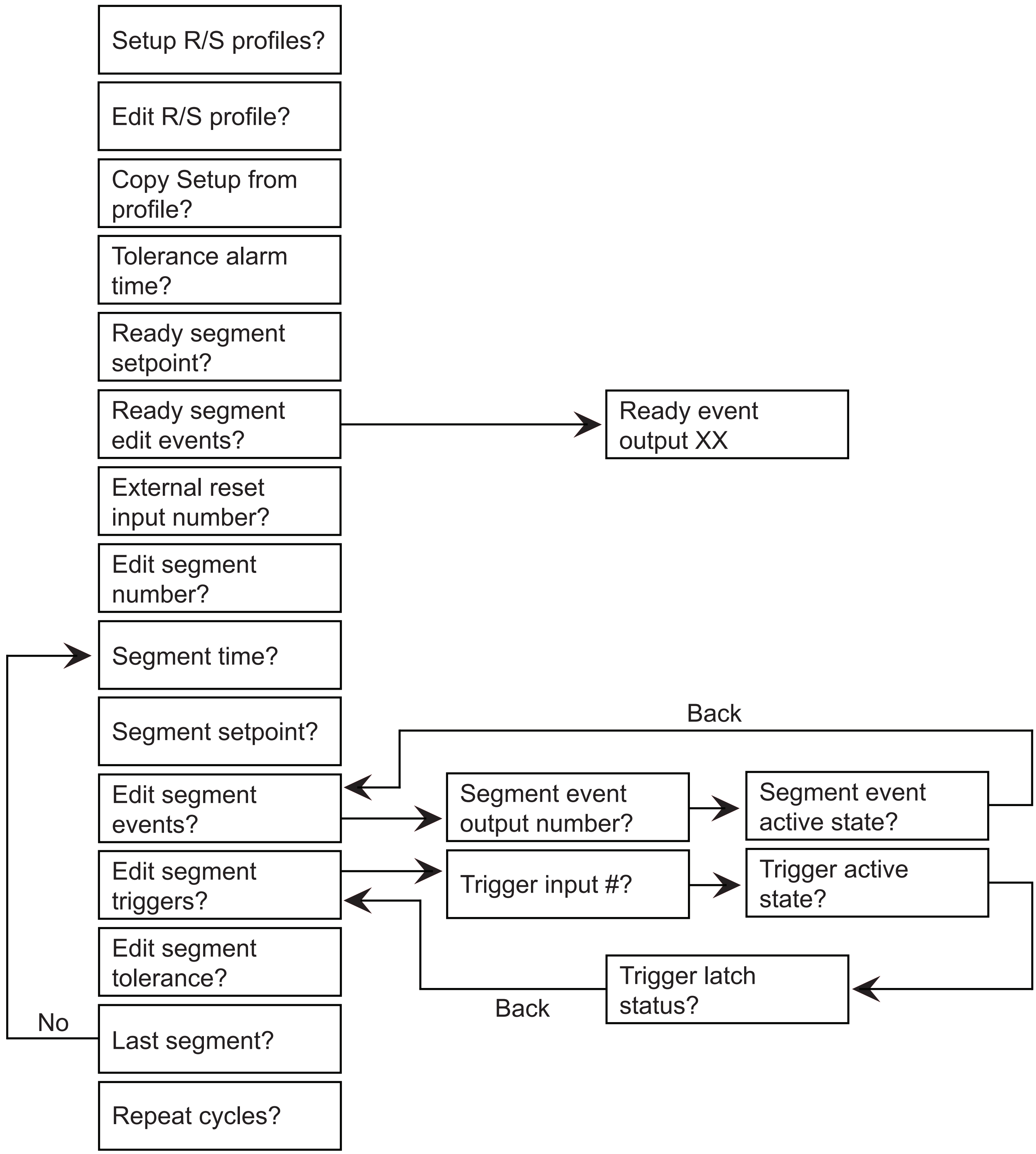
Specifications

Number of possible profiles	17
Number of times to repeat a profile	1-99 or continuous
Number of segments per profile	1-20
Number of triggers per segment	Up to 2
Type of triggers	ON, ON Latched, OFF, OFF Latched
Number of possible inputs for triggers	8
Number of events per segment	Up to 4
Number of possible outputs for events (At least one of these outputs must be used for control)	34

Touch Key

Configuring Ramp/Soak

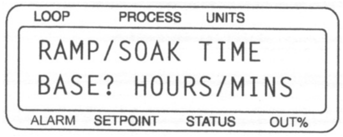
This section will teach you how to setup R/S profiles. The following diagram show the R/S configuration menu tree.



Setting the R/S Time Base

The R/S time base menu is in the Setup Globals main menu.

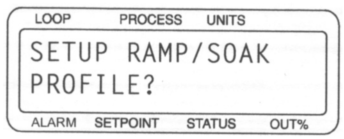
Use this menu to set the time base in all your R/S profiles.



Selectable values: Hours/Mins or Mins/Secs.

Editing R/S Parameters

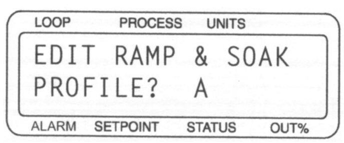
You can reach the rest of the menus in this section from the Setup Ramp/Soak profile main menu. This menu is located between the Setup Loop Alarms main menu and the Manual I/O Test main menu.



Answering Yes to this prompt allows you to setup or edit R/S profiles.

Choosing a Profile to Edit

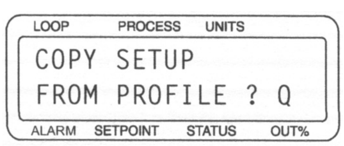
Use this menu to choose a profile to setup or edit.



Selectable values: A to Q (17 profiles).

Copying the Setup from Another Profile

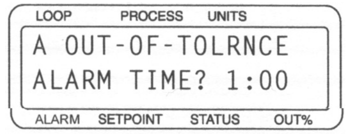
Use this menu to setup similar profiles quickly, by copying a profile to another one.



Selectable values: A to Q.

Editing the Tolerance Alarm Time

Use this menu to set a tolerance time that applies to the entire profile.



When the segment goes out of tolerance,

- The segment goes into tolerance hold.
- The segment timer holds.
- The loop's single loop display shows TOHO (Tolerance Hold).

When the segment has been out of tolerance for more than the tolerance alarm time,

- The controller goes into tolerance alarm.
- The tolerance timer resets.

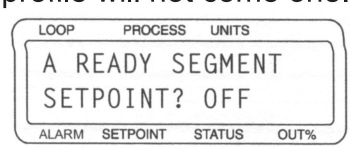
You must acknowledge the tolerance alarm by pressing the ALARM ACK key before you can do any other editing.

Selectable values: 0:00 to 99:59 (minutes or hours, depending on the time base setting).

Editing the Ready Setpoint

When you assign a profile to a loop, the profile doesn't start immediately; instead, it goes to the ready segment (segment 0) and stays there until you put the profile in Run mode.

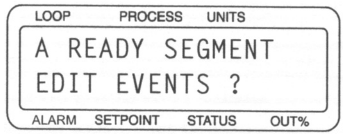
You can set a setpoint, assign events, and set event states for the ready segment. Use this menu to set the ready segment setpoint. Setting the setpoint to **OFF** ensure that control outputs for the loop running the profile will not come one.



Selectable values: -999 to 9999, or Off.

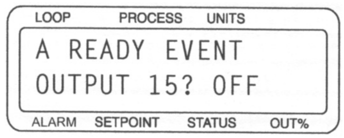
Editing the Ready Event States

Use this menu to set the ready state for all outputs that are not used for control or for the SDAC clock. When you assign a profile, the controller starts the ready segment: it goes to the ready setpoint and puts all the outputs in the ready state you set here. The outputs stay in the states they are set to until their states are changed at the end of subsequent segments.



When you press **NO**, you will advance to the next menu. If you press **YES**, this menu appears.

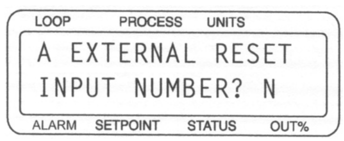
Press **NO** to increment the output number, **YES** to set the ready segment event state.



Selectable values: You can toggle inputs that are not IN USE to On or Off.

Choosing an External Reset Input

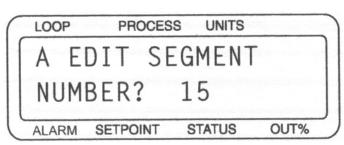
Use this menu to select an external reset input. Toggle the input to set the profile to the Run state at its beginning when it is in Start, Run, Hold, or Wait state. You can make any of the eight digital inputs the external reset input.



Selectable values: 1-8, or N (for no external reset).

Editing a Segment

Each profile is made up of several segments (up to 20). Use this menu to choose the segment to edit.

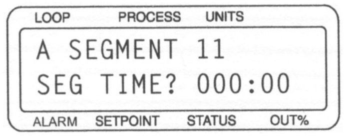


Selectable values: 1-20.

The first time you use this menu, it defaults to segment 1. when you have finished editing a segment, the controller returns you to this menu and goes to the next segment. This loop continues until you make a segment the last segment of a profile.

Setting Segment Time

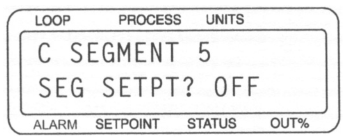
Use this menu to change the segment time.



Selectable values: 000:00 to 999:59 (minutes or seconds, depending on the selected time base).

Setting a Segment Setpoint

Use this menu to set a setpoint for the segment you are editing. The process will go to this setpoint by the end of the segment time.



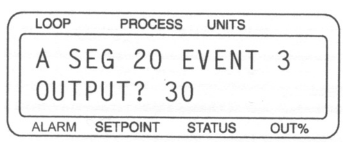
Selectable values: YES or NO.

Starting A Segment With An Event

If you want a segment to start with an event (usually events happen at the end of the segment), program the event in the previous segment. You can also create a segment with zero time preceding the event during which you want the event on.

Editing Event Outputs

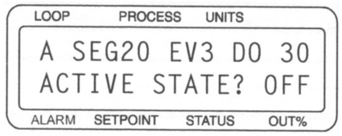
This menu appears only if you answered YES to the previous menu. Use it to assign a digital output to each event. Assign digital outputs that are not being used for PID control or for SDAC clock.



Selectable values: Any digital output from 1 to 34, except those IN USE, or None (no event).

Changing Event States

Use this menu to assign an output state to each event: On (Low) or Off (High). When the event occurs, the output goes to the state you assign here.

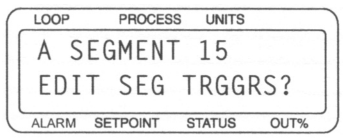


Selectable values: Off (High) or On (Low).

Editing Segment Triggers

Each segment may have up to two triggers (digital inputs). Triggers are checked at the beginning of the segment. All triggers must be true in order for the segment to run. If a trigger is not true, the profile goes into the trigger wait site.

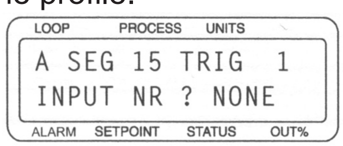
Use this menu to edit triggers for the current segment.



Selectable values: **YES** (to edit triggers of current segment), or **NO** (to advance to the Edit Segment Tolerance menu).

Assigning an Input to a Trigger

This menu appears only if you answered **YES** to the Edit Segment Triggers menu. Use it to assign one of the controller's eight digital inputs to a segment trigger. You can assign any digital input to any trigger. You can also assign the same digital input as a trigger in more than one segment and more than one profile.

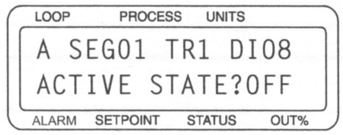


Selectable values: Any digital input from 1-8, or None (no input assigned). Setting a trigger to None disables it.

Changing a Trigger's True State

Use this menu to set the state, ON or OFF, that will satisfy the trigger condition. This menu appears only if you answered YES to the Edit Segment triggers menu.

- A trigger input is ON when pulled low by an external device.
- A trigger input is off when no external creates a path to ground.

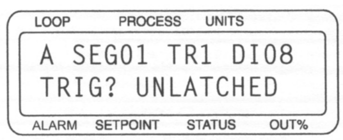


Selectable values: Off or On.

Latching or Unlatching a Trigger

Use this menu to make a trigger latched or unlatched.

- A latched trigger is checked once, at the beginning of a segment.
- An unlatched trigger is checked constantly while a segment is running. If an unlatched trigger becomes false, the segment timer stops and the loop goes into trigger wait state.

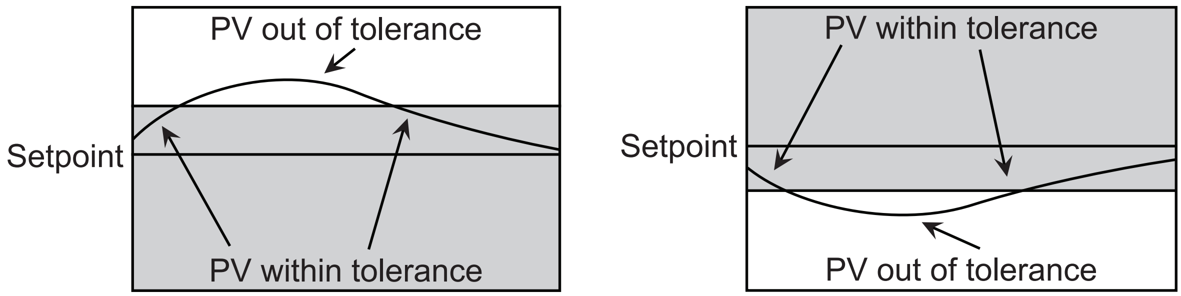


Selectable values: Latched or Unlatched.

Setting Segment Tolerance

Use this menu to set a positive or negative tolerance value for each segment, this value is displayed in the engineering units of the process and is a deviation from the setpoint.

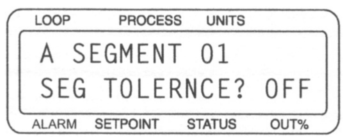
Tolerance works as shown in this diagram:



If you enter a positive tolerance, the process is out of tolerance when the PV goes above the setpoint plus the tolerance.

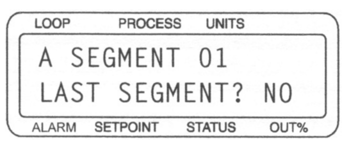
If you enter a negative tolerance, the process goes out of tolerance when the PV goes below the setpoint minus the tolerance.

Selectable values: -99 to 99, or Off (no tolerance limit).



Ending a Profile

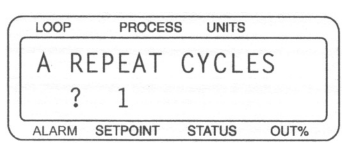
Use this menu to make the current segment the last one in the profile.



Selectable values: No or Yes.

Repeating a Profile

Use this menu to set the number of times you want a profile to repeat or cycle.

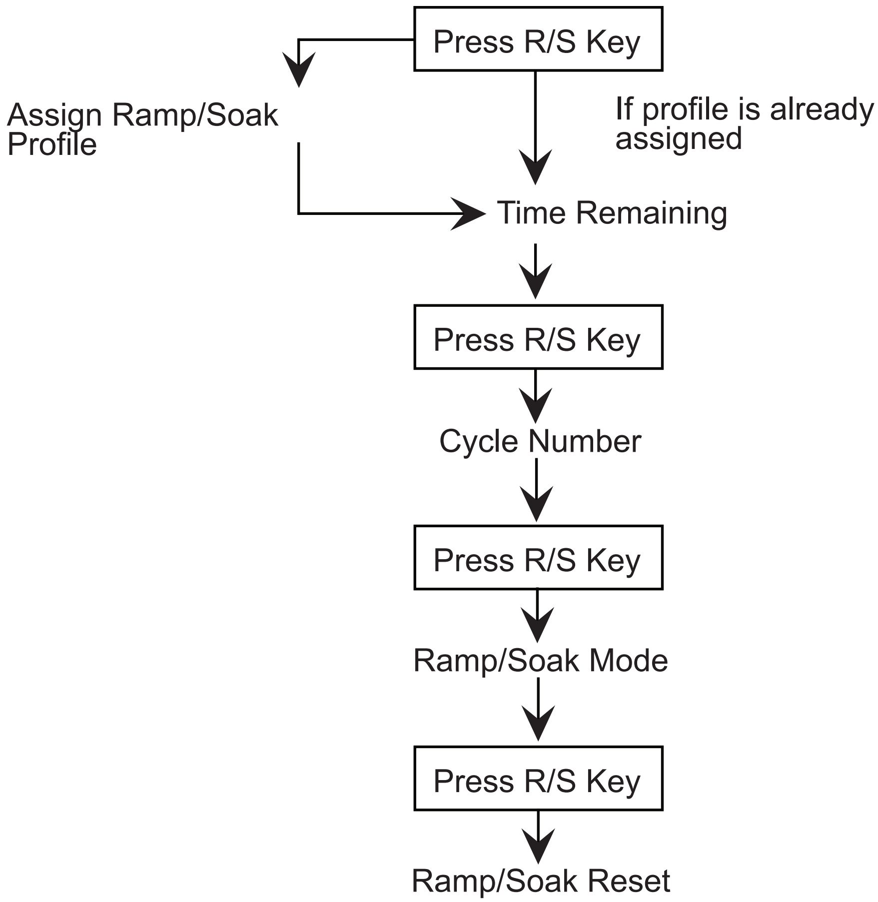


Selectable values: 1-99, or C (continuous cycling).

