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Chapter 9: Features



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Saving and Restoring User Settings

Recording setup and operations parameter settings for future reference is very important. If you unintentionally change these, you will need to program the correct settings back into the controller to return the equipment to operational condition.

After you program the controller and verify proper operation, use User Settings Save (**USr.S**) (Setup Page, Global Menu) to save the settings into either of two files in a special section of memory. If the settings in the controller are altered and you want to return the controller to the saved values, use User Settings Restore (**USr.r**) (Setup Page, Global Menu) to recall one of the saved settings.

A digital input or the Function Key can also be configured to restore parameters.

Note:

Only perform the above procedure when you are sure that all the correct settings are programmed into the controller. Saving the settings overwrites any previously saved collection of settings. Be sure to document all the controller settings.

Note:

I/O assemblies for Modbus, DeviceNet, Profibus and Ethernet will be overwritten when restoring factory defaults.

Programming the Home Page

Watlow's patented user-defined menu system improves operational efficiency. The user-defined Home Page provides you with a shortcut to monitor or change the parameter values that you use most often.

You can create your own Home Page with as many as 20 of the active parameters. When a parameter normally located in the Setup Page or Operations Page is placed in the Home Page, it is accessible through both. If you change a parameter in the Home Page, it is automatically changed in its original page. If you change a parameter in its original page it is automatically changed in the Home Page.

The default parameters will automatically appear in the Home Page.

Change the list of parameters in the Home Page from the Custom Menu (**CUSE**) (Factory Page).

Tuning the PID Parameters

Autotuning

When an autotune is performed on the EZ-ZONE PM, the set point is used to calculate the tuning set point.

For example, if the active set point is 200° and Autotune Set Point (**AEsp**) (Operations Page, Loop Menu) is set to 90 percent, the autotune function utilizes 180° for tuning. This is also how autotuning works in previous Watlow Winona controllers. In

addition, changing the active set point in previous controllers causes the autotune function to restart; where with the EZ-ZONE PM changing the set point after an autotune has been started has no affect.

A new feature in EZ-ZONE PM products will allow set point changes while the control is autotuning, this includes while running a profile or ramping. When the auto tune is initially started it will use the current set point and will disregard all set point changes until the tuning process is complete. Once complete, the controller will then use the new set point.

This is why it is a good idea to enter the active set point before initiating an autotune.

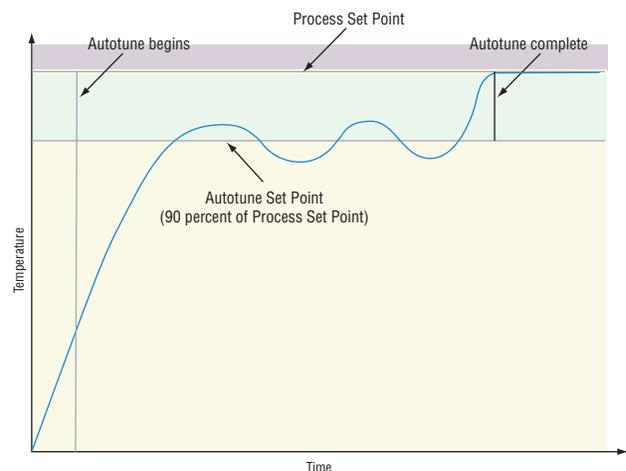
Autotuning calculates the optimum heating and/or cooling PID parameter settings based on the system's response. Autotuning can be enabled whether or not TUNE-TUNE+® is enabled. The PID settings generated by the autotune will be used until the autotune feature is rerun, the PID values are manually adjusted or TRU-TUNE+® is enabled.

To initiate an autotune, set Autotune (**AUT**) (Operations Page, Loop Menu) to (**YES**). You should not autotune while a profile is running. If the autotune cannot be completed in 60 minutes, the autotune will time-out and the original settings will take effect.

The lower display will flash between (**TUNE**) and the set point while the autotuning is underway. The temperature must cross the Autotune Set Point five times to complete the autotuning process. Once complete, the controller controls at the normal set point, using the new parameters.

Select a set point for the tune with Autotune Set Point. The Autotune Set Point is expressed as a percent of the Closed Loop Set Point.

If you need to adjust the tuning procedure's aggressiveness, use Autotune Aggressiveness (**EAgr**) (Setup Page, Loop Menu). Select under damped (**Undr**) to bring the process value to the set point quickly. Select over damped (**over**) to bring the process value to the set point with minimal overshoot. Select critical damped (**crit**) to balance a rapid response with minimal overshoot.



Manual Tuning

In some applications, the autotune process may not provide PID parameters for the process characteristics you desire. If that is the case, you may want to tune the controller manually.

1. Apply power to the controller and establish a set point typically used in your process.
2. Go to the Operations Page, Loop Menu, and set Heat Proportional Band and/or Cool Proportional Band to 5. Set Time Integral to 0. Set Time Derivative to 0.
3. When the system stabilizes, watch the process value. If it fluctuates, increase the Heat Proportional Band or Cool Proportional Band value in 3 to 5° increments until it stabilizes, allowing time for the system to settle between adjustments.
4. When the process has stabilized, watch Heat Power or Cool Power (Operations Page, Monitor Menu). It should be stable $\pm 2\%$. At this point, the process temperature should also be stable, but it will have stabilized before reaching the set point. The difference between the set point and actual process value can be eliminated with Integral.
5. Start with an Integral value of 6,000 and allow 10 minutes for the process temperature to reach the set point. If it has not, reduce the setting by half and wait another 10 minutes. Continue reducing the setting by half every 10 minutes until the process value equals the set point. If the process becomes unstable, the Integral value is too small. Increase the value until the process stabilizes.
6. Increase Derivative to 0.1. Then increase the set point by 11° to 17°C. Monitor the system's approach to the set point. If the process value overshoots the set point, increase Derivative to 0.2. Increase the set point by 11° to 17°C and watch the approach to the new set point. If you increase Derivative too much, the approach to the set point will be very sluggish. Repeat as necessary until the system rises to the new set point without overshoot or sluggishness.

For additional information about autotune and PID control, see related features in this chapter.

Autotuning with TRU-TUNE+®

The TRU-TUNE+® adaptive algorithm will optimize the controller's PID values to improve control of dynamic processes. TRU-TUNE+® monitors the process variable and adjusts the control parameters automatically to keep your process at set point during set point and load changes. When the controller is in the adaptive control mode, it determines the appropriate output signal and, over time, adjusts control parameters to optimize responsiveness and stability. The TRU-TUNE+® feature does not function for on-off control.

The preferred and quickest method for tuning a loop is to establish initial control settings and continue with the adaptive mode to fine tune the settings.

Setting a controller's control mode to tune starts this two-step tuning process. (See Autotuning in this chapter.) This predictive tune determines initial, rough settings for the PID parameters. Then the loop automatically switches to the adaptive mode which fine tunes the PID parameters.

Once the process variable has been at set point for a suitable period (about 30 minutes for a fast process to roughly two hours for a slower process) and if no further tuning of the PID parameters is desired or needed, TRU-TUNE+® may be turned off. However, keeping the controller in the adaptive mode allows it to automatically adjust to load changes and compensate for differing control characteristics at various set points for processes that are not entirely linear.

Once the PID parameters have been set by the TRU-TUNE+® adaptive algorithm, the process, if shut down for any reason, can be restarted in the adaptive control mode.