Using Ramp/Soak

This section explains how to assign a profile to a loop, how to put a profile in Run or Hold mode, how to reset a profile, and how to display profile statistics.

The next figure shows the Ramp/Soak key menus.

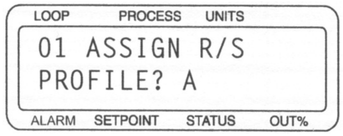


From the Ramp/Soak Reset display:

- Press NO to return to Single Loop display.
- Press BACK to return to the Time Remaining display.

Assigning a Profile to a Loop

Use this menu to assign a profile to a loop.



Assigning a Profile to a Loop

To assign a profile to a loop that doesn't have a profile currently assigned:

1. In Single Loop display, switch to the loop you want to assign a profile to.

2. Press the **RAMP/SOAK** key. The assigning menu appears. (See menu in previous page.)

3. Choose one of the available profiles and press **ENTER**.

4. Press **BACK** if you wish to return to Single Loop display without sending profile data to the controller.

Assigning, Changing and Un-assigning a Profile

To assign a new profile to a loop that already has one assigned, follow these steps from the single loop screen:

1. Press the **RAMP/SOAK** key three times.

2. Press the **NO** key. You will see the Reset Profile menu.

3. Press **YES**, the **ENTER**, to reset the profile. You will see the Assign Profile menu. (See previous page.)

4. Choose one of the available profiles or **NONE** to (un-assign) and press **ENTER**.

5. Press **BACK** if you wish to return to Single Loop display without changing the profile assignments.

Assigning a Profile to a Linear Input Loop

If you assign a profile to a loop with a linear input, these variables will depend on the display format setting you chose for linear input:

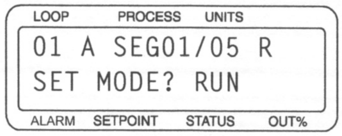
- Ready setpoint.
- Segment setpoint.
- Segment tolerance.

Before you assign a profile to a linear input loop, consult the following table.

Display Format Setting	Effect on Parameter
-999 to 3000	Parameter is as set in profile.
-9999 to 30000	Controller multiplies your parameter by ten.
-999.9 to 3000.0	Controller adds a decimal point and a zero to your parameter.
-99.9 to 300.0	Controller divides your parameter by ten.
-9.999 to 30.000	Controller divides your parameter by 100.
0.999 to 3.00	Controller divides your parameter by 1000.

Running a Profile

When you assign a profile, it does not start running immediately; instead, the loop is in the Start mode and the Ready segment (segment 0). Use this menu to start a profile (put it in Run mode).



Starting a Profile

You can start a profile only when it's in the Ready segment.

1. Press the **RAMP/SOAK** key repeatedly until you see the Ramp/Soak mode menu.

2. While the profile is in Ready segment, the only mode available is the Run mode.

3. Press **YES** and **ENTER** to start the profile.

Running Several Profiles Simultaneously

To run several profiles simultaneously, follow these steps:

1. Setup the profiles so that segment 1 of each profile has the same latched trigger.

2. Assign the profiles to the appropriate loops. The loops will go to the Ready segment of each profile.

3. Set each profile to Run mode.

4. Trip the trigger.

Editing a Profile While It Is Running

You can edit a profile while it is running, but the changes you have made will not take effect until the next time it runs.

Ramp/Soak Displays

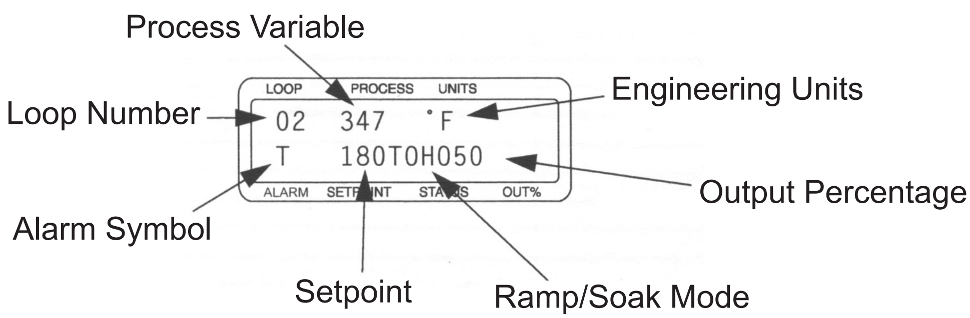
The Single Loop and Bar Graph displays show additional codes for R/S controllers.

Single Loop Display

When the controller is running a profile, the Single Loop display shows the Ramp/Soak mode where it would usually show MAN or AUTO. The next table shows the available codes and their meaning.

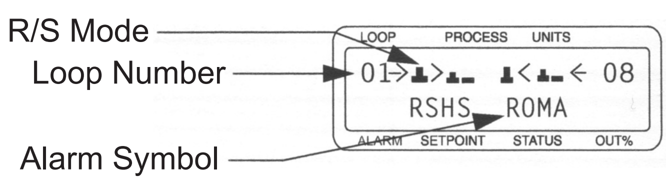
Code	Mode
STRT	The profile is in the Ready segment.
RUN	The profile is running.
HOLD	The user has put the profile in Hold mode.
TOHO	The profile is in tolerance hold.
WAIT	The profile is in trigger wait state.

This is the Single Loop display when a profile is running.



Bar Graph Display

Loops that are running R/S profiles have different Bar Graph display codes. For these loops, you will see the first letter of each mode where the controller would normally display M (for Manual control) or A (for Automatic control).



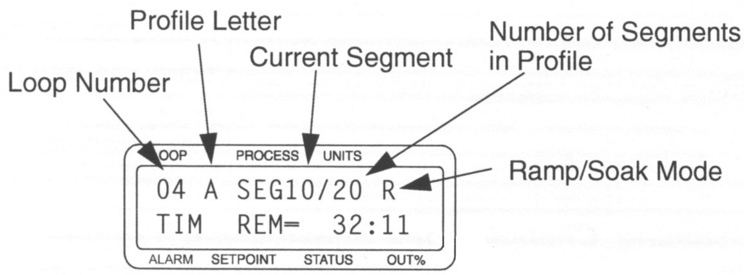
The next table shows the codes you would see in loops running R/S profiles.

Code	Meaning
R	A profile is running.
H	A profile is holding.
S	A profile is in Ready state.
O	A profile is in tolerance hold.
W	A profile is in trigger wait.

RAMP/SOAK Key Displays

Use the RAMP/SOAK key to see the time left in the current profile, the profile's status, or the number of times the profile has cycled.

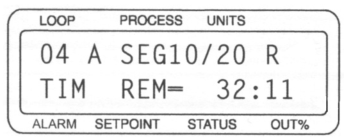
All the menus you can reach from the RAMP/SOAK key have the same information on the top line.



How long has the profile run?

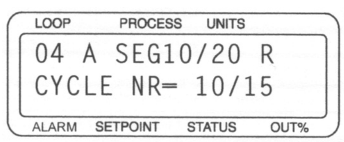
From Single Loop display, press the RAMP/SOAK key once.

This next menu appears only if you have already assigned a profile to the loop.



How many times has it cycled?

From Single Loop display, press the RAMP/SOAK key twice. The next menu will appear.



This menu displays the number of times the profile has run out of the total number of cycles.

Holding a Profile or Continuing from Hold

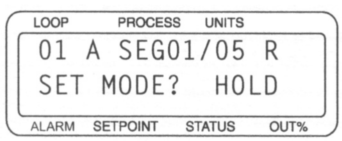
Use the profile mode menu to hold a profile or continue from Hold. The next table shows the available modes.

Current Mode	Available Mode	Description
Start	Run	Begin running the assigned profile.
Hold	Cont	Continue from user-selected hold. Profile runs from the point when you put the profile in Hold mode. (You cannot continue from a tolerance hold or a trigger wait.) After you choose this mode, the controller switches back to Run mode.
Run	Hold	Hold the profile.

Holding a Profile

In Hold mode, all loop parameters stay at their current settings until you change the mode or reset the profile. To put a profile in hold, follow these steps:

- Press **RAMP/SOAK** key repeated until you see the R/S mode menu.



- While the profile is running, the only mode you will be able to select is Hold.
- Press **YES** and **ENTER** to hold the profile.

Continuing a Profile

If a profile is holding and you want it to run, select Continue on the Ramp/Soak mode menu.

- Press **RAMP/SOAK** key repeatedly until you see the R/S mode menu.
- While the profile is holding, the only mode you will be able to select is Cont (Continue).
- Press **YES** and **ENTER** to continue running the profile.

Resetting a Profile

Use this menu to reset a profile. When you reset a profile, the following happens:

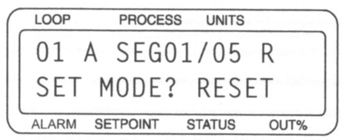
- The profile returns to the ready segment. The PV goes to the ready setpoint, and the ready segment events go to the state you specified in the Edit Ready Event State menu.
- The controller show you the Assign Profile menu in case you would like to assign a different profile to the loop or select NONE to un-assign the profile.

To reset a profile, follow these steps:

1. Press **RAMP/SOAK** key repeatedly until you see the R/S mode menu.

2. Press the **NO** key. You should see the menu below.

3. Press **YES** to reset the profile, and then **ENTER** to confirm your choice.



Glossary

A

AC:
See Alternating Current.

AC Line Frequency:
The frequency of the AC power line measured Hertz (Hz), usually 50 or 60 Hz.

Accuracy:
Closeness between the value indicated by a measuring instrument and a physical constant or known standards.

Action:
The response of an output when the process variable is changed. See also Direct action, Reverse action.

Address:
A numerical identifier for a controller when used in computer communications.

Alarm:
A signal that indicates that the process has exceeded or fallen below a certain range around the setpoint. For example, an alarm may indicate that a process is too hot or too cold. See also:
- Deviation Alarm
- Failed Sensor Alarm
- Global Alarm
- High Deviation Alarm
- High Process Alarm
- Loop Alarm
- Low Deviation Alarm
- Low Process Alarm

Alarm Delay:
The lag time before an alarm is activated.

Alternating Current (AC):
An electric current that reverses at regular intervals, and alternates positive and negative values.

Ambient Temperature:
The temperature of the air or other medium that surrounds the components of a thermal system.

American Wire Gauge (AWG):
A standard of the dimensional characteristics of wire used to conduct electrical currents or signals. AWG is identical to the Brown and Sharpe (B&S) wire gauge.

Ammeter:
An instrument that measures the magnitude of an electric current.

Ampere (Amp):
A unit that defines the rate of flow of electricity (current) in the circuit. Units are one coulomb (6.25×10^{18} electrons) per second.

Analog Output:
A continuously variable signal that is used to represent a value, such as the process value or setpoint value. Typical hardware configurations are 0-20mA, 4-20mA or 0-5Vdc.

Automatic Mode:
A feature that allows the controller to set PID control outputs in response to the Process Variable (PV) and the setpoint.

Autotune:
A feature that automatically sets temperature control PID values to match a particular thermal system.

B

Baud Rate:
The rate of information transfer in serial communications, measured in bits per second.

Block Check Character (BCC):
A serial communications error checking method.

Bumpless Transfer:
A smooth transition from Auto (closed loop) to Manual (open loop) operation. The control output does not change during the transfer.

C

Calibration:
The comparison of a measuring device (an unknown) against an equal or better standard.

Celsius (Centigrade):
Formerly known as Centigrade. A temperature scale in which water freezes at 0°C and boils at 100°C at standard atmospheric pressure. The formula for conversion to the Fahrenheit scale is: °F=(1.8x°C)+32.

Central Processing Unit (CPU):
The unit of a computing system that includes the circuits controlling the interpretation of instructions and their execution.

Circuit:
Any closed path for electrical current. A configuration of electrically or electromagnetically connected components or devices.

Closed Loop:
A control system that uses a sensor to measure a process variable and makes decisions based on that feeback.

Cold Junction:
Connection point between thermocouple metals and the electronic instrument.

Common Mode Rejection Ratio:
The ability of an instrument to reject electrical noise, with relation to ground, from a common voltage. Usually expressed in decibels (dB).

Communications:
The use of digital computer messages to link components.
See Serial Communications
See Baud Rate.

Control Action:
The response of the control output relative to the error between the process variable and the setpoint. For reverse action (usually heating), as the process decreases below the setpoint the output increases. For direct action (usually cooling), as the process increases above the setpoint, the output increases.

Control Mode:
The type of action that a controller uses. For example, On/Off, Time Proportioning, PID, Automatic or Manual, and combinations of these.

Current:
The rate of flow of electricity. The unit of measure is the ampere (A).
1 ampere = 1 coulomb per second.

Cycle Time:
The time required for a controller to complete one on-off-on cycle. It is usually expressed in seconds.

Cyclic Redundancy Check (CRC):
An error checking method in communications. It provides a high level of dara security but is more difficult to implement than Block Check Character (BCC).
See Block Check Character.

D

Data Logging:
A method of recording a process variable over a period of time. Used to review or document process performance.

Default Parameters:
The programmed instructions that are permanently stored in the microprocessor software.

Derivative Control (D):
The last term in the PID algorithm. Action that anticipates the rate of change of the process; and compensates to minimize overshoot and undershoot. Derivative control is an instantaneous change of the control output based on the rate of change of the PV. The TD is in units of seconds.

Deutsche Industrial Norms (DIN):
A set of technical, scientific and dimensional standards developed in Germany. Many DIN standards have worldwide recognition.

Deviation Alarm:
Warns that a process has exceeded or fallen below a certain range around the setpoint.

Digital to Analog Converter (DAC):
A device that converts a voltage or current input signal to a binary number by digital circuitry.

Direct Action:
An output control action in which an increase in the process variable, causes an increase in the output. Cooling applications usually use direct action.

Direct Current (DC):
An electric current that flows in one direction.

Distributed Zero Crossing (DZC):
A form of digital output control. Similar to burst fire.

E

Earth Ground:
A metal rod, usually copper, that provides an electrical path to the earth, to prevent or reduce the risk of electrical shock.

Electrical Noise:
See Noise.

Electromagnetic Interference (EMI):
Electrical and magnetic noise imposed on a system. There are many possible sources, such as power switching devices and radios. EMI can interfere with the operation of controls and other devices.

Electrical-Mechanical Relays:
See Relay, electromechanical.

Emissivity:
The ratio of radiation emitted from a surface compared to radiation emitted from a black-body at the same temperature.

Engineering Units:
Selectable units of measure, such as degrees Celsius and Fahrenheit, pounds per square inch, newtons per meter, gallons per minute, liters per minute, cubic feet per minute or cubic meters per minute.

EPROM:
Erasable Programmable, Read-Only Memory inside the controller.

Error:
The difference between the correct or desired value and the actual value.

F

Fahrenheit:
The temperature scale that sets the freezing point of water at 32°F and its boiling point at 212°F at standard atmospheric pressure. The formula for conversion to Celsius is: °C=5/9(°F-32°F).

Failed Sensor Alarm:
Warns that an input sensor no longer produces a valid signal. For example, when there are thermocouple breaks, infrared problems or resistance temperature detector (RTD) open or short failures.

Filter:

Filters are used to handle various electrical noise problems.

Digital Filter (DF) - A filter that slows the response of a system when inputs change unrealistically or too fast. Equivalent to a standard resistor-capacitor (RC) filter.

Digital Adaptive Filter - A filter that rejects high frequency input signal noise (noise spikes).

Heat/Cool Output Filter - A filter that slows the change in the response of the heat or cool output. The output responds to a step change by going to approximately 2/3 its final value within the numbers of scans that are set.

Frequency:

The number of cycles over a specified period of time, usually measured in cycles per second. Also referred to as Hertz (Hz). The reciprocal is called the period.

G

Gain:

The amount of amplification used in an electrical circuit. Gain can also refer to the Proportional (P) mode of PID.

Global Alarm:

Alarm associated with a global digital output that is cleared directly from a controller or through a user interface.

Global Digital Outputs:

A user-selected digital output for each specific alarm that alerts the operator.

Ground:

An electrical line with the same electrical potential as the surrounding earth. Electrical systems are usually grounded to protect people and equipment from shocks due to malfunctions. Also referred to as “safety ground” or “chassis ground”.