Turn TRU-TUNE+® on or off with TRU-TUNE+® Enable (Setup Page, Loop Menu).

Use TRU-TUNE+® Band (Setup Page, Loop Menu) to set the range above and below the set point in which adaptive tuning will be active. Adjust this parameter only in the unlikely event that the controller is unable to stabilize at the set point with TRU-TUNE+® Band set to auto (0). This may occur with very fast processes. In that case, set TRU-TUNE+™ Band to a large value, such as 100.

Use TRU-TUNE+® Gain (Setup Page, Loop Menu) to adjust the responsiveness of the adaptive tuning calculations. Six settings range from 1, with the most aggressive response and most potential overshoot (highest gain), to 6, with the least aggressive response and least potential for overshoot (lowest gain). The default setting, 3, is recommended for loops with thermocouple feedback and moderate response and overshoot potential.

Before Tuning

Before autotuning, the controller hardware must be installed correctly, and these basic configuration parameters must be set:

- Sensor Type (Setup Page, Analog Input Menu), and scaling, if required;
- Function (Setup Page, Output Menu) and scaling, if required.

How to Autotune a Loop

1. Enter the desired set point or one that is in the middle of the expected range of set points that you want to tune for.
2. Enable TRU-TUNE+®.
3. Initiate an autotune. (See Autotuning in this chapter.)

When autotuning is complete, the PID parameters should provide good control. As long as the loop is in the adaptive control mode, TRU-TUNE+® continuously tunes to provide the best possible PID control for the process.



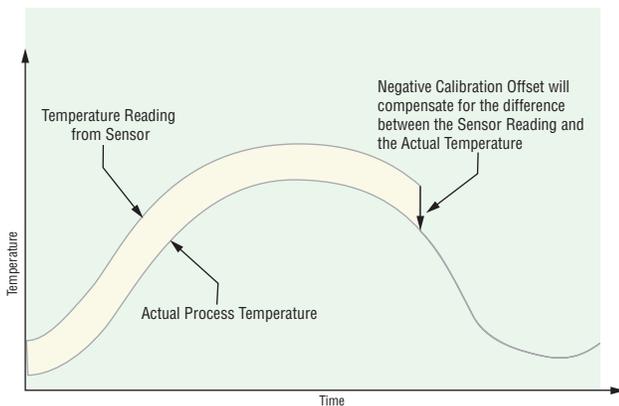
WARNING! During autotuning, the controller sets the output to 100 percent and attempts to drive the process variable toward the set point. Enter a set point and heat and cool power limits that are within the safe operating limits of your system.

Inputs

Calibration Offset

Calibration offset allows a device to compensate for an inaccurate sensor, lead resistance or other factors that affect the input value. A positive offset increases the input value, and a negative offset decreases the input value.

The input offset value can be viewed or changed with Calibration Offset (Operations Page, Analog Input Menu).



Calibration

Before performing any calibration procedure, verify that the displayed readings are not within published specifications by inputting a known value from a precision source to the analog input. Next, subtract the displayed value with the known value and compare this difference to the published accuracy range specification for that type of input.

Use of the Calibration Offset parameter found in the Operations Page , Analog Input Menu , shifts the readings across the entire displayed range by the offset value. Use this parameter to compensate for sensor error or sensor placement error. Typically this value is set to zero.

Equipment required while performing calibration: Obtain a precision source for millivolts, volts, milliamperes or resistance depending on the sensor type to be calibrated. Use copper wire only to connect

the precision source to the controller's input. Keep leads between the precision source and controller as short as possible to minimize error. In addition, a precision volt/ohm meter capable of reading values to 4 decimal places or better is recommended. Prior to calibration, connect this volt/ohm meter to the precision source to verify accuracy.

Actual input values do NOT have to be exactly the recommended values, but it IS critical that the actual value of the signal connected to the controller be accurately known to at least four digits.

Calibration of Analog Inputs:

To calibrate an analog input, you will need to provide a source of two electrical signals or resistance values near the extremes of the range that the application is likely to utilize. See recommended values below:

Sensor Type	Precision Source Low	Precision Source High
thermocouple	0.000 mV	50.000 mV
millivolts	0.000 mV	50.000 mV
volts	0.000V	10.000V
milliamps	0.000 mA	20.000 mA
100 Ω RTD	50.00 Ω	350.0 Ω
1,000 Ω RTD	500.0 Ω	3,500 Ω
thermistor 5 kΩ	50.00	5,000
thermistor 10 kΩ	150.0	10,000
thermistor 20 kΩ	1,800	20,000
thermistor 40 kΩ	1,700	40,000
potentiometer	0.000	1,200

Note:

The user may only calibrate one sensor type. If the calibrator interferences with open thermocouple detection, set Sensor Type in Setup Page , Analog Input Menu to millivolt instead of Thermocouple to avoid interference between the calibrator and open thermocouple detect circuit for the duration of the calibration process. Be sure to set sensor type back to the thermocouple type utilized.

1. Disconnect the sensor from the controller.
2. Record the Calibration Offset parameter value in the Operations Page , Analog Input Menu , then set value to zero.
3. Wire the precision source to the appropriate controller input terminals to be calibrated. Do not have any other wires connected to the input terminals. Please refer to the Install and Wiring section of this document for the appropriate connections.
4. Ensure the controller sensor type is programmed to the appropriate Sensor Type to be utilized in the Setup Page , Analog Input Menu .
5. Enter Factory Page , Calibration Menu via RUI or EZ-ZONE Configurator Soft-

ware.

6. Select the Calibration **[CAL]** input instance to be calibrated. This corresponds to the analog input to be calibrated.
7. Set Electrical Input Slope **[EL .5]** to 1.000 and Electrical Input Offset **[EL 1.0]** to 0.000 (this will cancel any prior user calibration values)
8. Input a Precision Source Low value. Read Electrical Measurement value **[P70]** of controller via EZ-Configurator or RUI. This will be referred to as Electrical Measured Low.

Record low value _____

9. Input a Precision Source High value.
10. Read Electrical Measurement value **[P70]** of controller via EZ-Configurator or RUI. This will be referred to as Electrical Measured High.

Record high value _____

11. Calculated Electrical Input Slope = (Precision High – Precision Low) / (Electrical Measured High – Electrical Measured Low)

Calculated Slope value _____

12. Calculated Electrical Input Offset = Precision Low – (Electrical Input Slope * Measured Low)

Calculated Offset value _____

13. Enter the calculated Electrical Input Slope **[EL .5]** and Electrical Input Offset **[EL 1.0]** into the controller.

14. Exit calibration menu.
15. Validate calibration process by utilizing a calibrator to the analog input.
16. Enter calibration offset as recorded in step 2 if required to compensate for sensor error.

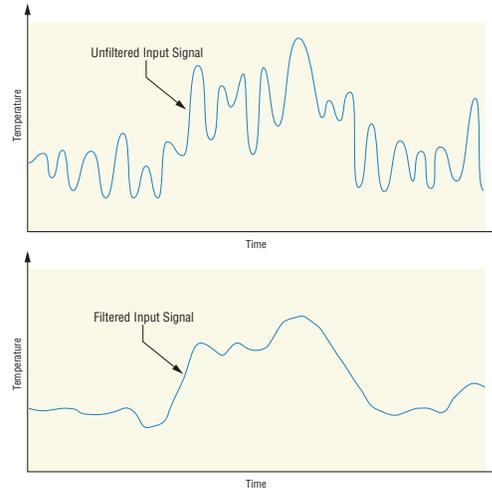
Setting Electrical Input Slope **[EL .5]** to 1.000 and Electrical Input Offset **[EL 1.0]** to 0.000, restores factory calibration as shipped from factory.