H

Hertz (Hz):

Unit of frequency, equal to cycles per second.

High Deviation Alarm:

Warns that the process is above setpoint.

High Power:

Any voltage above 24 Vac or Vdc and any current level above 50 mAac or mAdc.

High Process Alarm:

Warns that the process has exceeded a set maximum value.

High Process Variable (PV):

See Process Variable (PV).

High Reading:

An input level that corresponds to the high process value. For linear inputs, the high reading is a percentage of the full scale input range. For pulse inputs, the high reading is expressed in cycles per second (Hz).

I

Infrared:

A region of the electromagnetic spectrum with wavelengths ranges from one to 1,000 microns These wavelengths are most suited for radiant heating and infrared (noncontact) temperature sensing.

Input:

Signal representing the process variable supplied to the instrument.

Input Scaling:

The conversion of input readings to the engineering units of the process variable.

Input Type:

The signal or sensor type that is connected to an input, such as thermocouple, RTD, linear or process.

Integral Control (I):
Control action that automatically eliminates offset, or droop, between setpoint and actual process temperature.
See Auto-reset.

J

Job:
A set of operating conditions for a process that can be stored and recalled in a controller's memory. Also called a Recipe.

Junction:
The point where two dissimilar metal conductors join to form a thermocouple.

L

Lag:
The delay between the change in an output signal and the response of the instrument to which the signal is sent.

Linear Input:
A process input signal that is proportional to the process variable it represents.

Linearity:
The deviation in response from an expected or theoretical straight line value for instruments and transducers, also called Linearity Error.

Liquid Crystal Display (LCD):
A type of digital display made of a material that changes reflectance or transmittance when an electrical field is applied to it.

Load:
The electrical demand of a process expressed in power (watts), current (amps), or resistance (ohms). The item or substance that is to be heated or cooled.

Loop Alarm:
Any alarm system that includes high and low process, deviation band, deadband, digital outputs, and auxiliary control outputs.

Low Deviation Alarm:
Warns that the process is below the setpoint.

Low Process Alarm:
Warns that the process has exceeded a set minimum value.

Low Reading:
An input level corresponding to the low process value. For linear inputs, the low reading is a percentage of the full scale input range of the controller. For pulse inputs, the low reading is expressed in cycles per second (Hz).

M

Manual Mode:
A selectable mode that has no automatic control aspects. The operator sets output level.

Manual Reset:
See Reset.

Milliampere (mA):
One thousandth of an ampere.

N

No-Key Reset:
A method for resetting the controller's memory (for instance, after an EPROM change).

Noise:
Unwanted electrical signals that usually produce signal interference.
See Electromagnetic Interference.

Noise Suppression:
The use of components to reduce electrical interference.

Non Linear:
Through Watlow-Anafaze's software, the Non Linear field sets the system to linear control, or to one of two non linear control options. Input 0 for Linear, 1 or 2 for Non Linear.

O

Offset:
The difference in temperature between the setpoint and the actual process temperature. Offset is the error in the process variable that is typical of proportional-only control.

On/Off Control:
A method of control that turns the output full on until setpoint is reached, and then off until the process error exceeds the spread.

Open Loop:
A control system with no sensory feedback.

Operator Menus:
The menus accessible from the front panel of a controller. These menus allow operators to set or change various control actions or features.

Optical Isolation:
Two electronic networks that are connected through an LED (Light Emitting Diode) and a photoelectric receiver. There is no electrical continuity between the two networks.

Output:
Control signal action in response to the difference between setpoint and process variable.

Output Type:
The form of control output, such as Time Proportioning, Distributed Zero Crossing, SDAC, or Analog. Also the description of the electrical hardware that makes up the output.

Overshoot:
The amount by which a process variable exceeds the setpoint before it stabilizes.

P

Panel Lock:
A feature that prevents operation of the front panel by unauthorized people.

PID:
Proportional, Integral, Derivative. A control mode with three functions: Proportional action dampens the system response, Integral corrects for droops, and Derivative prevents overshoot and undershoot.

Polarity:
The electrical quality of having two opposite poles, one positive and one negative. Polarity determines the direction in which a current tends to flow.

Process Variable:
The parameter that is controller or measured. Typical examples are temperature, relative humidity, pressure, flow, fluid level, events, etc. The high process variable is the highest value of the process range, expressed in engineering units. The low process variable is the lowest value of the process range.

Proportional (P):
Output effort proportional to the error from setpoint. For example, if the proportional band is 20° and the process is 10° below the setpoint, the heat proportioned effort is 50%. The smaller the PB value, the greater the output due to proportional action.

Proportional Band (PB):
A range in which the proportioning function of the control is active. Expressed in engineering units. See PID.

Proportional Control:
A control using only the P (proportional) algorithm of PID control.

Pulse Input:
Digital pulse signals from devices, such as optical encoders.

R

Ramp:
A programmed increase or decrease in the temperature of a setpoint system.

Range:
The area between two limits in which a quantity or value is measured. It is usually described in terms of lower and upper limits.

Recipe:
See Job.

Reflection Compensation Mode:
A control feature that automatically corrects the reading from a sensor.

Relay:
A switching device.

Electromechanical Relay - A power switching device that completes or interrupts a circuit by physically moving electrical contacts into contact with each other. Not recommended for PID control.

Solid State Relay - A switching device with no moving parts that completes or interrupts a circuit electrically.

Reset:
Control action that automatically eliminates offset or droop between setpoint and actual process temperature. Also see Integral.

Automatic Reset - The integral function of a PI or PID temperature controller that adjusts the process temperature to the setpoint after the system stabilizes. The inverse of integral.

Resistance:
Opposition to the flow of electric current, measured in ohms.

Resistance Temperature Detector (RTD):
A sensor that uses the resistance temperature characteristic to measure temperature. There are two basic types of RTDs: the wire RTD, which is usually made of platinum, and the thermistor which is made of a semiconductor material. Wire RTDs come with positive temperature coefficients only, while the thermistor can have either a negative or positive temperature coefficient.

Reverse Action:
An output control action in which an increase in the process variable causes a decrease in the output. Heating applications usually use reverse action.

RTD:
See Resistance Temperature Detector.

S

Serial Communications:
A method of transmitting information between devices by sending all bits serially over a single communication channel.

RS-232 - An Electronics Industries of America (EIA) standard for interface between data terminal equipment and data communications equipment for serial binary data interchange. This is usually for communications over a short distance (50 feet or less) and to a single device.

RS-485 - An Electronics Industries of America (EIA) standard for electrical characteristics of generators and receivers for use in balanced digital multipoint systems. This is usually used to communicate with multiple devices over a common cable or where distances over 50 feet are required.

Setpoint (SP):
The desired value for a process variable programmed into a controller. For example, the temperature at which a system is to be maintained.

Shield:
A metallic foil or braided wire layer surrounding conductors that is designed to prevent electrostatic or electromagnetic interference from external sources.

Signal:
Any electrical transmittance that conveys information.

Solid State Relay (SSR):
See Relay, Solid State.

Span:
The difference between the lower and upper limits of a range expressed in the same units as the range.

Spread:
In heat/cool applications, the +/- difference between heat and cool. Also known as process deadband.

Stability:
The ability of a device to maintain a constant output with the application of a constant input.

T

T/C Extension Wire:
A grade of wire used between the measuring junction and the reference junction of a thermocouple. Extension wire and thermocouple wire have similar properties, but extension wire is less costly.

TD (Timed Derivative):
The Derivative function.

Thermistor:
A temperature-sensing device made of semi-conductor material that exhibits a large change in resistance for a small change in temperature. Thermistors usually have negative temperature coefficients, although they are also available with positive temperature coefficients.

Thermocouple (T/C):
A temperature sensing device made by joining two dissimilar metals. This junction produces an electrical voltage in proportion to the difference in temperature between the hot junction (sensing junction) and the lead wire connection to the instrument (cold junction).

TI (Timed Integral):
The Integral term.

Transmitter:
A device that transmits temperature data from either a thermocouple or RTD by way of two-wire loop. The loop has external power supply. The transmitter acts as a variable resistor with respect to its input signal. Transmitters are desirable when long lead or extension wires produce unacceptable signal degradation.

U

Upscale Break Protection:
A form of break detection for burned-out thermocouples. Signals the operator that the thermocouple has burned out.

Undershoot:
The amount by which a process variable falls below the setpoint before it stabilizes.

V

Volt (V):
The unit of measure for electrical potential, voltage or electromotive force (EMF).
See Voltage.

Voltage (V):
The difference in electrical potential between two points in a circuit. It's the push or pressure behind current flow through a circuit. One volt (V) is the difference in potential required to move one coulomb of charge between two points in a circuit, consuming one joule of energy. In other words, one volt (V) is equal to one ampere of current (I) flowing through one ohm of resistance (R), or V=IR.

Z

Zero Cross:
Action that provides output switching only at or near the zero-voltage crossing points of the ac sine wave.

TUNING

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This chapter consists of pages copied directly from two other manuals on the subject of “tuning”. On the surface, tuning is a simple concept. It means adjusting the control to be efficient and tight. It is a perfect tune if the control process involves no overshoot, no undershoot, and no oscillation.

Under the surface, however, tuning is a little more complex. Among other things, it involves multiple variables which are used in algorithms to continuously calculate the outputs required to reduce the error between the process variable (e.g. oxygen) and the process setpoint to zero. It takes time to learn how to tune well. It takes a lot of gas too, you have to try each new tuneset to see if it works sufficiently. It is best to start out changing just one variable at a time to see the result.

It is usually possible to achieve a perfect tune with enough effort. However, sometimes it is more practical to settle for an “acceptable” tune. For example, if you want to control 70% oxygen for four days and you overshoot to 70.8 for a minute or two before the process settles down to exactly 70% for the rest of the four days, the imperfect tune is not likely to have any adverse effects. However the additional effort it might take to tune out the overshoot would be a significant waste of time.

The simplest guide to correcting an unacceptable tune are the graphs at the end of this section. First look at the trend plot of your poorly tuned process. Then look through the graphs until you find one that resembles your process. At the top of the page is a short explanation of the problem that is likely to result in such a graph, and thus a clue on how to correct it.

Again, as in the previous sections, be prepared to translate certain terms in these third party documents in order to understand the important concepts of tuning.

Contents

1.0 PID CONTROL

In the industrial control field there are many written explanations of PID control and yet, after reading the theory, many users are still mystified. What is PID and how do you tune it? Why do I need PID? These are some of the questions that are asked over and over again. This is an attempt to answer from the user's viewpoint, those questions and others, realizing that a complicated control system may or may not need complicated answers.

The control industry has over the years, developed their own terms and the specialized usage of those terms. The passing of time and new methods contributes to the confusion over PID control. Where there are two or more terms, all will be included if possible in the explanation, but only one will be used.

1.1 BASIC ELEMENTS OF PID CONTROL SYSTEMS

A control loop may consist of four or five elements depending upon placement of the functions of some elements. The PRIMARY ELEMENT, the CONTROLLER ELEMENT, the SIGNAL CONDITIONER ELEMENT, the FINAL CONTROL ELEMENT, and the MANIPULATED VARIABLE ELEMENT.

The PRIMARY ELEMENT senses the PROCESS VARIABLE (PV), a thermocouple (T/C) measuring temperature is an example.

The CONTROLLER ELEMENT accepts the signal from the PRIMARY ELEMENT without signal conditioning if it is designed to do so.

If not, then a SIGNAL CONDITIONER ELEMENT is needed and thus another element is added to the control loop. This element transduces the PRIMARY ELEMENT signal into a signal that is acceptable to the CONTROLLER ELEMENT. Example: PSI into 4-20madc.

The FINAL CONTROL ELEMENT is the element the CONTROLLER ELEMENT sends the control signal to. The FINAL CONTROL ELEMENT controls the MANIPULATED VARIABLE ELEMENT.

The CONTROLLER ELEMENT may be a stand-alone controller or a loop in a distributive control system using PID to send a control signal to the FINAL CONTROL ELEMENT. The FINAL CONTROL ELEMENT may be a motor positioning valve unit for the control of natural gas into a burner system or a Solid State Relay (SSR) controlling voltage into an electric load.

The MANIPULATED VARIABLE ELEMENT is the energy of the process such as Steam, Natural Gas, etc... needed by the process for the Process Variable to reach Setpoint.

The control loop may be open or closed loop. The open loop utilizes no feedback from the process, so the control output from the CONTROLLER ELEMENT is preset to some output to produce a desired effect. This assumes that the process is slow enough for corrective action due to information from another source other than the PRIMARY ELEMENT or the process characteristics are such that open loop control will hold the Setpoint within desired limits.

Closed loop makes use of feedback from the process, comparing the Process Variable to the Setpoint, thus providing automatic control to the process.

OPEN LOOP is also known as MANUAL CONTROL, while CLOSED LOOP is known as AUTOMATIC CONTROL.

1.2 CONTROL MODES

The control mode is the form of control function, not to be confused with the type of control output signal. Sometimes, the two are confused as often the mode of control can be a determining factor as to the output type and vice versa.

ON/OFF CONTROL

The simplest way to control PROCESS VARIABLE (PV), otherwise known as process temperature on an over type process to a desired temperature, also known as SETPOINT (SP), is to use ON/OFF control.

The characterization of ON/OFF control is cycling of the Process Variable around the Setpoint. The amount of Process Variable deviation from the Setpoint is primarily due to the process dynamics rather than the controller gain.

Most ON/OFF controllers GAIN, also know as DEADBAND or HYSTERESIS or SENSITIVITY is a fixed percentage of the controller input span. Thus, a gain of 1/2% of a 0-1400 °F Type J span would be 7 °F. This means the controller will not switch the output on, until the PV falls below SP by 3.5 °F and will not switch the output off, until the PV rises above SP by 3.5 °F. Occasionally the deadband is too narrow for the process and intermittent chattering of the Final Control Element may be present. An adjustable gain on the ON/OFF controller function is very useful for eliminating Final Control Element chatter. These particular controllers provide adjustable gain for ON/OFF control loops.

The main output type used with ON/OFF control is the relay. This is used for electrical heating loads, solenoid valves, and two position motor control, just to name a few applications. An analog output such as 0-5 vdc may also be operated as ON/OFF.

PID CONTROL

The PID or 3-mode control is used when ON/OFF control is not satisfactory for the control requirements of the process. If cycling of the PV cannot be tolerated, if process loading is a variable, and if the SP is changeable, the PID would most likely be used in place of ON/OFF control.

The PID initials stand for PROPORTIONAL INTEGRAL DERIVATIVE and the terms are standard throughout the control industry. Confusion about PID may be traced to what once was PID as compared to what is now standard PID terms. Also the definition has changed somewhat from the original concept. Lets take these three-modes one at a time, in the proper order of understanding as well as the proper order of adjustment.

1.3 PROPORTIONAL

PROPORTIONAL is also known as GAIN. The gain of the controller element is the amount of input change required to obtain 100% change in the output of the controller. Maximum gain of one or unity minus the deadband is the highest gain possible. Since cycling of the PV can be the result of high gain, reducing the gain is one way to reduce cycling of the PV. Because of this requirement for the output to be proportional to a change of the input, proportional mode became the common usage term for this control function.

In temperature control systems, the need for the proportional function to be above and below the SP or a band around the SP, caused the term PROPORTIONAL BAND (PB) to represent the gain function of the controller element. The PB is normally expressed as a percent in older instruments. This represents the percentage of the span of the instrument over which the PB is active. Thus, a 0-1400 °F instrument with a PB of 10%, would have a band of 140 °F around the SP in which the output would be proportional. The need to know the span of the instruments involved in the setting of the PB became critical, as 10% PB did not represent the same gain on all instruments. The latest state of the art in control represents PB IN THE ACTUAL ENGINEERING UNIT OF THE INPUT regardless of the span of the instrument. Thus, a PB of 30 represents 30 °F of any T/C range in the these controllers.

Gain may also be used, but once again the span of the instrument becomes critical. A gain of 30 could represent 48 °F for a Type J T/C, 87 °F for a Type K T/C, and 29 °F for a Type T T/C. To obtain PB divide the span by the gain setting.

For temperature control, the most useful and easiest to use is the PB in actual degrees. The nominal setting of the PB can be between 5-20% of the SP. Thus, a SP of 300 °F may require a PB of 15-60 °F. To start use 10% of the SP.

The ideal setting of the PB is to set the PB at a wide band width and then to keep decreasing the band width (increasing gain) until the process cycles about the SP. Take note of the PB at this point and double the figure. PB should be set at this number. Integral and Derivative should be at zero before tuning PB.

The PB of 30 with a SP of 300 °F is saying that the output from the controller will change proportionally from 0 to 100% over 30 degrees. The output will be at 0% or 100%, if the PV is outside the PB of 30 °F from the SP of 300 °F. Below 270 °F the output will be at 100%, at 285 °F it will be at 50% and at 300 °F it will be at 0%.

All control functions take place within the PB, otherwise the controller output is full on or full off with no Integral or Derivative action.

1.4 INTEGRAL

The integral mode is also know as RESET. Reset is the older of the two terms and is more descriptive of the control action that actually takes place. What is Reset and why is it needed?

When the PV is lined out at a point above or below the SP, the deviation from the SP is known as OFFSET. The control action that corrects for this offset, is Reset.

Reset is only active when the PV is away from SP. It is not working when PV is at SP. The unit of Reset most often used is called Repeats/Minute (R/M). This expresses the number of times the PB response is repeated in one minute. As long as reset is active, it will repeat the PB response until the output has reached 0% or 100%.

MANUAL RESET is a manual biasing of the output, so that when PV and SP are together, the output will be at the proper level to hold SP. It is used on batch jobs with the older type controls, but the newer type controls use AUTOMATIC RESET as cost is no longer a factor, with multiloop systems.

AUTOMATIC RESET automatically makes the correction for offset errors, but the R/M value must be set for the process. A .5 to 1 R/M would be a good starting point for most processes. A slow process requires a slow reset (less than 1R/M). When too fast of a reset is used, the PV may slowly cycle around the SP. When using PB only, process dynamics will insure an offset. Changing SP, changing loads, and weather changes could and do require Reset mode to be added to a control loop.

In controlling a process to a SP, process engineering must allow the controller to be within it's control capability. In most processes, the controller element is the fine control, while the process itself is the course control. If all of the variables could be defined and precisely controlled, when engineering a process, then a predetermined reset could be used. When sizing control valves, electrical loads or whatever the final element might be, the correct sizing will be one that allows the controller output to be in the 40-60% of it's output when PB lines out at SP at mid-range of the process control span.

In the example of the PB at 30 and the SP at 300 °F, we said that 50% of the output would be obtained at 285 °F. With the above statement, about engineering the process for the controller output to be at 40-60% to obtain control, then it would be reasonable to assume that the PV could line out at 285 °F. This is an offset of 15 °F from 300 °F.

To shift the PB so that 50% of the output is at 300 °F, Reset is used. This would place the PB around the SP with 100% output at 285 °F, 50% at 300 °F and 0% at 315 °F. The shifting of the PB may be by Manual Reset which requires someone to shift the output, so that it would increase the output at 285 °F to 100%.

If, AUTOMATIC RESET is .5 R/M and assuming the last PB response was 10%, with the output at 50% needing to go to 100%, after the first minute, the output will be at 55%. After the second minute, it will be at 60%. After the third minute, it will be at 65% and so on until the output is at 100%.

It would take ten minutes to do this, assuming that there was no temperature rise. With some temperature increase, the PB would try to decrease the output, this could take longer then the original time frame. The PB and RESET interact and thus the output signal is a composite of the two control modes. This interaction would continue until SP was reached, where RESET becomes inactive, but a new output level has been established for the necessary level required to hold the PB to the SP.

When adding RESET to the control mode of a controller, the addition of the RESET mode normally requires widening of the PB from the PROPORTIONAL mode control only setting.

1.5 DERIVATIVE

The Derivative mode is also known as RATE or ANTICIPATING or APPROACH. The RATE is the more common term used. The function of RATE is to prevent the overshoot or undershoot of PV with respect to the SP. It does this by slowing the rate of approach of the PV to the SP.

When using PB with RESET, the PV must go past the SP in order for the RESET function to reduce the output and the correct setting of the PB will also cause the PV to exceed the SP.

Thus, a Two-Mode control will have overshoot, if it is correctly set. Most processes can tolerate an overshoot, but if the overshoot of the PV to the SP cannot be tolerated, then the RATE function must be used. RATE is used for rapid load changes, slow large capacity processes and to overcome the slew rates of electric motor actuators.

The RATE function is derived from the PB response to a change of the PV to the SP and is only active while the PV is in a rate of change to the SP. It anticipates that the PV will overshoot the SP and will add it's control function to the PB response, thus reducing the output by twice the amount of the PB function alone.

The RATE time in minutes is how long the RATE function is applied to the controller output. After the RATE time is up, the RATE function response is taken off the output, raising the output back to the PB response only. The higher the number, the longer the RATE function is applied and the faster the output is reduced, thus preventing overshoot. Too high of a setting of the RATE will cause undershooting of the PV.

With 3-MODE control the output signal is a composite of the three control functions and will vary as the functions require to hold the PV to the SP.

1.6 ANAFAZE OUTPUT FILTER

The OUTPUT FILTER used by ANAFAZE controllers is a digital filter on the output signal after the PID functions. It has a range of 0-255 divided by 2 that gives a time constant of 0-127.5 seconds. It is used to filter out erratic swings of the output due to extremely sensitive input signals, such as open air T/C in a dry air gas oven or a turbine flow signal.

It can be used also to allow the PID to function more effectively than a PID alone. Some processes may be so sensitive and the PB so wide, that good control is not possible due to the low gain of the PB. By increasing the digital output filter to reduce the output high and low swing due to the process, the PB may be narrowed (lower number) to obtain good control by using a higher gain.

The filter can also be used to forgive badly tuned PID loops and poorly designed processes.

2.0 CONTROL OUTPUTS

2.1 RELAY OUTPUT

Relay outputs have two types of operation and two forms that must be considered. The one type of operation is ON/OFF and the other is TIME PROPORTIONING. The form of the relay may be ELECTROMECHANICAL or SOLID STATE. The SOLID STATE RELAY is known as an SSR and will be referred to as such.

When using ON/OFF control the output form may be relay or SSR. The ANAFAZE controller outputs a 5 vdc gate signal for the SSR. The SSR may drive the coil of a relay of the coil of a solenoid valve. The SSR output may also be selected to directly drive heating loads up to 75 Amps at 480 vac. When using ON/OFF control, the cycling of the PV is considered as typical and may not be a problem. When controlling an electrical load, the cycling may be smoothed out to straight line control by using TIME PROPORTIONING on the output relay or SSR.

TIME PROPORTIONING is the proportioning of a selected fixed cycle time as to the ON time versus the OFF time. With a cycle time of 10 seconds and the PV at SP the ON time would be 5 seconds and the OFF time would be 5 seconds. The ON time would increase and the OFF time decrease proportionally, if required to increase the temperature in an electrical oven. The PID control function varies the ON time versus the OFF time as required to hold the PV to the SP.

TIME PROPORTIONING is primarily used on electrical energy type of processes. Some applications may use solenoid valves in a time proportioning mode, rather then ON/OFF. The general rule of thumb for cycle time is no less than 10 seconds for the electromechanical relay and no more than 5 seconds for the SSR. Normally the faster the cycle time, the closer the control. Suggested cycle times for relays would be 20 seconds and for SSR 2 seconds.

2.2 ANAFAZE DISTRIBUTIVE ZERO CROSSING

The DISTRIBUTIVE ZERO CROSSING (DZC) output is one of the options available with the ANAFAZE controller. This output is primarily for very fast acting electrical heating loads using SSR. The open air heater coil is an example of a fast acting load. It should never be used with electromechanical relays.

The DZC output is a CYCLE PROPORTIONING output. Whereas the TIME PROPORTIONING is a fixed cycle time with an ON-OFF time in seconds, the DZC determines the number of cycles needed as well as how many of the cycles are on or off as required by the controller function to hold the PV to the SP.

The output of 25% from the controller function would have one cycle on with three off for 25% output to the load. An output of 50% would have one cycle on and one cycle off. The output of 30% would have one cycle on with two off and every fourth cycle group would have four cycles in it, with two cycles on and two cycles off. This makes up the 1/3 of the cycle that was not being turned on it the first three cycle groups. An output of 75% would have three cycles on with one off. The total number of cycles and their on-off states must add up to the 100% of the controller output.

With the use of the DZC output, a very fine resolution of the available energy for process control is obtained.

2.3 ANALOG OUTPUTS

Analog output may be CURRENT or VOLTAGE and are continuously proportional over the range of the output signal level. The standard industrial signal level is 4 to 20 madc for the CURRENT output and 0 to 5 vdc for the VOLTAGE output control signals. There have been many signal levels over the past years, but the 4-20 is the most widely used today. It is a PID control output signal, as well as the transmission signal of remote transmitters of analog inputs used in the industrial control field. It should not be confused with the 20 ma current loop of computer communications.

The analog signals drive many types of FINAL CONTROL ELEMENTS such as electric proportioning motors for gas valve control of burner systems, I/P transducers for pneumatic control of valves, and SCR controls for phase angle control of electrical loads.

2.4 REVERSE-DIRECT ACTION

The ACTION of the control OUTPUT with RESPECT to the PV is known as REVERSE ACTION, if the OUTPUT INCREASES as the PV DECREASES. If the OUTPUT INCREASES as the PV INCREASES, then it is known at DIRECT ACTION.

Heating applications normally use REVERSE ACTION and Cooling applications normally will use DIRECT ACTION. The selection of the control ACTION is usually dependent upon what is the process requirement upon power failure. The selection may also be dependent upon the application of two competing mediums of energy such as in a HEAT/COOL or TEMPERATURE/HUMIDITY applications.

2.5 HEAT/COOL DUAL OUTPUTS

The requirement of HEAT/COOL modes of operation on some processes, such as in the plastics field, require DUAL OUTPUT control from the controller. The DUAL OUTPUT control uses only one Input as the PV for both Outputs. The standard use of the DUAL OUTPUT is in a HEAT/COOL mode of operation. It may also be used as a HEAT/HEAT or COOL/COOL for two stage control requirements.

ANAFAZE controllers provide separate PROPORTIONAL and RATE adjustments for the HEAT and COOL outputs with spread control that allows infinite tuning for process control requirements.

3.0 ANALOGY OF PID CONTROL TERMINOLOGY

The terminology of PID may be confusing to technical, as well as non-technical individuals, who have a need to have some understanding of PID control, due to work requirements. The comparing of an unknown to the known has been a relative easy way to explain a difficult subject for many years. The following analogy has been used for many years and very successfully. The PID terms have been equated to that of driving a car.

The little ole lady from Pasadena, the grandmother type, was out for a Sunday drive. As she was waiting at a stop light for the light to turn green, a young man who shall remain nameless, pulled up along side her. This young man had just received his driver's license and had Daddy's car out for the first time by himself. Pumping the gas pedal, he was gunning the engine and looking over at the little ole lady. Needless to say, when the light turned green, he stepped on the gas hard. With burning tires, he squealed away leaving the little ole lady behind. She in her turn, gradually stepped on the gas, gently bringing the car up to the speed of 30 mph. The young man in the meantime had reached the next stop light and it was red. He slammed on the brakes and came to a very quick stop.

While waiting for the light to turn green, the young man was gunning the engine and watching in his mirror as the little ole lady gradually came up behind him. As she approached the light, it turned green. She went through the light without needing to change the car speed, while the young man once again stepped on the gas hard. They continued to repeat the same action over and over again. She proportioned her speed to reach each light as it turned green, while the young man was cycling between stepping on the gas or the brake. His gain was too high, as he reacted too fast to changing conditions. This caused cycling of his car speed to an on-off state, not to say anything about his Dad's state of mind, if he had known. The little ole lady had proportional control over her car speed by reacting gradually to changing conditions. This is known as the PROPORTIONAL FUNCTION.

Now, the little ole lady with proportional control was trying very hard to maintain the 30 mph. This was the speed that the traffic lights were set for, this allowing the smooth flow of traffic. As she approached a fairly steep hill, her speed started to fall off. Her initial response was a proportional push on the gas pedal. This was not enough to hold the speed to the 30 mph she wanted. She very gently increased the pressure on the gas pedal, raising the speed back up to 30 mph. As she started to go on the downside of the hill, the car speed started to slowly increase. She slowly backed off the pressure to the gas pedal, trying to maintain the 30 mph. This is known as reset, as the was resetting the engine speed to maintain 30 mph with changing load conditions. This is the RESET FUNCTION.

The little ole lady now was very close to home and had turned off the highway she was on. A couple of blocks in front of her, she could see the traffic light was green. As she was watching, the light turned yellow and then went to red. Upon seeing the light turn yellow, she took her foot off the gas pedal, because she had anticipated that she was going to stop, as the light was soon to be red. Now, the rate of approaching the light was too fast and she knew that she would coast into the intersection, if she did not step on the brake. By gently stepping on the brake, she could control the rate of approach of the car to the white line. If, upon stepping on the brake too lightly, she could overshoot the white line and go into the intersection. Then, by stepping on the brake too hard, she could undershoot, stopping way back of the white line and then would need to creep up to the white line. By applying the proper amount of braking, she was able to stop the car at the white line with no over or undershooting. This is known as the RATE FUNCTION.

With the OUTPUT FILTER of the Anafaze System, a new function had to be added to the analogy.

Remember the young man from the proportional section that had was too much gain? It seems that Daddy did find out and started to look for ways to curb the young man's appetite for rash action without cutting off his foot or waiting until he was 40 years old. Daddy's car is an 8 cylinder engine with a 4 barrel carb which reacted very fast to the young man's demand. Daddy acquired a 6 cylinder for his son to drive and decided after a couple of tickets for squealing tires, to replace it with a 4 cylinder. Things were going along very well, until Daddy took the car out for a drive. Upon trying to pass a truck and forgetting about the 4 cylinder's response to a rapid demand for speed, Daddy made another swap. He got a 4 cylinder with a turbo. All in all, Daddy and his young man were happy with the response of the car to various conditions.

The 8 cylinder is equivalent to a low filter number. The 4 cylinder would be a high filter number. A single cylinder engine would be equivalent to a very high filter number. By having a high gain due to youth and a low horsepower due to engine size, a fast response would not allow squealing of the tires. A response may be made, but not fast enough to hurt anything. Thus, a high filter setting would reduce high reactions to changing conditions. This is the OUTPUT FILTER FUNCTION.

4.0 TUNING PID CONSTANTS

The tuning of 1, 2, and 3-mode PID control loops, is in truth, a relative simple matter. The amount of change of the controller output, controlling the final control element, with respect to a change of the input process variable (PV) is the key.

The technique for tuning is done in steps of order: PB, TI, and TD. The process may require P only, PI only, or PID. They are also known as single mode, two mode, or three mode control.

4.1 PROPORTIONAL CONTROL

The P mode of the PID is the Proportional Band (PB) or Gain (Kp) of a PID controller and it is the major element in the tuning of a PID loop. It is the function that responds to a process change on a proportional basis and will adjust the controller output proportionally.

ANAFAZE controllers automatically present the PB in the engineering units of the input. Thus, a PB of 20 for a T/C input will be 20 degrees F or C, no matter the T/C type. For a PSI input, it will be 20 PSI. For ease of understanding, the engineering unit of temperature will be used.

The PB is the control band around the SP and when the PV is outside this band, the output will be 0% or 100%. ANAFAZE sets the PB with no TI as all below the SP. Thus a PB of 20 with a SP of 400 will give 100% output at 380 or below, 50% output will result in a high change in the process variable and cycling of the PV will normally be the result.

The general rule for proportional control is the smaller the change of the output for a given change of the input, the finer the resolution of control, and thus a more proportional control is achieved. A high amount of change in the output will result in a high change in the process variable and cycling of the PV will normally be the result.

PB is selected to give the highest amount of output change without causing the output and/or the PV to cycle. This is determined by the actual process physical characteristics, such as the primary energy source, the thermal loading, and the response of the primary as well as the final control element.

The general range of change in the output as a change of the input, is 1-5% change per degree, in a temperature control system. There are processes requiring other than the 1-5% change, but this range will handle most temperature control systems.

To obtain the PB for a given change in the output divide the output range of 100% by the degrees of the PB. Thus a PB of 25 will give a 4% change of output per degree change of the input.

The practical range of PB is listed with the resultant change in the output. PB outside of this range are not useful in most temperature applications.

PB DEG F	OUTPUT % CHANGE/DEG	PB DEG F	OUTPUT % CHANGE/DEG
5	20	65	1.53
10	10	70	1.42
15	6.6	75	1.33
20	5.0	80	1.25
25	4.0	85	1.17
30	3.3	90	1.11
35	2.8	95	1.05
40	2.5	100	1.00
45	2.2	125	.80
50	2.0	150	.66
55	1.8	175	.57
60	1.6	200	.50

Another general rule of thumb for setting the PB is to use 10% of the Setpoint below 1000 degrees F and 5% above 1000 degrees F as the initial PB setting. Decrease the PB until the output is cycling about 2-3% or less of the output average. This should be the optimum PB setting.

4.2 INTEGRAL

Temperature is a function of time as well as a give BTU input with a given loss of BTU. No process is dependent on BTU only. The time constant of a process may be short or long depending on the physical characteristics of the process. The control mode that uses the time element as a control function is the RESET or INTEGRAL mode. This is the I of the PID.