Filter Time Constant

Filtering smoothes an input signal by applying a first-order filter time constant to the signal. Filtering the displayed value makes it easier to monitor. Filtering the signal may improve the performance of PID control in a noisy or very dynamic system.

Adjust the filter time interval with Filter Time **[FIL]** (Setup Page, Analog Input Menu).

Example: With a filter value of 0.5 seconds, if the process input value instantly changes from 0 to 100 and remained at 100, the display will indicate 100 after five time constants of the filter value or 2.5 seconds.



Sensor Selection

You need to configure the controller to match the input device, which is normally a thermocouple, RTD or process transmitter.

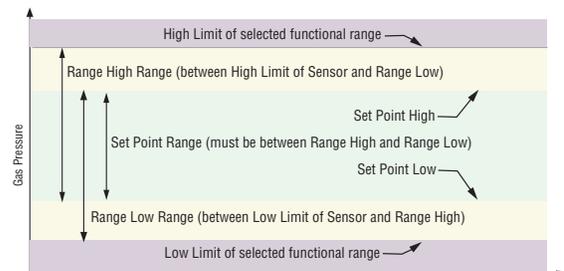
Select the sensor type with Sensor Type **[SEN]** (Setup Page, Analog Input Menu).

Set Point Low Limit and High Limit

The controller constrains the set point to a value between a set point low limit and a set point high limit.

Set the set point limits with Low Set Point **[LSP]** and High Set Point **[HSP]** (Setup Page, Loop Menu).

There are two sets of set point low and high limits: one for a closed-loop set point, another for an open-loop set point.



Scale High and Scale Low

When an analog input is selected as process voltage or process current input, you must choose the value of voltage or current to be the low and high ends. For example, when using a 4 to 20 mA input, the scale low value would be 4.00 mA and the scale high value would be 20.00 mA. Commonly used scale ranges are: 0 to 20 mA, 4 to 20 mA, 0 to 5V, 1 to 5V and 0 to 10V.

You can create a scale range representing other units for special applications. You can reverse scales from high values to low values for analog input signals that have a reversed action. For example, if 50 psi causes a 4 mA signal and 10 psi causes a 20 mA

signal.

Scale low and high values do not have to match the bounds of the measurement range. These along with range low and high provide for process scaling and can include values not measurable by the controller. Regardless of scaling values, the measured value will be constrained by the electrical measurements of the hardware.

Select the low and high values with Scale Low and Scale High . Select the displayed range with Range Low and Range High (Setup Page, Analog Input Menu).

Range High and Range Low

With a process input, you must choose a value to represent the low and high ends of the current or voltage range. Choosing these values allows the controller's display to be scaled into the actual working units of measurement. For example, the analog input from a humidity transmitter could represent 0 to 100 percent relative humidity as a process signal of 4 to 20 mA. Low scale would be set to 0 to represent 4 mA and high scale set to 100 to represent 20 mA. The indication on the display would then represent percent humidity and range from 0 to 100 percent with an input of 4 to 20 mA.

Select the low and high values with Range Low and Range High (Setup Page, Analog Input Menu).

Outputs

Duplex

Certain systems require that a single process output control both heating and cooling outputs. An EZ-ZONE PM controller with a process output can function as two separate outputs.

With a 4 to 20mA output the heating output will operate from 12 to 20mA (0 to +100 percent) and the cooling output will operate from 12 to 4mA (0 to -100 percent).

In some cases this type of output is required by the device that the EZ-ZONE PM controls, such as a three-way valve that opens one way with a 12 to 20mA signal and opens the other way with a 4 to 12mA signal. This feature reduces the overall system cost by using a single output to act as two outputs.

Outputs 1 and 3 can be ordered as process outputs. Select duplex as the Output Function (Setup Page, Output Menu). Set the output to volts or milliamps with Output Type . Set the range of the process output with Scale Low and Scale High .

NO-ARC Relay

A NO-ARC relay provides a significant improvement in the life of the output relay over conventional relays.

Conventional mechanical relays have an expected life of 100,000 cycles at the rated full-load current. The shorter life for conventional relays is due to the fact that when contacts open while current is flowing metal degradation occurs. This action produces unavoidable electrical arcing causing metal to transfer from one contact to the other. The arcing conditions continue on each subsequent contact opening until over time the resistance through the contacts increases causing the contacts to increase in temperature. Eventually, the contacts will weld together and the relay remains in the on state.

The Watlow NO-ARC relay is a hybrid relay. It uses a mechanical relay for the current load and a triac (solid-state switch) to carry the turn-on and turn-off currents. NO-ARC relays extend the life of the relay more than two million cycles at the rated full-load current.

Although a NO-ARC relay has significant life advantages, a few precautions must be followed for acceptable usage:

Do not use:

- hybrid relays for limit contactors. A limit or safety device must provide a positive mechanical break on all hot legs simultaneously;
- dc loads with hybrid relays. The triacs used for arc suppression will turn off only with ac line voltage;
- hybrid switches to drive any inductive loads, such as relay coils, transformers or solenoids;
- cycle times less than five seconds on hybrid switches;
- on loads that exceed 264V ac through relay;
- on loads that exceed 15 amperes load;
- on loads less than 100 mA;
- NO-ARC relays in series with other NO-ARC relays.

Retransmitting a Process Value or Set Point

The retransmit feature allows a process output to provide an analog signal that represents the set point or process value. The signal may serve as a remote set point for another controller or as an input for a chart recorder documenting system performance over time.

In choosing the type of retransmit signal the operator must take into account the input impedance of the device to be retransmitted to and the required signal type, either voltage or milliamps.

Typically applications might use the retransmit option to record one of the variables with a chart recorder or to generate a set point for other controls in a multi-zone application.

Output 1 can be ordered as process outputs. Select retransmit as the Output Function (Setup Page, Output Menu). Set the output to volts or milliamps with Output Type . Select the signal to retransmit with Retrans-

mit Source .



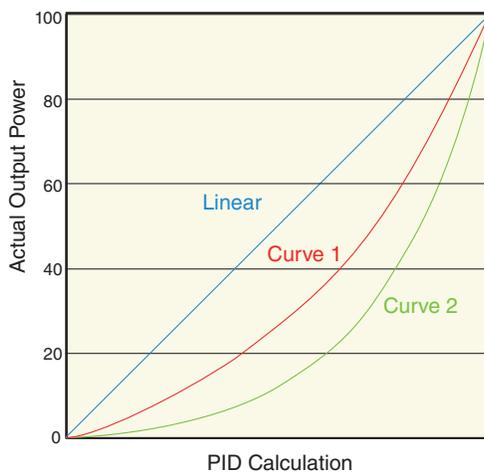
Set the range of the process output with Scale Low and Scale High . Scale the retransmit source to the process output with Range Low and Range High .

When the retransmit source is at the Range Low value, the retransmit output will be at its Scale Low value. When the retransmit source is at the Range High value, the retransmit output will be at its Scale High value.