ANAFAZE controllers present the INTEGRAL as TI which is the time function of the INTEGRAL/RESET mode. This number is in seconds and expresses how fast the control action will repeat itself. The smaller the number, the faster the repeat. The RESET unit of Repeats/Minute (R/M) = 60/TI. Thus a TI of 120 would be .5 R/M.

This repeat function is to repeat the PB change in output and to do it in the time frame of TI. The setting is in how many seconds, the INTEGRAL mode will increase or decrease the output, so the PV and the SP will be together with no error. This gives the effect of shifting the PB around the SP, thus the output will not be at 0% when PV is at SP.

Whenever the PV is away from SP, called Offset, there is a proportional error signal which is the first response of the PID control function. If the proportional error signal is not reduced to zero, the INTEGRAL mode will repeat the proportional error signal to the output, at the rate of the INTEGRAL TI. It will continue this function until the output has increased to 100% or decreased to 0%.

The INTEGRAL mode is not active with no PB error, thus INTEGRAL is not active when PV is at SP.

At some point the process should reach equilibrium with an output between 20-80%. The ideal range of the control output should be 40-60%. This is determined by the process characteristics, not by the controller.

The INTEGRAL is not only changing the output of the controller in the amount of the PB change, but at the rate of change of the TI setting. Thus a narrow PB will give a high level of change as well as a low setting of the TI. A wide PB will give a lower change in output as well as a higher TI. The range of a practical TI is 30 to 600 seconds (3 to .1 R/M). The setting below 30 seconds will normally cause cycling of the output, and the setting of 600 seconds and above is practically the equivalent of manual reset.

The general rule of setting the TI, is the faster the process, the lower the TI and the slower the process, the higher the TI. A process that will come to a new control point after a step change in 20 minutes is considered fast. After 1 hour, it is considered slow. Settings below 60 seconds are considered fast, with settings above 240 seconds are considered to be slow. In general, settings of 60, 120, 180, and 240 seconds will handle most processes.

To produce a 100% change in the output, with a PB of 20 and a TI of 60, a 1 degree change in the PV would result in a 5% change in the output. The INTEGRAL setting would result in a 95% change in the output in a time frame of 19 minutes.

100% output - 5% PB = 95% / 5% (1 R/M) = 19 minutes

Too high of a TI will not allow the PV to come to SP within a reasonable amount of time. Too low of a TI will cause the output to cycle, thus causing the PV to cycle at a slow rate.

4.3 DERIVATIVE

With proper setting of the PI and depending on the process characteristics, the PV will overshoot the SP, which is considered normal control characteristics of PI or Two-Mode control. This overshoot is known as a Quarter Wave Decay. The overshoot may not be a problem in most processes, but if it is of concern, then the D of the PID comes into play, known as the DERIVATIVE or RATE mode.

ANAFAZE controllers present the DERIVATIVE as TD which is the time function of the DERIVATIVE/RATE mode. This number is in seconds and expresses how long the DERIVATIVE will be active in adding to the output control signal. The higher the number, the longer the DERIVATIVE action is applied. The RATE unit of RATE MINUTES (RM) = TD/60. Thus a TD of 15 would be .25 RM.

As the PV approaches the SP, the rate of the approach may be too fast. This will be due to the PB and the TI mode settings for proper control at SP. In order to slow down the rate of approach of the PV, it will be necessary to change the controller output without changing the PB.

The RATE mode utilizes the amount of the PB change due to the changing PV. It will add the amount of the PB change to the controller output and will hold it for the amount of the TD setting. After the TD time is up, it will reduce the amount of the control change to the PB change only. This will produce the same effect as reducing the PB by half, for the amount of time of the TD time setting. This resultant change is to reduce or increase the output much quicker, than when using the PB mode only.

The DERIVATIVE mode is only active upon a change in the PB error, this it is not active when the PV is not changing.

The normal setting of the TD is strictly dependent upon the process. As all process responses may vary from process to process, the setting will need to be determined per process. The normal way to set the TD mode is to use a small amount such as 10 seconds and then using a step change in the SP, watching for a reduction in the overshoot. If need be, increase the TD time and do another step change until the overshoot is reduced to the desired amount. If, undershooting occurs, reduce the TD. In general, a setting of 15% of TI will produce satisfactory results. With a TI of 120, a TD of 18 should work.

DERIVATIVE TD should be turned off, if it is not required, as it will tend to reduce the stability of the control output signal.

4.4 PID CONSTANTS FOR THE ANAFAZE SYSTEMS

Useful Ranges	Nominal Setting
PB 10 to 200 Degrees	40 Degrees
TI 30 to 600 Seconds (2 to .1 R/M)	60 Seconds
TD 3 to 60 Seconds (.05 to 1 RM)	OFF or 10
Digital Filter 0 to 25	4

The PID control is a composite of three modes of control using gain, time and variable gain. It will be of a changing nature. Please allow time for the process to settle after making a change. A time period of 20 minutes is suggested.

ANAFAZE STANDARD SET VALUES FOR PID LOOPS

PROPORTIONAL BAND ONLY (P)
PB = Set 7% of SP Example: SP = 450 PB = 31 TI = OFF
TD = OFF
Output Filter = 0

P with INTEGRAL (PI)
PB = Set 10% of SP Example: SP = 450 PB = 45 TI = 60
TD = OFF
Output Filter = 2

PI with DERIVATIVE (PID)
PB = Set 10% of SP Example SP = 450 PB = 45 TI = 60
TD = Set 15% of TI Example TI = 60 TD = 9
Output Filter = 2

ABOVE VALUES HAVE BEEN USED FOR MANY APPLICATIONS AND IN GENERAL WILL BE USEFUL IF NOT FOR CONTROL THEN FOR A STARTING POINT FOR TUNING THE PID.
NOTE! CONTROL MUST BE IN AUTO.

GENERAL PID CONSTANTS BY APPLICATION

	PB	TI	TD	FIL	OUTPUT	CT	ACT
ELECTRIC HEAT W/ SOLID STATE RELAYS	50	60	15	4	TP	3	REV
ELECTRIC HEAT W/ MECHANICAL RELAYS	50	60	15	6	TP	20	REV
GAS HEAT W/ MOTORIZED VALVES	60	120	25	8	ANA	NA	REV
GAS HEAT SP/1200	100	240	40	8	ANA	NA	REV
EXTRUDERS W/ COOLING - HEAT W/ SSR SET SPREAD TO 0	50	300	90	8	TP	3	REV
COOL W/ SOLENOID VALVE	10	OFF	OFF	4	TP	20	DIR
COOL W/ FANS	10	OFF	OFF	4	TP	60	DIR
ELECTRIC HEAT W/ OPEN HEAT COILS	30	20	OFF	4	DZC	NA	REV
ELECTRIC HEAT W/ SCR CONTROLLERS	60	60	15	4	ANA	NA	REV

Tuning

5.0 PID TUNING CONSTANTS

PROPORTIONAL BAND SETTINGS

THE FOLLOWING TABLE REPRESENTS AN AVERAGE SETTING FOR THE PB IN RELATIONSHIP TO THE SETPOINT OF THE CONTROLLER WITH A TEMPERATURE INPUT:

TEMPERATURE SETPOINT	PB	TEMPERATURE SETPOINT	PB
-100 TO +100	20	1600 TO 1699	100
+100 TO +199	20	1700 TO 1799	105
200 TO 299	30	1800 TO 1899	110
300 TO 399	35	1900 TO 1999	120
400 TO 499	40	2000 TO 2099	125
500 TO 599	45	2100 TO 2199	130
600 TO 699	50	2200 TO 2299	135
700 TO 799	55	2300 TO 2399	140
800 TO 899	60	2400 TO 2499	145
900 TO 999	65	2500 TO 2599	150
1000 TO 1099	70	2600 TO 2699	155
1100 TO 1199	75	2700 TO 2799	160
1200 TO 1299	80	2800 TO 2899	165
1300 TO 1399	85	2900 TO 2999	170
1400 TO 1499	90	3000 TO 3099	175
1500 TO 1599	95	3100 TO 3199	180

As a general rule use 10% of the SP below 1000 and 5% above 1000 for a starting point in setting the PB.

INTEGRAL (TI) VERSUS RESET REPEATS/MINUTE (R/M)
RESET R/M = 60/TI

TI (SEC.)	R/M	TI (SEC.)	R/M	TI (SEC.)	R/M
30	2.0	150	.40	300	.20
45	1.3	180	.33	400	.15
60	1.0	210	.28	500	.12
90	.66	240	.25	600	.10
120	.50	270	.22		

As a general rule use 60, 120, 180, or 240 for TI.

DERIVATIVE (TD) VERSUS RATE MINUTES (RM)
RATE = TD/60

TI (SEC.)	R/M	TI (SEC.)	R/M	TI (SEC.)	R/M
5	.08	25	.41	45	.75
10	.16	30	.50	50	.83
15	.25	35	.58	55	.91
20	.33	40	.66	60	1.0

As a general rule set TD to be 15% of TI.

6.0 TUNING PID LOOPS

The control loop to be tuned should be placed in auto after tuning. If the loop is in auto and controlling, to avoid upsetting the process, place the control in manual. After the loop is placed in manual, the PID values may be changed without upsetting the output. After tuning, place the loop back into auto. If a small upset of the output is not important then the PID constants may be tuned while in auto.

When tuning, remember that time is a factor in most processes and especially in temperature processes. Along with the dynamics of the process, the results may be slow to see. Allow time between adjustments, before making new ones. Twenty minutes is highly recommended for most processes.

6.1 PROPORTIONAL CONTROL

When using single mode PB only for control, set the TI and TD to OFF. The initial PB setting may be obtained from the PID TUBING CONSTANTS Table. Normally using P only for control will require a smaller PB than using PI and PID. A range of 3% to 10% of the SP is a useful range for the PB with P only control.

To fine tune the PB, reduce the PB until the PV looks like Plot F, constant cycling around the SP. Increase the PB in steps of 1% of the SP, until there is no cycling of the PV.

6.2 PROPORTIONAL WITH INTEGRAL CONTROL

The Two-mode PI is the most common of the control modes in use in the industry. It must be tuned by tuning the PB first and then the TI may be tuned. Many times preset values may be used to shorten the time required for tuning.

The initial setting for the PB may be obtained from the PID TUNING CONSTANTS Table. A useful range will be in the 5% to 20% of the SP. The initial TI should be set for 60 with TD set to OFF. Set the Digital Filter to 2. Make a step change in the SP. The PV response should look like Plot B. Correct setting of the PI will give a Quarter Wave Decay response.

Look at Plot D, E, G, and H. If the PV responds to the step change by looking like one of those Plots, take the proper action decreasing or increasing the PI values as is required.

If the PV looks like Plot D, increase the PB in steps of 1% of the SP.

If the PV looks like Plot E, decrease the PB in steps of 1% of the SP.

If the PV looks like Plot G, increase the TI in steps of 30 seconds.

If the PV looks like Plot H, decrease the TI in steps of 30 seconds.

Repeat making step changes of the SP and adjustments of the PI until the PV response looks like Plot K.

Use of TI below 30 seconds will most likely cause cycling and is not recommended for most applications. Use of TI above 500 seconds is not recommended as it will give the effect of using manual reset. 500 seconds and above should only be used when manual reset is desired for the control action.

6.3 PROPORTIONAL W/INTEGRAL & DERIVATIVE CONTROL

The Three-mode PID control is used primarily when overshoot of the PV cannot be tolerated as in the Quarter Wave Decay response of two-mode PI control. The PI must be tuned first before attempting to tune the Derivative mode.

Initial setting of the PB may be selected from the PID TUNING CONSTANTS Table. Initial TI setting may be set to 60. Adjust as above in the PI tuning. After tuning PI, a setting of 15% of the TI may be used for the TD setting. Make a step change. The response should look like Plot A.

If the PV looks like Plot L, increase the TD setting by 1% steps of the TI setting.

If the PV looks like Plot M, decrease the TD setting in 1% steps of the TI setting.

Make step changes in the SP and the TD until the PV response looks like Plot N.

To see the difference between a narrow PB or a fast TI causing cycling of the PV, see Plot J. A small amplitude and short time period of the PV cycling is characteristic of a narrow PB. A greater amplitude and longer time period is characteristic of too fast of a TI.

6.4 OUTPUT DIGITAL FILTER

There is no tuning step for the Output Filter. Adjusting the PID without the Filter (set at 0) will give the fastest output response to a step change. The Filter may be turned on at any time. If the PV is cycling with the PB at 20% of SP or the output is changing more than 2-3% with good PID values, the Digital Filter may be turned on. Settings of 2, 4, 6, 8, 10, 12, and 15 have been used. Settings of 4, 6, and 10 are common filter settings. Increase filter setting in steps of 2 until output or PV has stabilized. Remember to allow at least 20 minutes between adjustments.

After PID values are selected for proper response of the PV, these values will remain the same in most processes without need of re-tuning. Most heat/cool processes do not have the characteristics that require re-tuning of the PID constants.

The PB is one variable that would change when operating at a very low temperature and then operating at a much higher temperature. For instance, controlling at 250°F and 2250°F with the same controller will require different PB values. See the PB Table on the PID Tuning Constants page.

TI and TD will most likely remain the same without need of further tuning. There are two situations that may require a new value for the TI. The first one is when changing process material loads from a very large load to a much lighter load. The second situation is of a changing process load due to exothermic based processes.

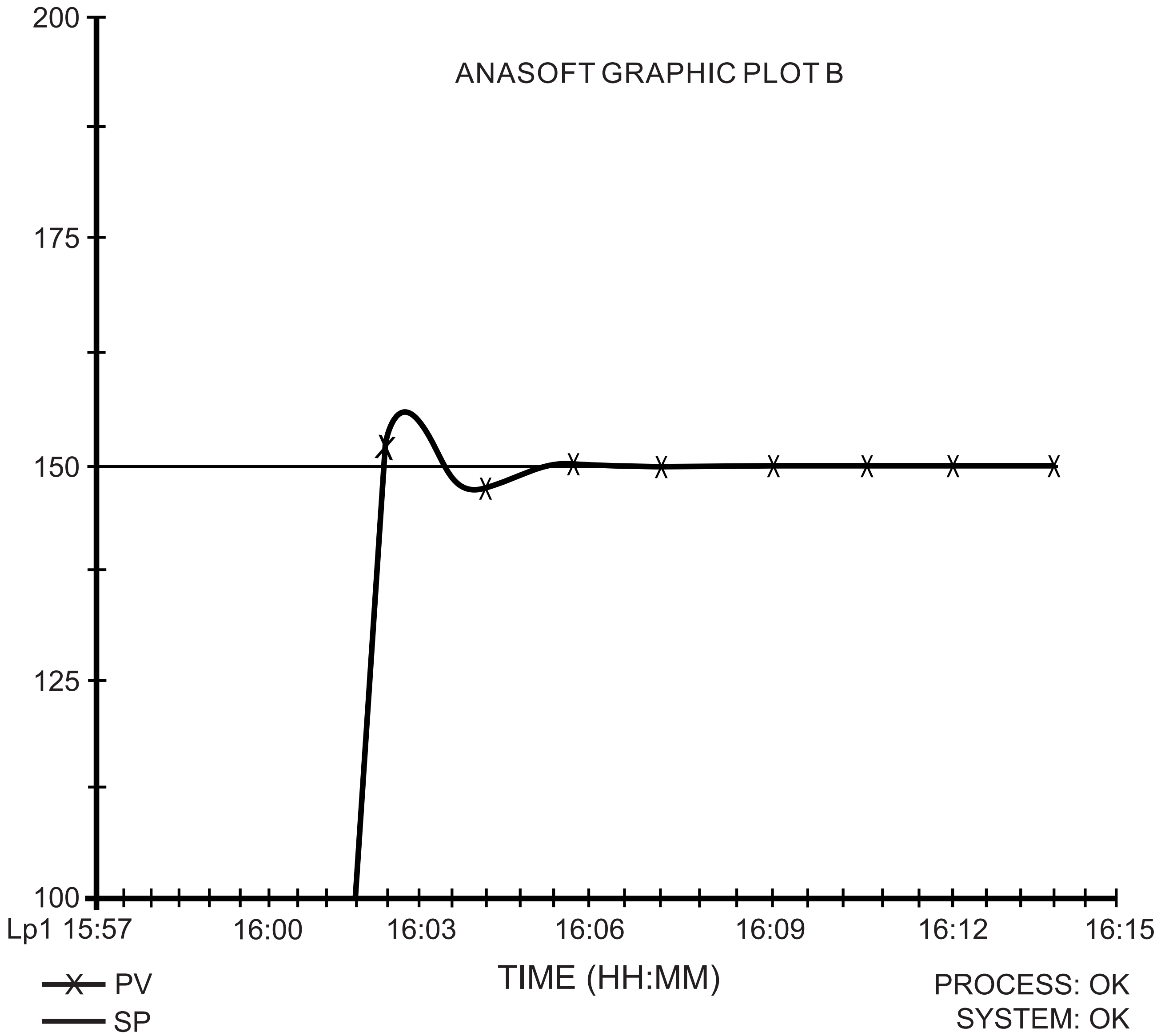
When changing TI and the Derivative is in use, the TD should also be changed.