Cool Output Curve

A nonlinear output curve may improve performance when the response of the output device is nonlinear. If a cool output uses one of the nonlinear curves a PID calculation yields a lower actual output level than a linear output would provide.

These output curves are used in plastics extruder applications: curve 1 for oil-cooled extruders and curve 2 for water-cooled extruders.



Select a nonlinear cool output curve with Cool Output Curve (Setup Menu, Loop Menu).

Control Methods

Output Configuration

Each controller output can be configured as a heat output, a cool output, an alarm output or deactivated. No dependency limitations have been placed on the available combinations. The outputs can be configured in any combination. For instance, all three

could be set to cool.

Heat and cool outputs use the set point and Operations parameters to determine the output value. All heat and cool outputs use the same set point value. Heat and cool each have their own set of control parameters. All heat outputs use the same set of heat control parameters and all cool outputs use the same set of cool output parameters.

Each alarm output has its own set of configuration parameters and set points, allowing independent operation.

Auto (closed loop) and Manual (open loop) Control

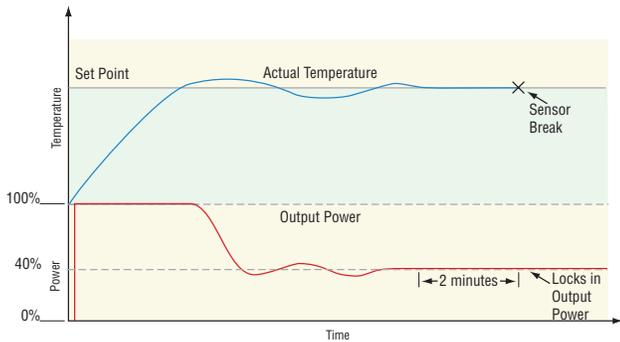
The controller has two basic modes of operation, auto mode and manual mode. Auto mode allows the controller to decide whether to perform closed-loop control or to follow the settings of Input Error Failure (Setup Page, Loop Menu). The manual mode only allows open-loop control. The EZ-ZONE PM controller is normally used in the auto mode. The manual mode is usually only used for specialty applications or for troubleshooting.

Manual mode is open-loop control that allows the user to directly set the power level to the controller's output load. No adjustments of the output power level occur based on temperature or set point in this mode.

In auto mode, the controller monitors the input to determine if closed-loop control is possible. The controller checks to make certain a functioning sensor is providing a valid input signal. If a valid input signal is present, the controller will perform closed-loop control. Closed-loop control uses a process sensor to determine the difference between the process value and the set point. Then the controller applies power to a control output load to reduce that difference.

If a valid input signal is not present, the controller will indicate an input error message in the upper display and in the lower display and respond to the failure according to the setting of Input Error Failure . You can configure the controller to perform a "bumpless" transfer , switch power to output a preset fixed level , or turn the output power off.

Bumpless transfer will allow the controller to transfer to the manual mode using the last power value calculated in the auto mode if the process had stabilized at a ± 5 percent output power level for the time interval of Time Integral (Operations Page, Loop) prior to sensor failure, and that power level is less than 75 percent.



Input Error Latching **[IER]** (Setup Page, Analog Input Menu) determines the controller's response once a valid input signal returns to the controller. If latching is on, then the controller will continue to indicate an input error until the error is cleared. To clear a latched alarm, press the Advance Key **[FWD]** then the Up Key **[▲]**.

If latching is off, the controller will automatically clear the input error and return to reading the temperature. If the controller was in the auto mode when the input error occurred, it will resume closed-loop control. If the controller was in manual mode when the error occurred, the controller will remain in open-loop control.

The Manual Control Indicator Light % is on when the controller is operating in manual mode.

You can easily switch between modes if the Control Mode **[CPM]** parameter is selected to appear in the Home Page.

To transfer to manual mode from auto mode, press the Advance Key **[FWD]** until **[CPM]** appears in the lower display. The upper display will display **[AUTO]** for auto mode. Use the Up **[▲]** or Down **[▼]** keys to select **[MAN]**. The manual set point value will be recalled from the last manual operation.

To transfer to auto mode from manual mode, press the Advance Key **[FWD]** until **[CPM]** appears in the lower display. The upper display will display **[MAN]** for manual mode. Use the Up **[▲]** or Down **[▼]** keys to select **[AUTO]**. The automatic set point value will be recalled from the last automatic operation.

Changes take effect after three seconds or immediately upon pressing either the Advance Key **[FWD]** or the Infinity Key **[∞]**.

On-Off Control

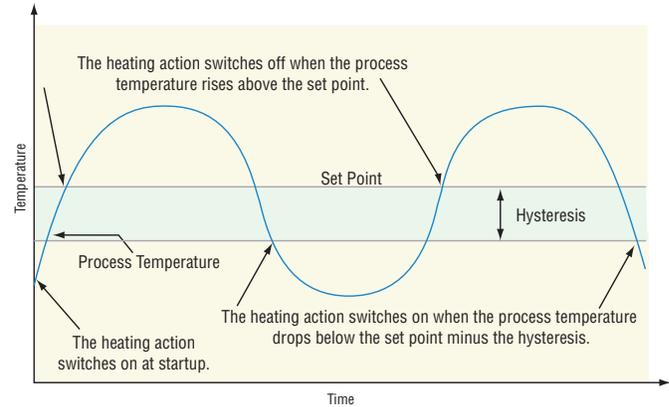
On-off control switches the output either full on or full off, depending on the input, set point and hysteresis values. The hysteresis value indicates the amount the process value must deviate from the set point to turn on the output. Increasing the value decreases the number of times the output will cycle. Decreasing hysteresis improves controllability. With hysteresis set to 0, the process value would stay closer to the set point, but the output would switch on and off more frequently, and may result in the output "chattering."

On-off control can be selected with Heat Algorithm **[HAG]** or Cool Algorithm **[CAG]** (Setup Page, Loop Menu).

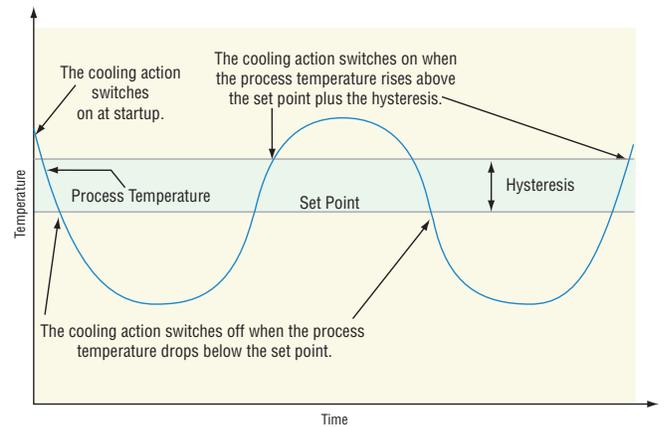
On-off hysteresis can be set with Heat Hysteresis **[HHY]** or Cool Hysteresis **[CHY]** (Operations Page, Loop Menu).

Note:

Input Error Failure Mode **[FAIL]** does not function in on-off control mode. The output goes off.



On/Off System Cycles



On/Off System Cycles

Proportional Control

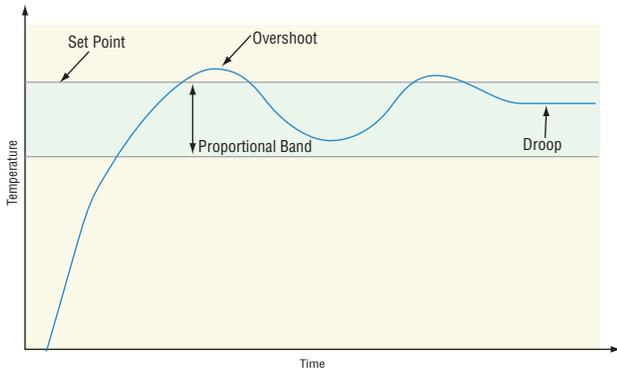
Some processes need to maintain a temperature or process value closer to the set point than on-off control can provide. Proportional control provides closer control by adjusting the output when the temperature or process value is within a proportional band. When the value is in the band, the controller adjusts the output based on how close the process value is to the set point.

The closer the process value is to the set point, the lower the output power. This is similar to backing off on the gas pedal of a car as you approach a stop sign. It keeps the temperature or process value from swinging as widely as it would with simple on-off control. However, when the system settles down, the temperature or process value tends to “droop” short of the set point.

With proportional control the output power level equals (set point minus process value) divided by the proportional band value.

In an application with one output assigned to heating and another assigned to cooling, each will have a separate proportional parameter. The heating parameter takes effect when the process temperature is lower than the set point, and the cooling parameter takes effect when the process temperature is higher than the set point.

Adjust the proportional band with Heat Proportional Band $\boxed{h.Pb}$ or Cool Proportional Band $\boxed{c.Pb}$ (Operations Page, Loop Menu).



Proportional plus Integral (PI) Control

The droop caused by proportional control can be corrected by adding integral (reset) control. When the system settles down, the integral value is tuned to bring the temperature or process value closer to the set point. Integral determines the speed of the correction, but this may increase the overshoot at start-up or when the set point is changed. Too much integral action will make the system unstable. Integral is cleared when the process value is outside of the proportional band.

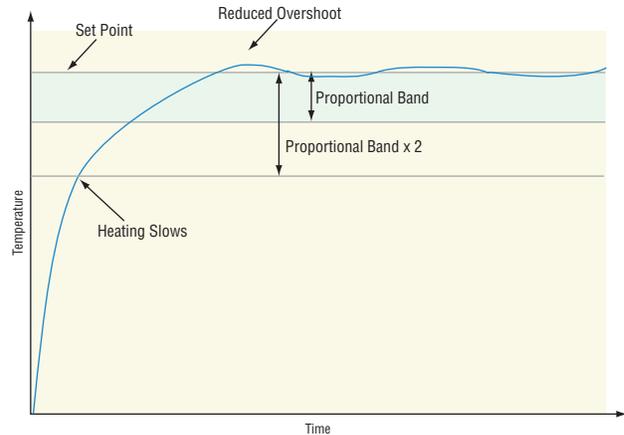
Adjust the integral with Time Integral $\boxed{t_i}$ (Operations Page, Loop Menu).

Proportional plus Integral plus Derivative (PID) Control

Use derivative (rate) control to minimize the overshoot in a PI-controlled system. Derivative (rate) adjusts the output based on the rate of change in the temperature or process value. Too much derivative (rate) will make the system sluggish.

Derivative action is active only when the process value is within twice the proportional value from the set point.

Adjust the derivative with Time Derivative $\boxed{t_d}$ (Operations Page, Loop Menu).

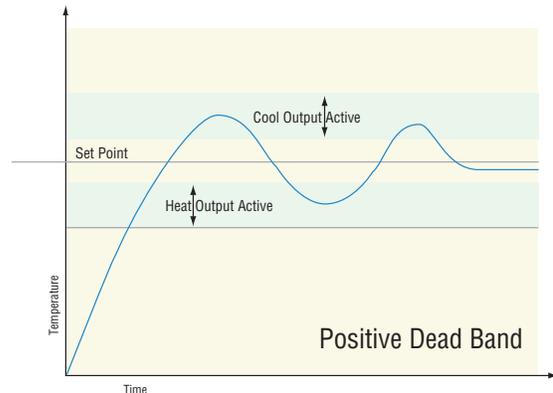


Dead Band

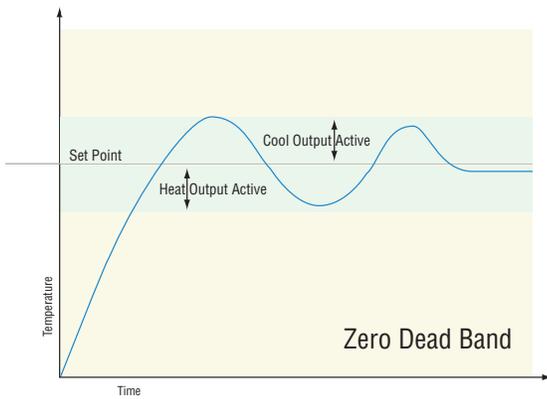
In a PID application the dead bands above and below the set point can save an application's energy and wear by maintaining process temperature within acceptable ranges.

Proportional action ceases when the process value is within the dead band. Integral action continues to bring the process temperature to the set point.

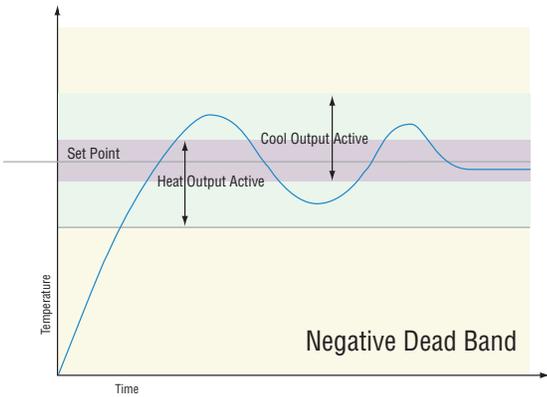
Using a **positive dead band value** keeps the two systems from fighting each other.



When the **dead band value is zero**, the heating output activates when the temperature drops below the set point, and the cooling output switches on when the temperature exceeds the set point.



When the **dead band value is a negative value**, both heating and cooling outputs are active when the temperature is near the set point.



Adjust the dead band with Dead Band (Operations Page, Loop Menu).

Variable Time Base

Variable time base is the preferred method for controlling a resistive load, providing a very short time base for longer heater life. Unlike phase-angle firing, variable-time-base switching does not limit the current and voltage applied to the heater.

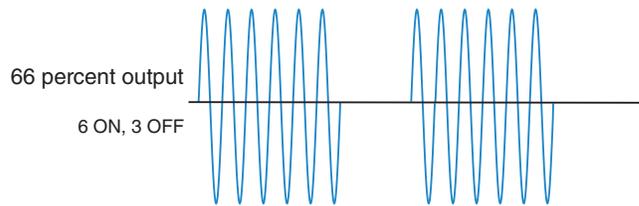
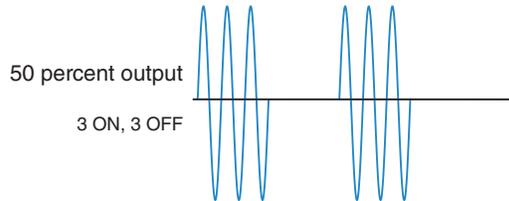
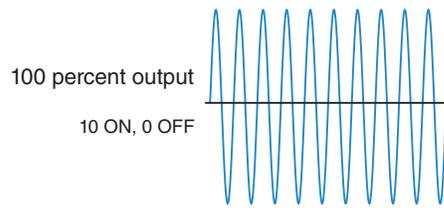
With variable time base outputs, the PID algorithm calculates an output between 0 and 100%, but the output is distributed in groupings of three ac line cycles. For each group of three ac line cycles, the controller decides whether the power should be on or off. There is no fixed cycle time since the decision is made for each group of cycles. When used in conjunction with a zero cross (burst fire) device, such as a solid-state power controller, switching is done only at the zero cross of the ac line, which helps reduce electrical noise (RFI).