Remember, most likely PID values will not need to be changed after they have been set correctly. Changing PID values to correct for process problems, will normally cause more problems.

7.0 Plot Examples

ANASOFT Plot B: 1/4 Wave Decay

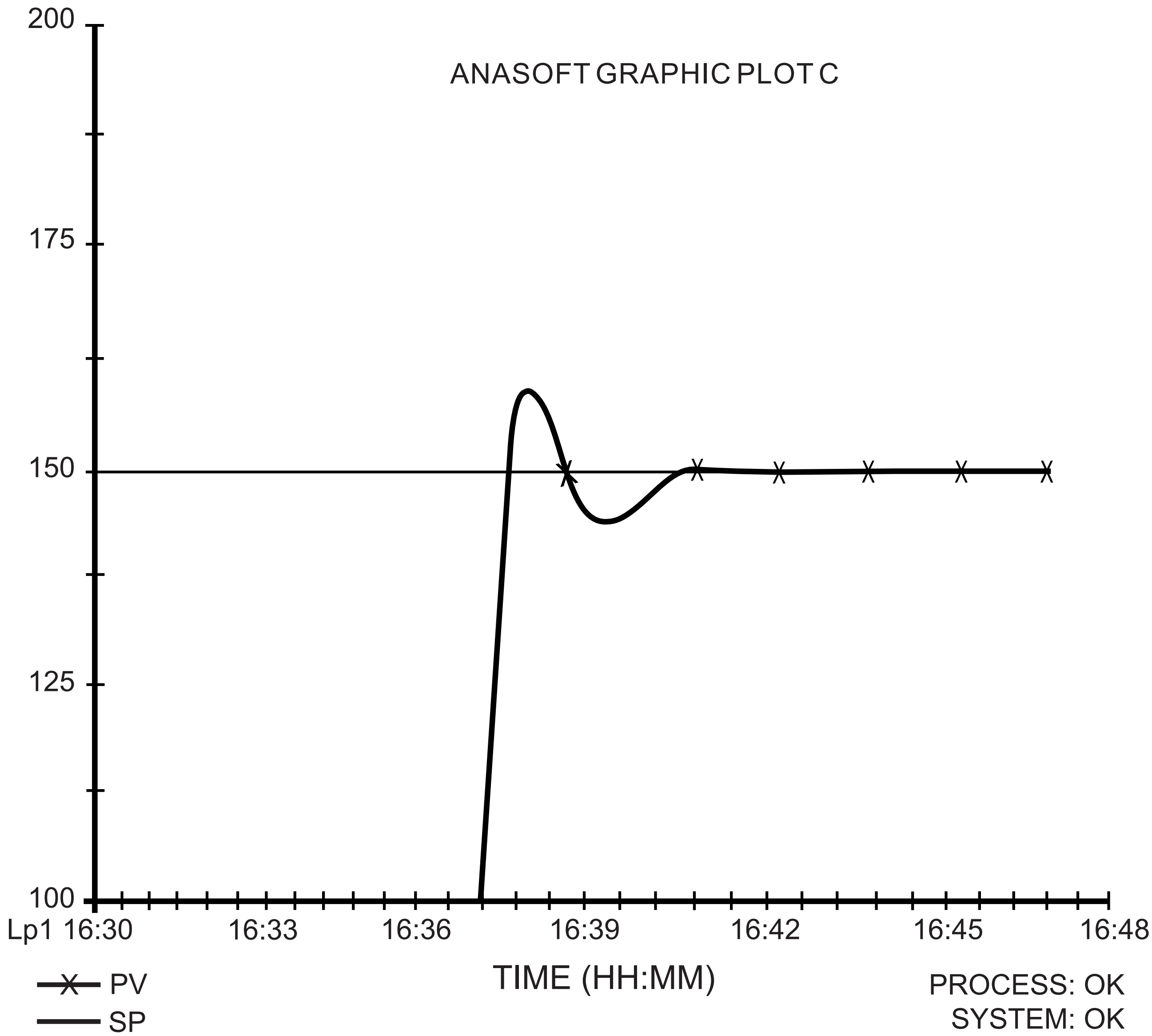
Plot B represents what is known as Quarter Wave Decay. The correct setting of PI will give overshoot. When the PI is correct the return to SP upon a step change will decay in what is known as Quarter Wave Decay. The amplitude of each overshoot and undershoot of the PV should be 1/4 of the preceding wave until it is reduced to no cycling of the PV at SP. The initial overshoot is about 6 degrees. The undershoot should be 1.5 degrees. The next overshoot is .375 degrees and so on until the PV is within the control resolution of the PID control.



1/4 WAVE DECAY WITH OVERSHOOT

ANASOFT Plot C: Correct PI Constants

Plot C represents the correct setting of the Proportional Band and the Integral. Note that with the overshoot, the return to the new SP is with the minimum number of cycles of the PV. The PB = 20 and the TI = 60.

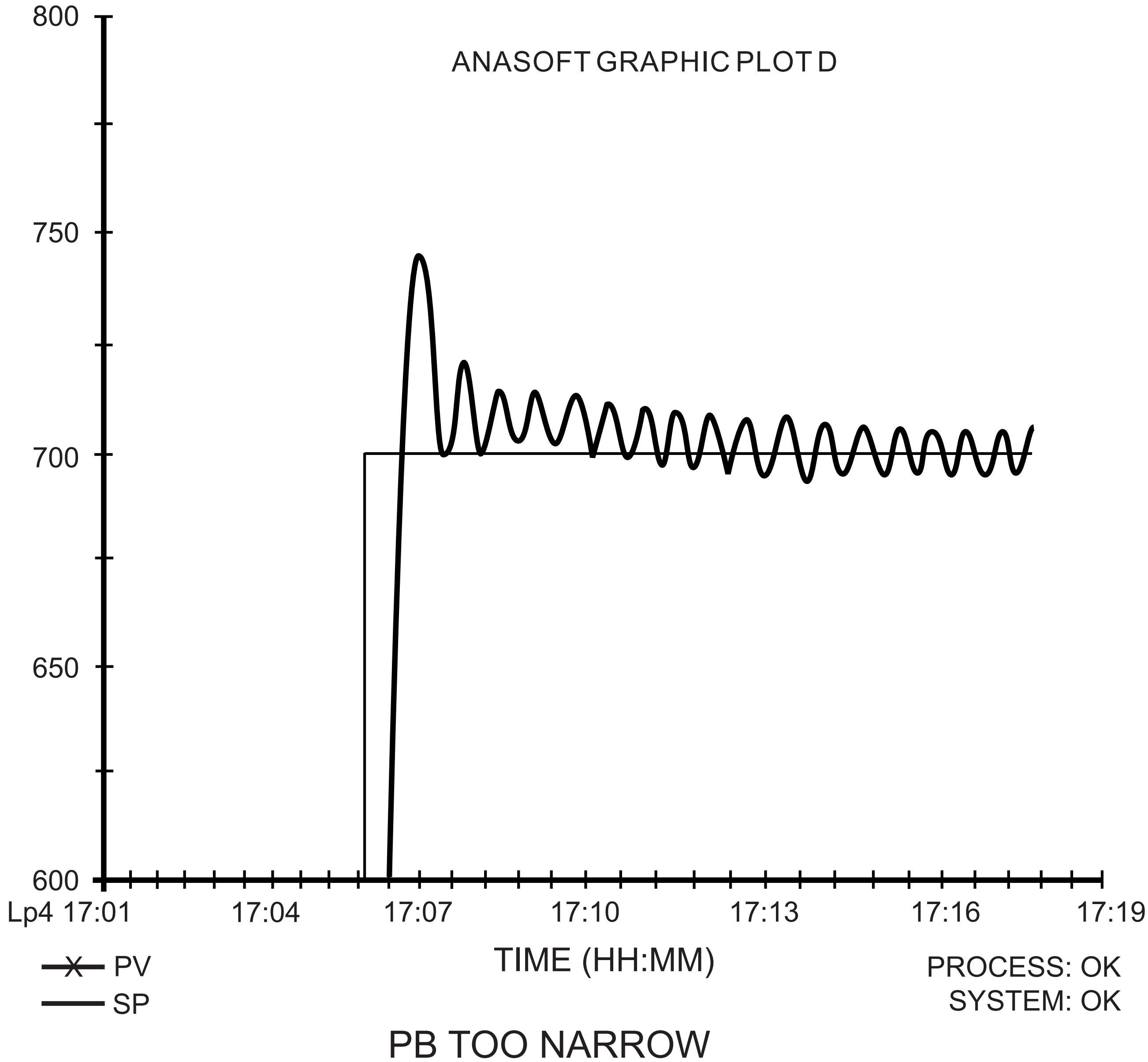


CORRECT P AND I VALUES

Tuning

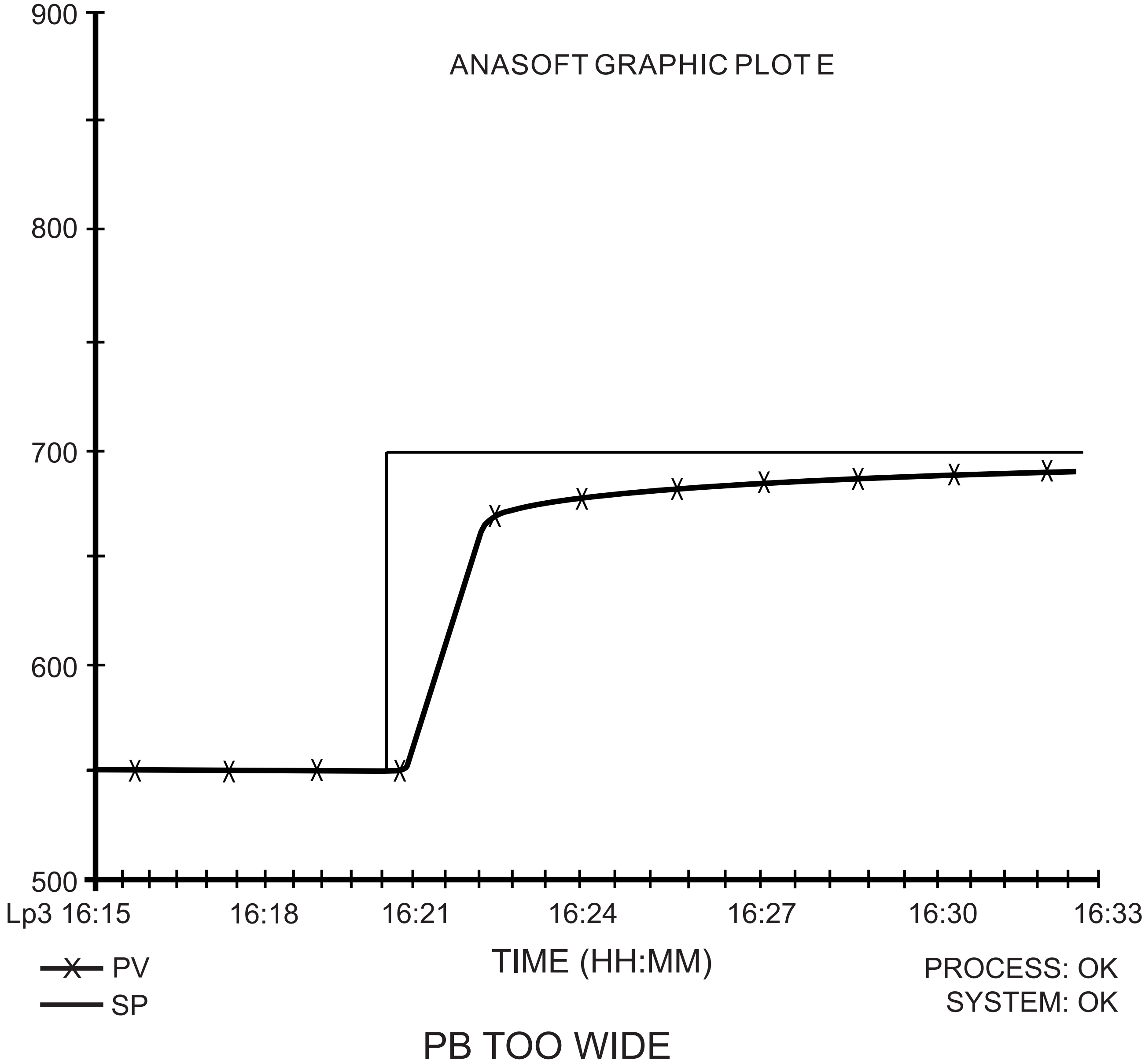
ANASOFT Plot D: PB Too Narrow - Number Too Low

Plot D represents what happens to the PV when the PB is too narrow for the SP. The PV will overshoot upon a SP step change and then continue to cycle about the SP. Note the slow reduction of the PV to the SP. This is the same effect as ON/OFF control. The output level may cycle from 0% to 100%. The PB = 10 whereas the nominal setting for 700° should be 55.



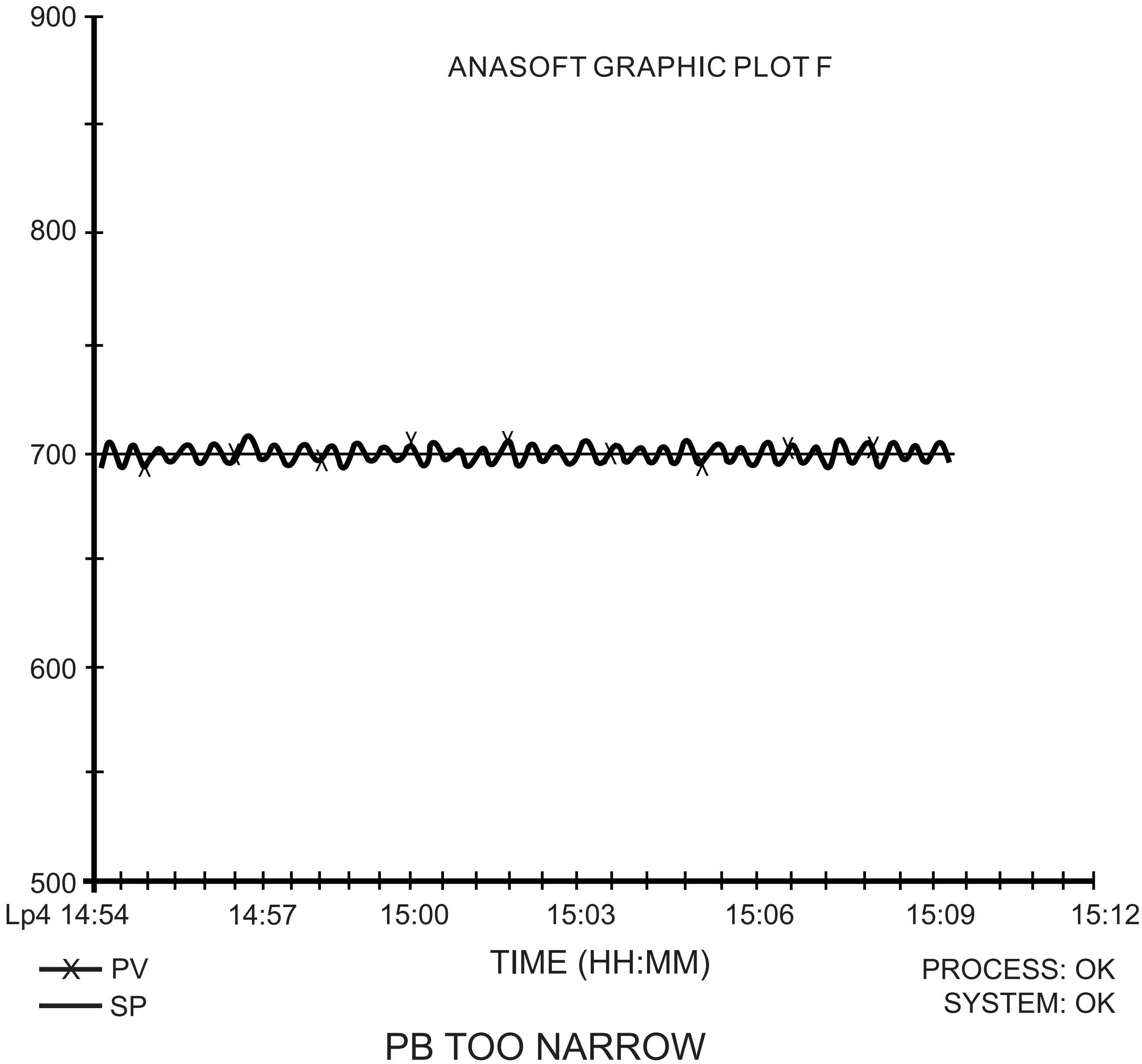
ANASOFT Plot E: PB Too Wide - Number Too High

Plot E represents what happens to the PV when the PB is too wide for the SP. The PV will take a very long time to reach SP, if it ever reaches it. The response to a step change of the SP or change in the PV will be too small to allow the control output to effect the necessary change in the final controller element. The PB = 200 whereas the nominal setting for 700° should be 55. Note that the PV undershoots the SP as compared to Plot E with TI too slow whereas the PV will overshoot the SP.