Variable time base should be used with solid-state power controllers, such as a solid-state relay (SSR) or silicon controlled rectifier (SCR) power controller. Do not use a variable time base output for controlling electromechanical relays, mercury displacement relays, inductive loads or heaters with unusual resistance characteristics.

The combination of variable time base output and a solid-state relay can inexpensively approach the ef-

fect of analog, phase-angle fired control.

Select the AC Line Frequency (Setup Page, Global Menu), 50 or 60 Hz.



Note:

When output 1 is a universal process output, output 2 cannot use variable time base, fixed time base only.

Single Set Point Ramping

Ramping protects materials and systems that cannot tolerate rapid temperature changes. The value of the ramp rate is the maximum degrees per minute or hour that the system temperature can change.

Select Ramp Action (Setup Page, Loop Menu):

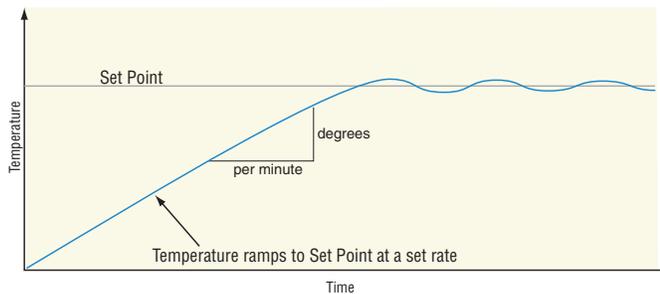
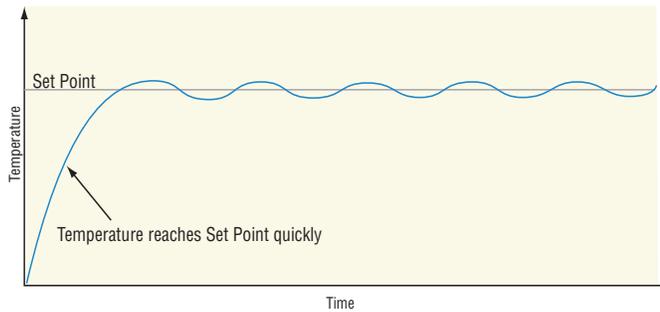
ramping not active.

ramp at startup.

ramp at a set point change.

ramp at startup or when the set point changes.

Select whether the rate is in degrees per minute or degrees per hour with Ramp Scale . Set the ramping rate with Ramp Rate (Setup Page, Loop Menu).



Alarms

Alarms are activated when the output level, process value or temperature leaves a defined range. A user can configure how and when an alarm is triggered, what action it takes and whether it turns off automatically when the alarm condition is over.

Configure alarm outputs in the Setup Page before setting alarm set points.

Alarms do not have to be assigned to an output. Alarms can be monitored and controlled through the front panel or by using software.

Process and Deviation Alarms

A process alarm uses one or two absolute set points to define an alarm condition.

A deviation alarm uses one or two set points that are defined relative to the control set point. High and low alarm set points are calculated by adding or subtracting offset values from the control set point. If the set point changes, the window defined by the alarm set points automatically moves with it.

Select the alarm type with Type **[ALY]** (Setup Page, Alarm Menu).

Alarm Set Points

The alarm high set point defines the process value or temperature that will trigger a high side alarm. It must be higher than the alarm low set point and lower than the high limit of the sensor range.

The alarm low set point defines the temperature that will trigger a low side alarm. It must be lower than the alarm high set point and higher than the low limit of the sensor range.

View or change alarm set points with Low Set

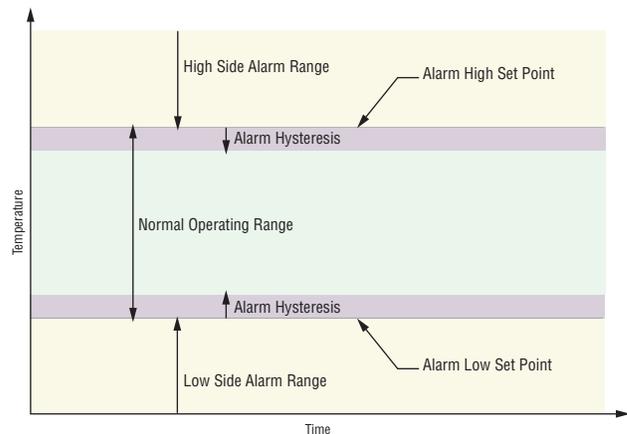
Point **[ALo]** and High Set Point **[AHi]** (Operations Page, Alarm Menu).

Alarm Hysteresis

An alarm state is triggered when the process value reaches the alarm high or alarm low set point. Alarm hysteresis defines how far the process must return into the normal operating range before the alarm can be cleared.

Alarm hysteresis is a zone inside each alarm set point. This zone is defined by adding the hysteresis value to the alarm low set point or subtracting the hysteresis value from the alarm high set point.

View or change alarm hysteresis with Hysteresis **[Ahy]** (Setup Page, Alarm Menu).



Alarm Latching

A latched alarm will remain active after the alarm condition has passed. It can only be deactivated by the user.

An active message, such as an alarm message, will cause the display to toggle between the normal settings and the active message in the upper display and **[ALEn]** in the lower display.

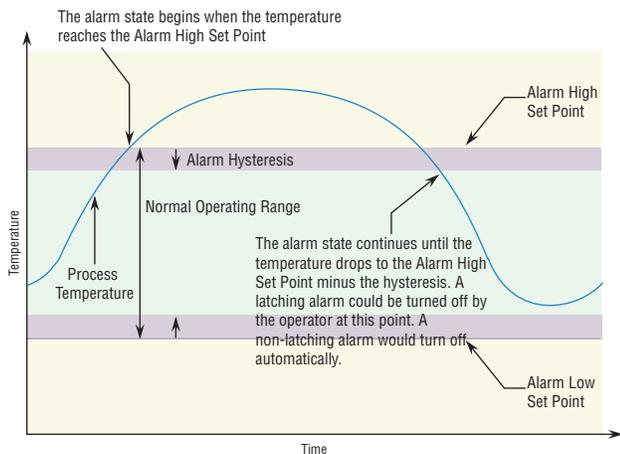
Push the Advance Key to display **[9nr]** in the upper display and the message source in the lower display.

Use the Up **▲** and Down **▼** keys to scroll through possible responses, such as Clear **[CLR]** or Silence **[SIL]**. Then push the Advance **⊙** or Infinity **∞** key to execute the action.

See the Keys and Displays chapter and the Home Page chapter for more details.

An alarm that is not latched (self-clearing) will deactivate automatically when the alarm condition has passed.

Turn alarm latching on or off with Latching **[ALR]** (Setup Page, Alarm Menu).



Alarm Silencing

If alarm silencing is on the operator can disable the alarm output while the controller is in an alarm state. The process value or temperature has to enter the normal operating range beyond the hysteresis zone to activate the alarm output function again.

An active message, such as an alarm message, will cause the display to toggle between the normal settings and the active message in the upper display and **ALARM** in the lower display.

Push the Advance Key to display **ALARM** in the upper display and the message source in the lower display.

Use the Up **▲** and Down **▼** keys to scroll through possible responses, such as Clear **CLR** or Silence **SIL**. Then push the Advance **⊕** or Infinity **∞** key to execute the action.

See the Keys and Displays chapter and the Home Page chapter for more details.

Turn alarm silencing on or off with Silencing **AS** (Setup Page, Alarm Menu).

Alarm Blocking

Alarm blocking allows a system to warm up after it has been started up. With alarm blocking on, an alarm is not triggered when the process temperature is initially lower than the alarm low set point or higher than the alarm high set point. The process temperature has to enter the normal operating range beyond the hysteresis zone to activate the alarm function.

If the EZ-ZONE PM has an output that is functioning as a deviation alarm, the alarm is blocked when the set point is changed, until the process value re-enters the normal operating range.

Turn alarm blocking on or off with Blocking **ABL** (Setup Page, Alarm Menu).

Open Loop Detection

When Open Loop Detection is enabled **LOD**, the controller will look for the power output to be at

100%. Once there, the control will then begin to monitor the Open Loop Detect Deviation **LODD** as it relates to the value entered for the Open Loop Detect Time **LODT**. If the specified time period expires and the deviation does not occur, an Open Loop Error will be triggered. Once the Open Loop Error condition exists the control mode will go off.

Note:

All prompts identified in this section can be found in the Loop Menu of the Setup Page.

Programming the EZ Key/s

You can program the EZ Key either in the Setup Menu or with configuration software, such as EZ-ZONE Configurator, using a personal computer.

The following examples show how to program the EZ Key to start and stop a profile.

Using keys and display:

- To go to the Setup Page from the Home Page, press both the Up **▲** and Down **▼** keys for six seconds. **SET** will appear in the upper display and **SET** will appear in the lower display.
- Press the Up Key **▲** until **Fun** appears in the upper display and **SET** will appear in the lower display.
- Press the Advance Key **⊕** until Digital Input Level **LEW** appears in the lower display. Use an arrow key to specify the state of the key (high or low) when the controller is powered up. Functions will toggle with each press of the EZ Key, such as Profile Start/Stop.
- Press the Advance Key **⊕**. The lower display will show Digital Function **Fn**. Press the Up **▲** or Down **▼** key to scroll through the functions that can be assigned to the EZ Key
When Profile Start/Stop **PSET** appears in the upper display and **Fn** appears in the lower display, press the Advance Key **⊕** once to select that function and move to the Function Instance **F5** parameter.
- Press the Up **▲** or Down **▼** key to scroll to the profile that you want the EZ Key to control.
- The instance tells the controller which of the numbered functions should be acted upon. For profiles, there are 4 instances. Press the Infinity Key **∞** once to return to the submenu, twice to return to the main menu or three times to return to the Home Page.

Using Lockout and Password Security

If unintentional changes to parameter settings might raise safety concerns or lead to downtime, you can use the lockout feature to make them more secure. There are two methods of lockout that can be deployed, both of which are accessible from the Factory Page.

Method 1- Change the value of the Read Lock **rLoC** (1 to 5) and Set Lock **SLoC** (0 to 5) prompts where the higher the value or setting for each translates to a higher security clearance (greater access).

Method 2- Enable Password Security **PRSE** and then modify the Lock Level **LoCL** value which ranges from 1 to 5. See the section entitled [Using Lockout Method 2](#) for more detail.

Using Lockout Method 1 (Read and Set Lock)

All Pages have security levels assigned where two of those cannot be changed (Home and Setup). Defaults (factory settings) for each are shown below:

- Home Page = 1
- Operations Page = 2 (changeable to 1, 2 or 3)
- Setup Page = 4
- Profiling Page = 3 (changeable to 1, 2 or 3)
- Factory Page = 5*

* The Factory Page is always visible where all menus within it may or may not be visible/writable. For further detail see table "[Factory Page Menus](#)".

The table below represents the various levels of lockout for the Set Lockout Security prompt **SLoC** and the Read Lockout Security prompt **rLoC**. Looking at the table, "Y" equates to yes (can write/read) where "N" equates to no (cannot write/read). The colored cells simply differentiate one level from the next while also showing the level where read/write is enabled. As stated previously, the Set Lockout has 6 levels (0 to 5) of security where the Read Lockout has 5 (1 to 5). Therefore, level "0" applies to Set Lockout only.

Lockout Security SLoC & rLoC						
Pages	Security Level					
	0	1	2	3	4	5
Home Page (cannot be changed)	N	Y	Y	Y	Y	Y
Operations Page	N	N	Y	Y	Y	Y
Setup Page (cannot be changed)	N	N	N	N	Y	Y
Profile Page	N	N	N	Y	Y	Y
Factory Page	Y	Y	Y	Y	Y	Y

Being able to change the page security level for the Operations and Profile pages allows a user to give access to the Profile Page while locking out the Operations Page. The following example shows how the Lockout feature may be used to accomplish this:

1. Press and hold the Advance  and Infinity  keys for approximately 6 seconds to enter the Factory Page
2. Navigate to the **LoC** Menu using the Up or Down arrow keys
3. Using the green Advance key navigate to the Lock Operations prompt **LoLo** and change it

(push the Up arrow) from the default value of 2 to 3

4. Push the Advance key again and change the Lock Profiling prompt **LoCP** from the default of 3 to 2
5. Change Read Lockout Security **rLoC** to 2 and the Set Lockout **SLoC** to 2 or higher

With the above settings, the Home Page and the Profiling Page can be accessed, and all writable parameters can be written to. Due to the Read lock setting of 2 all pages with security levels greater than 2 will be locked out (inaccessible).

Another example of Method 1 lockout usage could be that an operator wants read access to all pages while allowing read/write access to the Home Page and the Lockout Menu only.

1. Press and hold the Advance and Infinity keys for approximately 6 seconds to enter the Factory Page
2. Navigate to the **LoC** Menu using the Up or Down arrow keys
3. Using the green Advance key navigate to the Read Lockout Security **rLoC** and change it to 5
4. Push the green Advance key and navigate to the and Set Lockout Security **SLoC** changing it to 1

Although the Factory Page is always visible, some menus within it can be restricted.

Lockout Security SLoC & rLoC						
Factory Page Menus						
Menus	Security Level					
	0	1	2	3	4	5
Custom Menu	N	N	N	N	N	Y
Lockout Menu*	Y	Y	Y	Y	Y	Y
Diagnostic Menu**	N	Y	Y	Y	Y	Y
Calibration Menu	N	N	N	N	N	Y

* Using lockout Method 1 with **SLoC** set to 0, all writable parameters within the control will be inhibited (not writable) with two exceptions, **SLoC** and **rLoC**. As shown below, both of these parameters can always be seen and modified.