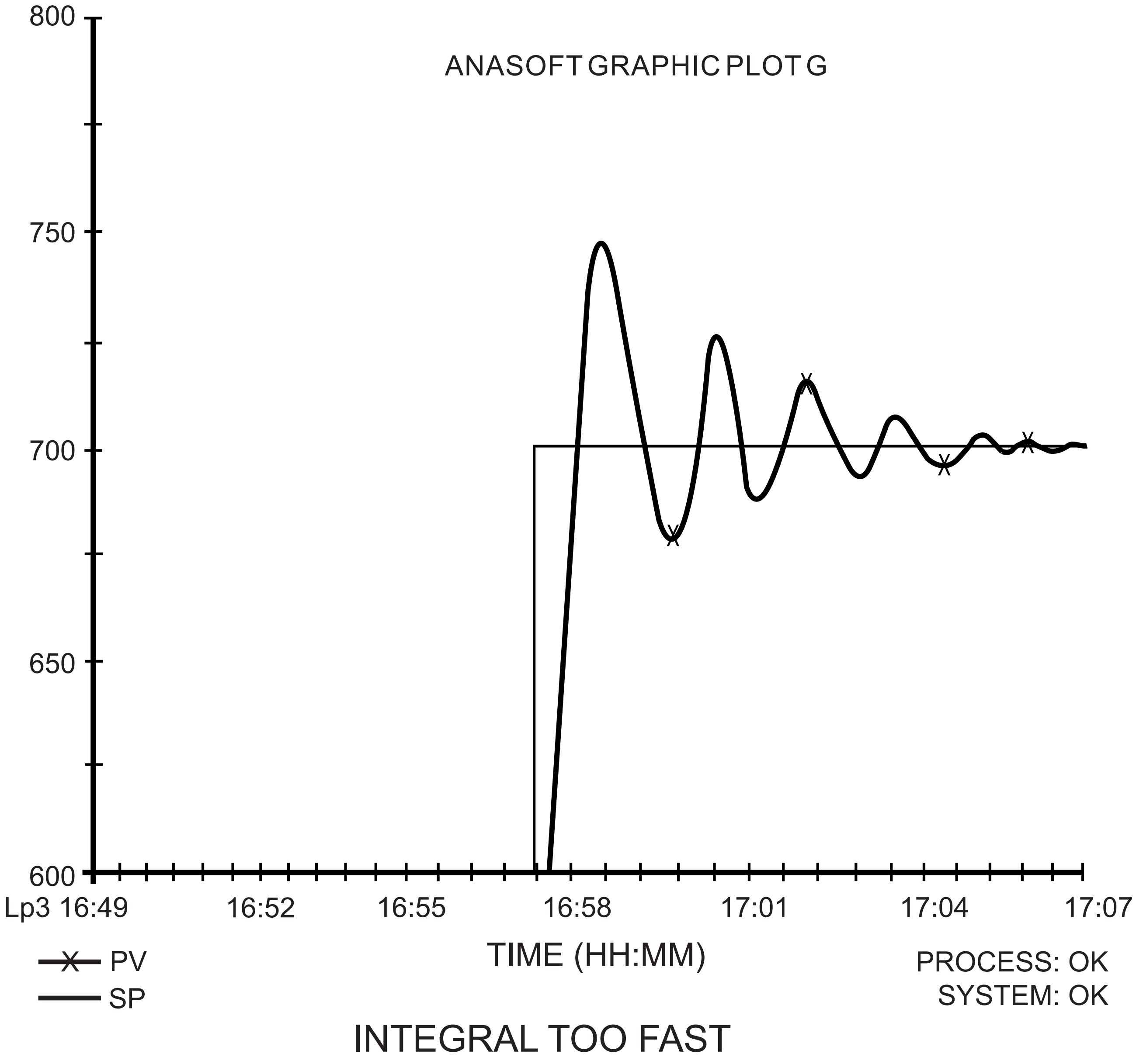
ANASOFT Plot F: PB Too Narrow

Plot F represents the continued cycling of the PV around the SP. This may be due to the type of control. The output may be ON/OFF and cycling is characteristic of ON/OFF control. Proportional control operating in this manner would indicated that the PB is too narrow. This Plot is a proportional controller operating with a PB of 10. The nominal PB setting for 700° is 55.



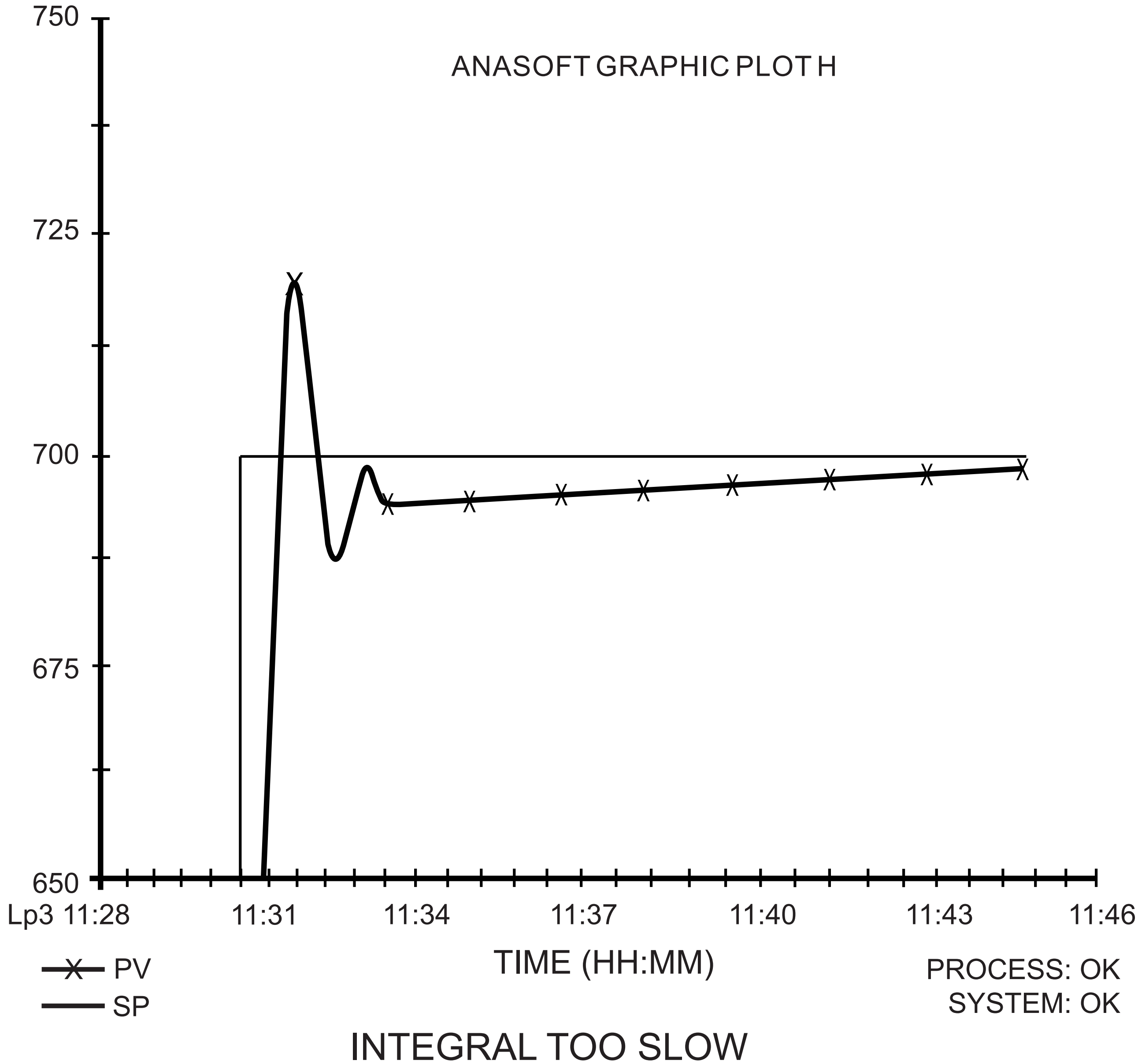
ANASOFT Plot G: Integral Too Fast - Number Too Low

Plot G represents what happens to the PV when the Integral is too fast for the process. Upon a step change, the PV will overshoot and then continue to cycle around the SP for a longer period of time than a Quarter Wave Decay (Plot B). The PV may also continue to cycle around the SP and never stabilize. This Plot indicates Integral as too fast, but not fast enough to continue a cycling of the PV around the SP. TI = 20.



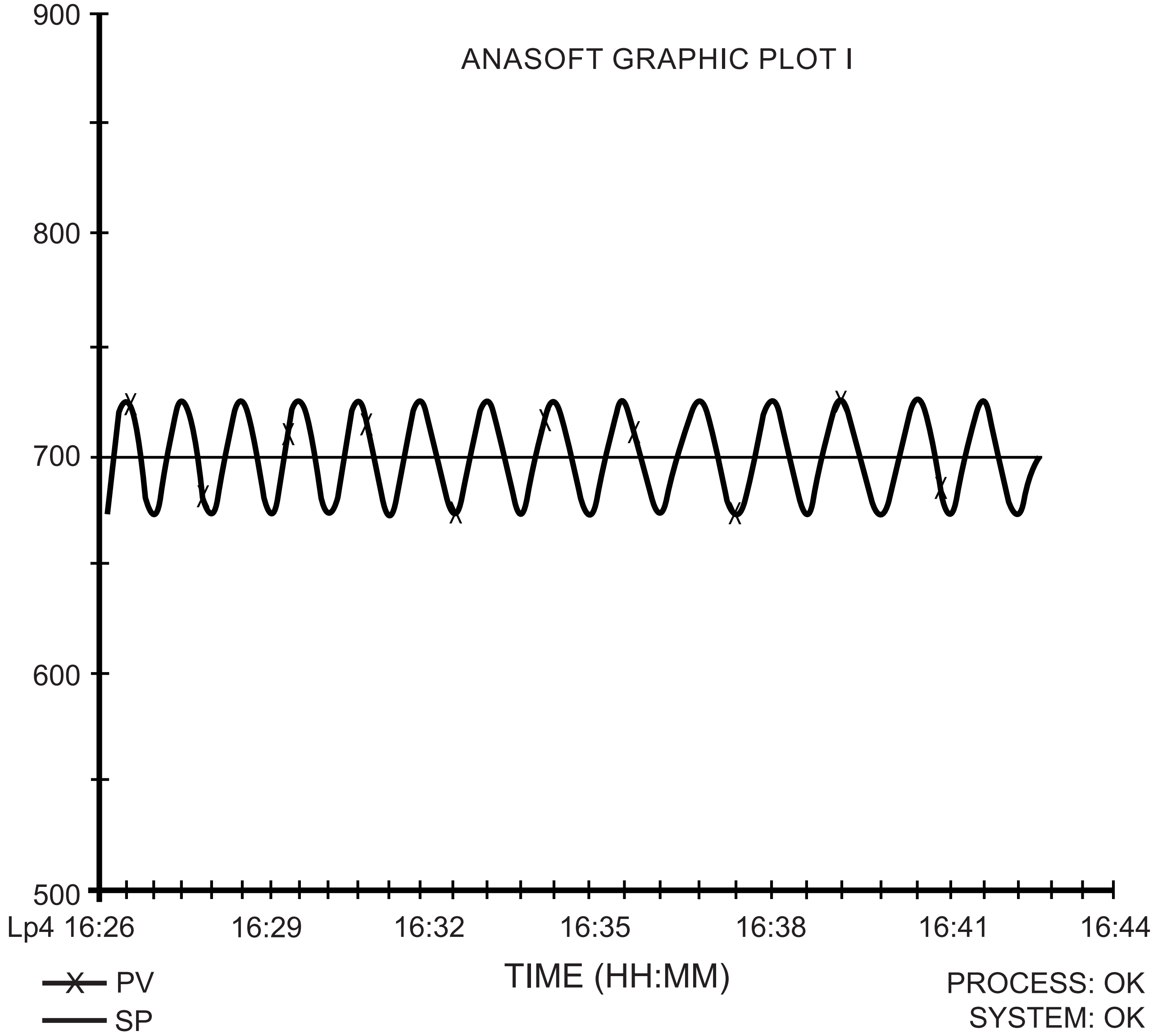
ANASOFT Plot H: Integral Too Slow - Number Too High

Plot H represents what happens to the PC when the Integral is too slow for the process. Upon a step change, the PV will overshoot the SP, and upon going below the SP, will require a very long time to reach SP. The output is changing too slowly to reach SP in as short a period of time that is possible without cycling of the PV. Note that a slow Integral will cause an overshoot of the PC with a slow return to SP as compared to Plot E with the PB too wide that has an undershoot of the PV with a slow return to SP. TI = 400.



ANASOFT Plot I: Integral Too Fast

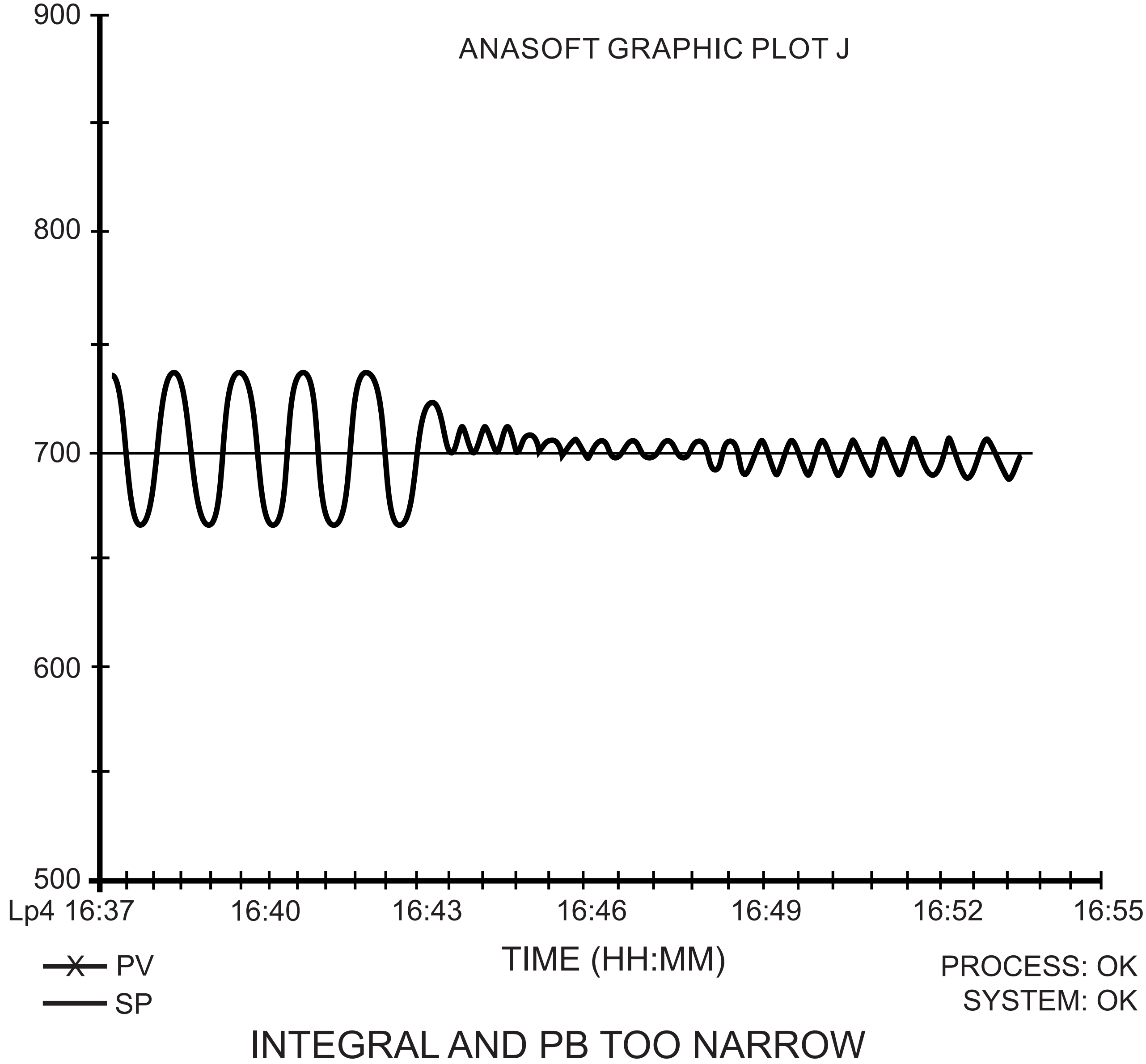
Plot I represents what happens to the PV when the Integral is too fast for the process. The PV will cycle around the SP. TI settings of less than 30 will cause this type of response in most processes. The TI of 10 resulted in this type of cycling.



INTEGRAL TOO FAST

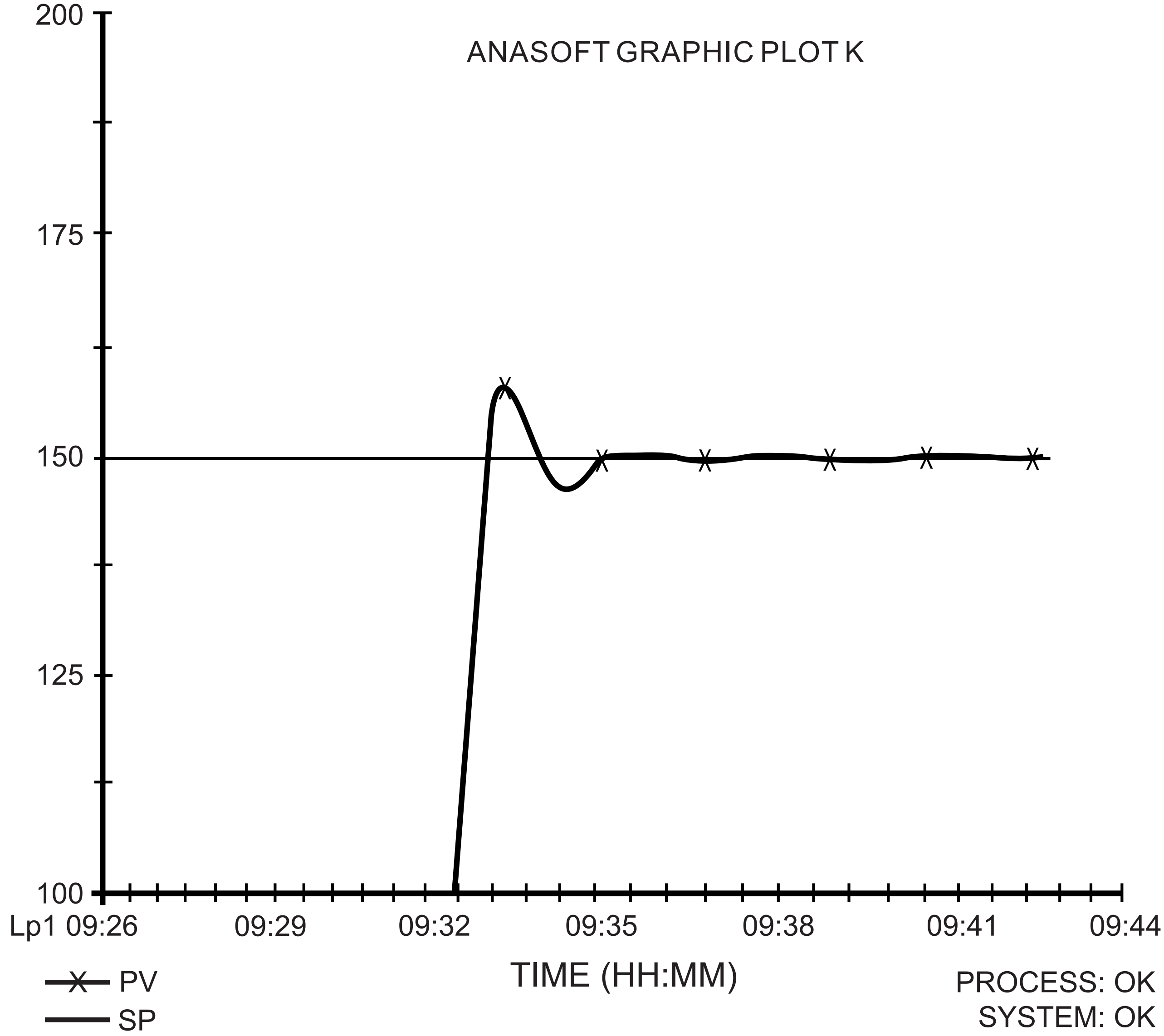
ANASOFT Plot J: Integral Too Fast - PB Too Narrow

Plot J represents the different type of cycling between too fast Integral and too narrow PB. Note the Integral cycling not only has a longer time period than the PB cycling, but the amplitude is higher than the PB cycling.



ANASOFT Plot K: Correct PB and TI Values

Plot K represents the 1/4 Wave overshoot of P and I only mode of control. The Derivative is turned off. PB = 20 and TI = 60.

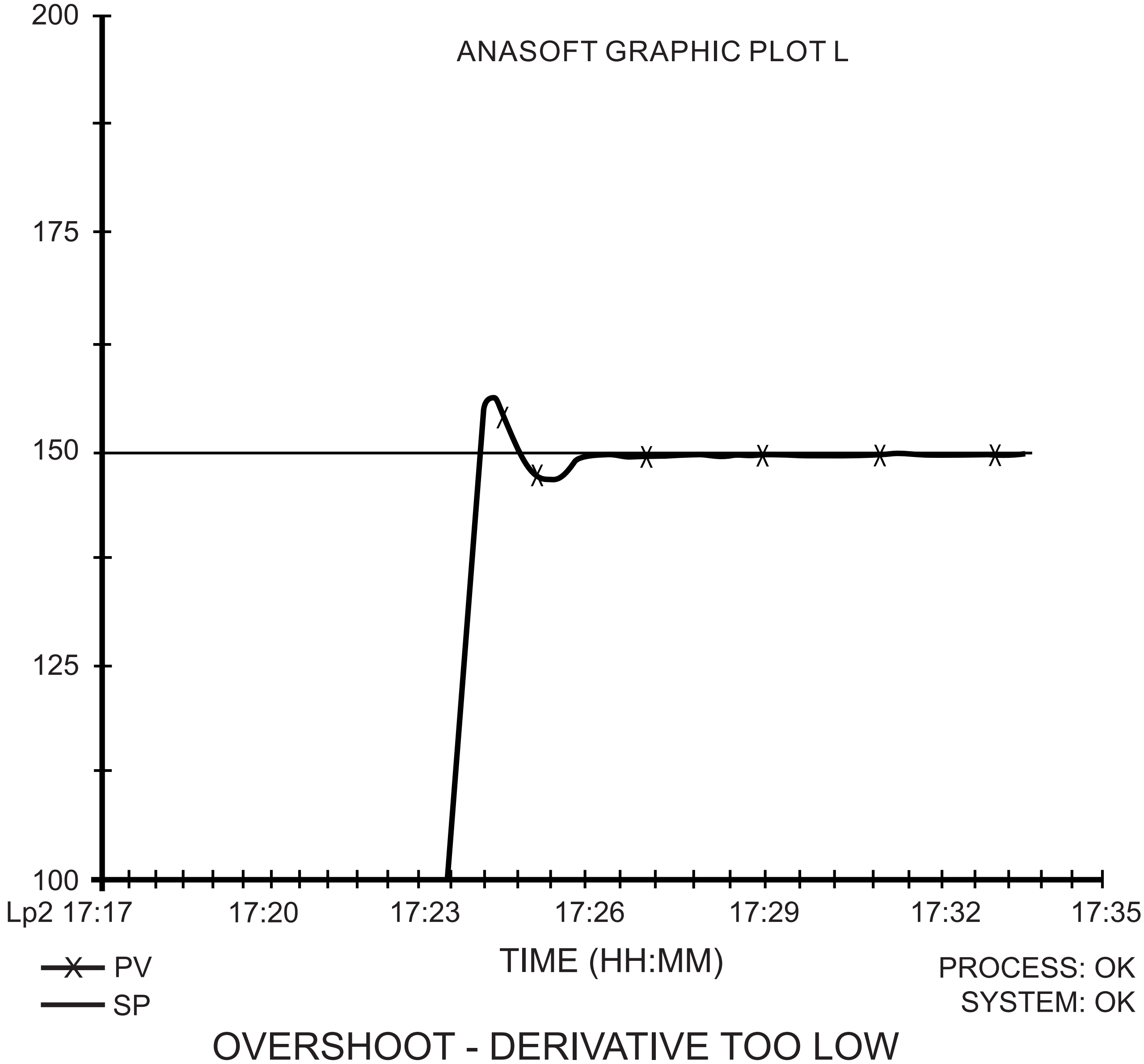


CORRECT PB & TI VALUES

Tuning

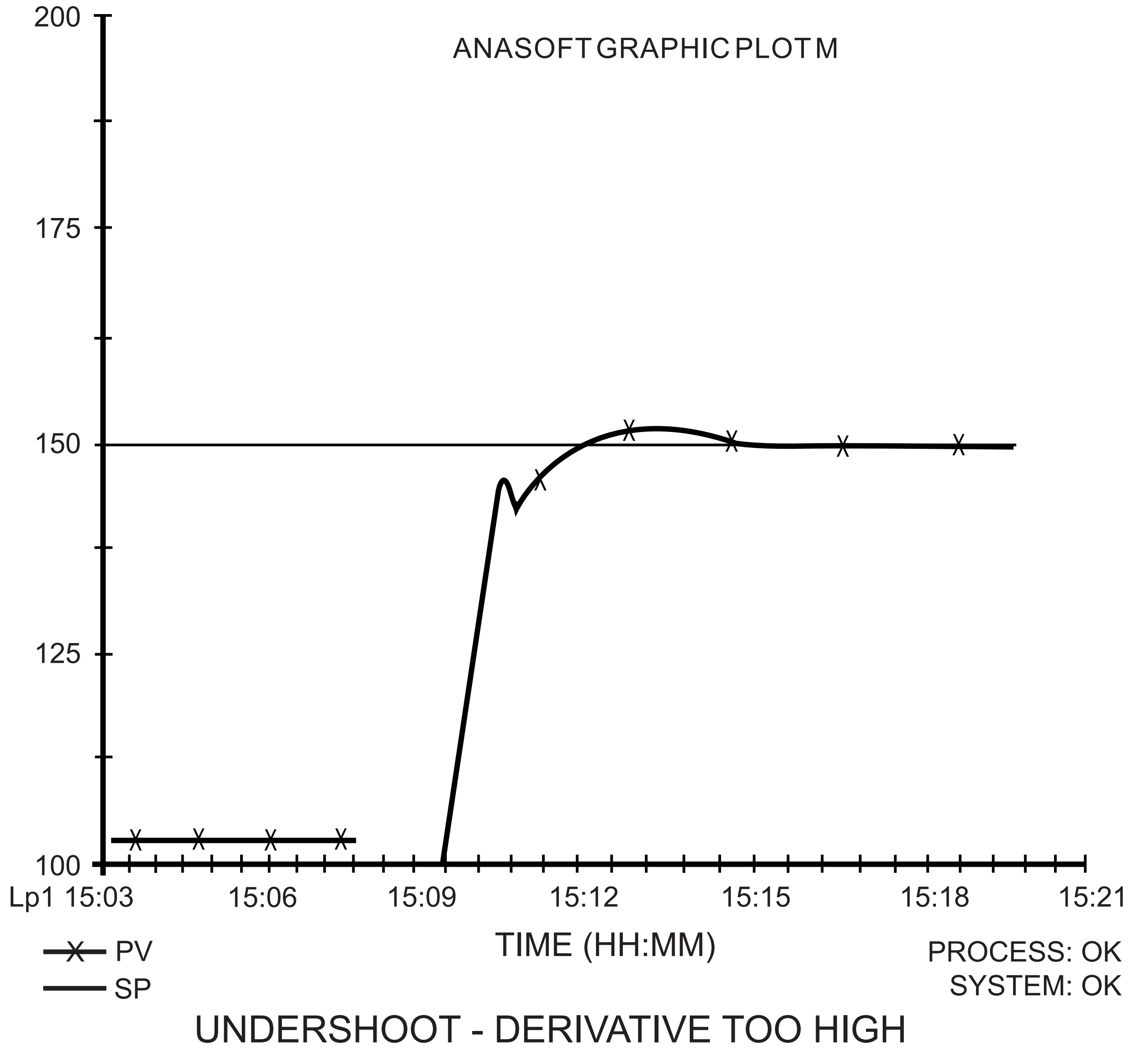
ANASOFT Plot L: Overshoot - Derivative Too Low

Plot L represents the response of too small of a TD setting. The PV still overshot the SP. TD = 1.



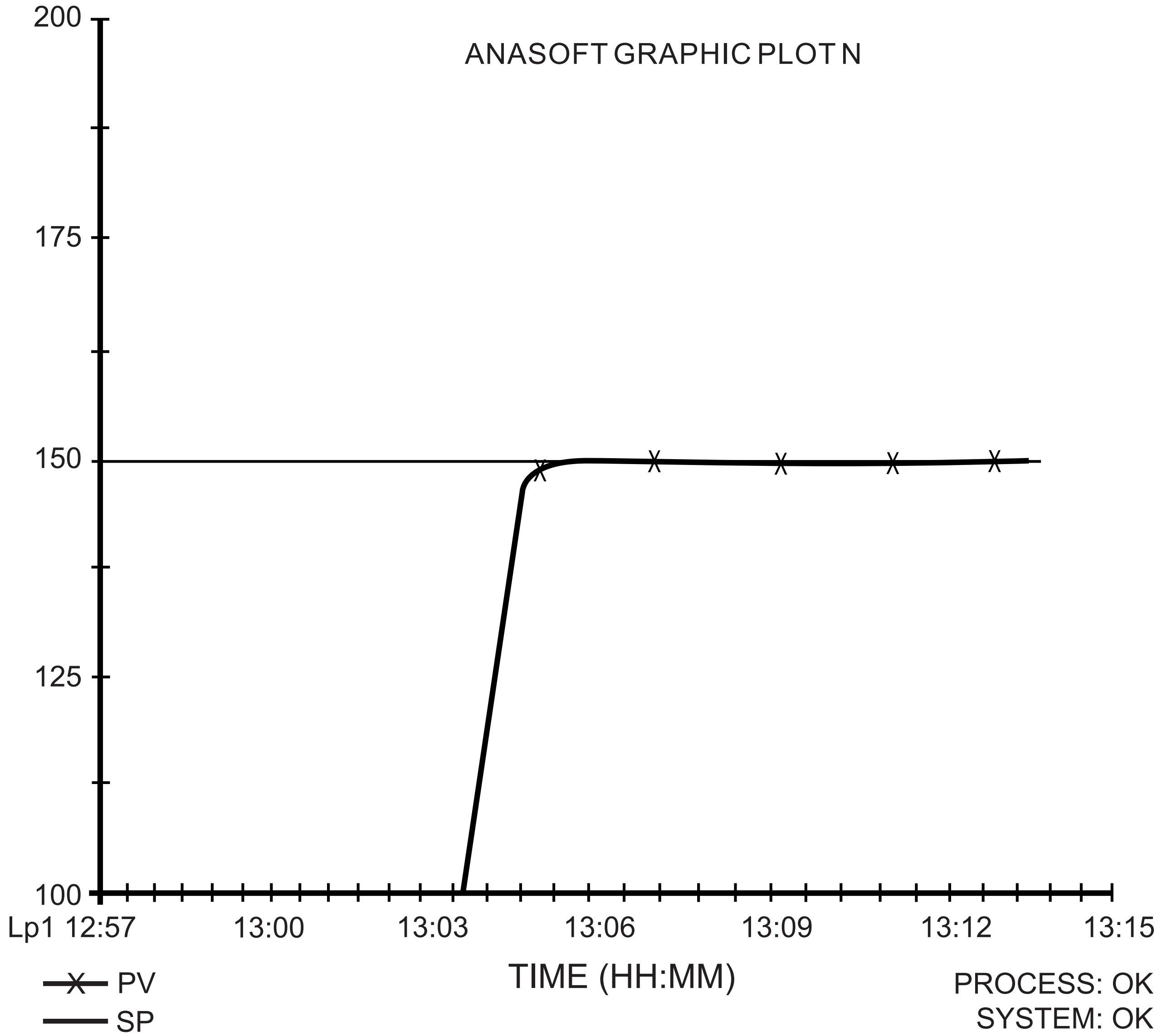
ANASOFT Plot M: Undershoot - Derivative Too High

Plot M represents the response of the PV to a setting of too high of a TD. Note the undershoot of the PV and then the resumption of the PV going to the SP. TD = 20.



ANASOFT Plot N: Correct PID Values

Plot N represents the response of the PV with a step change of the SP. This is the type of response when the PID is set correctly. PB = 20, TI = 60, and TD = 6.



CORRECT PID VALUES P20 - I60 - D6

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