** Diagnostic Menu and all associated prompts are always visible and never writable

Lockout Security SLoC & rLoC						
Factory Page Menu Parameters						
Parameters	Security Level					
	0	1	2	3	4	5
LoLo	N	Y	Y	Y	Y	Y
LoCP	N	Y	Y	Y	Y	Y
PRSE	N	Y	Y	Y	Y	Y
rLoC	Y	Y	Y	Y	Y	Y
SLoC	Y	Y	Y	Y	Y	Y

Note:

Using Method 1 Lockout all settings can be modified by anyone who knows how to find their way to the **[SLoc]** and **[rLoc]** parameters

Using Lockout Method 2 (Password Enable)

It is sometimes desirable to apply a higher level of security to the control where a password would be required to access the control. If Password Enabled **[PASS.E]** in the Factory Page under the **[Loc]** Menu is set to on, an overriding Password Security will be in effect. Without the appropriate password, specified menus will remain inaccessible. Page and Menu access is defined in the Locked Access Level **[LoCL]** prompt. On the other hand, a User with a password would have visibility restricted by the Read Lockout Security **[rLoc]**. As an example, with Password Enabled and the Locked Access Level **[LoCL]** set to 1 and **[rLoc]** is set to 3, the available Pages for a User without a password would be limited to the Home and Factory Pages (locked level 1). If the User password is entered all pages would be accessible with the exception of the Setup Page as defined by level 3 access.

How to Enable Password Security

Follow the steps below:

1. Go to the Factory Page by holding down the Infinity **[∞]** key and the Advance **[⊕]** key for approximately six seconds.
2. Push the Down **[▼]** key one time to get to the **[Loc]** menu. Again push the Advance **[⊕]** key until the Password Enabled **[PASS.E]** prompt is visible.
3. Push either the up or down key to turn it on. Once on, 4 new prompts will appear:
 1. **[LoCL]**, Locked Access Level (1 to 5) corresponding to the lockout table above.
 2. **[roll]**, Rolling Password will change the Customer Code every time power is cycled.
 3. **[PASS.U]**, User Password which is needed for a User to acquire access to the control.
 4. **[PASS.A]**, Administrator Password which is needed to acquire administrative access to the control.

The Administrator can either change the User and or the Administrator password or leave them in the default state. Once Password Security is enabled they will no longer be visible to anyone other than the Administrator. In other words the Lock Menu **[Loc]** is not available to a User. As can be seen in the formula that follows either the User or Administrator will need to know what those passwords are to acquire a higher level of access to the control. Back out of this menu by pushing the Infinity **[∞]** key. Once out of the menu, the Password Security will be enabled.

How to Acquire Access to the Control

To acquire access to any inaccessible Pages or Menus, go to the Factory Page and enter the **[ULoc]** menu. Once there follow the steps below:

Note:

If Password Security (Password Enabled **[PASS.E]** is On) is enabled the two prompts mentioned below in the first step will not be visible. If the password is unknown, call the individual or company that originally setup the control.

1. Acquire either the User Password **[PASS.U]** or the Administrator Password **[PASS.A]**.
2. Push the Advance **[⊕]** key one time where the Code **[Code]** prompt will be visible.

Note:

- a. If the the Rolling Password is off push the Advance key one more time where the Password **[PASS]** prompt will be displayed. Proceed to either step 7a or 8a. Pushing the Up **[▲]** or Down **[▼]** arrow keys enter either the User or Administrator Password. Once entered, push and hold the Infinity **[∞]** key for two seconds to return to the Home Page.
 - b. If the Rolling Password **[roll]** was turned on proceed on through steps 3 - 9.
3. Assuming the Code **[Code]** prompt (Public Key) is still visible on the face of the control simply push the Advance key **[⊕]** to proceed to the Password **[PASS]** prompt. If not find your way back to the Factory Page as described above.
 4. Execute the calculation defined below (7b or 8b) for either the User or Administrator.
 5. Enter the result of the calculation in the upper display play by using the Up **[▲]** and Down **[▼]** arrow keys or use EZ-ZONE Configurator Software.
 6. Exit the Factory Page by pushing and holding the Infinity **[∞]** key for two seconds.

Formulas used by the User and the Administrator to calculate the Password follows:

Passwords equal:

7. User

- a. If Rolling Password **[roll]** is Off, Password **[PASS]** equals User Password **[PASS.U]**.
- b. If Rolling Password **[roll]** is On, Password **[PASS]** equals:

$$((PASS.U \times code) \text{ Mod } 929) + 70$$

8. Administrator

- a. If Rolling Password **[roll]** is Off, Password **[PASS]** equals User Password **[PASS.A]**.
- b. If Rolling Password **[roll]** is On, Password **[PASS]** equals:

$$((PASS.A \times code) \text{ Mod } 997) + 1000$$

Differences Between a User Without Password, User With Password and Administrator

- User **without** a password is restricted by the Locked Access Level `[LoLL]`.
- A User **with** a password is restricted by the Read Lockout Security `[rLoL]` never having access to the Lock Menu `[LoL]`.
- An Administrator is restricted according to the Read Lockout Security `[rLoL]` however, the Administrator has access to the Lock Menu where the Read Lockout can be changed.

Modbus - Using Programmable Memory Blocks

When using the Modbus protocol, the PM control features a block of addresses that can be configured by the user to provide direct access to a list of 40 user configured parameters. This allows the user easy access to this customized list by reading from or writing to a contiguous block of registers.

To acquire a better understanding of the tables found in the back of this document (See [Appendix: \(Modbus Programmable Memory Blocks\)](#)) please read through the text below which defines the column headers used.

Assembly Definition Addresses

- Fixed addresses used to define the parameter that will be stored in the "Working Addresses", which may also be referred to as a pointer. The value stored in these addresses will reflect (point to) the Modbus address of a parameter within the ST control.

Assembly Working Addresses

- Fixed addresses directly related to their associated "Assembly Definition Addresses" (i.e., Assembly Working Addresses 200 & 201 will assume the parameter pointed to by Assembly Definition Addresses 40 & 41).

When the Modbus address of a target parameter is stored in an "Assembly Definition Address" its corresponding working address will return that parameter's actual value. If it's a writable parameter, writing to its working register will change the parameter's actual value.

As an example, Modbus register 360 contains the Analog Input 1 Process Value (See Operations Page, Analog Input Menu). If the value 360 is loaded into Assembly Definition Address 91, the process value sensed by analog input 1 will also be stored in Modbus registers 250 and 251. Note that by default this parameter is also stored in working registers 240 and 241 as well.

The table (See Appendix: Modbus Programmable Memory Blocks) identified as "Assembly Definition Addresses and Assembly Working Addresses" reflects the assemblies and their associated addresses.

Software Configuration

Using EZ-ZONE® Configurator Software

To enable a user to configure the PM control using a personal computer (PC), Watlow has provided free software for your use. If you have not yet obtained a copy of this software insert the CD (Controller Support Tools) into your CD drive and install the software. Alternatively, if you are viewing this document electronically and have a connection to the internet simply click on the link below and download the software from the Watlow web site free of charge.

http://www.watlow.com/products/software/zone_config.cfm

Once the software is installed double click on the EZ-ZONE Configurator icon placed on your desktop during the installation process. If you cannot find the icon follow the steps below to run the software:

1. Move your mouse to the "Start" button
2. Place the mouse over "All Programs"
3. Navigate to the "Watlow" folder and then the sub-folder "EZ-ZONE Configurator"
4. Click on EZ-ZONE Configurator to run.

The first screen that will appear is shown below.



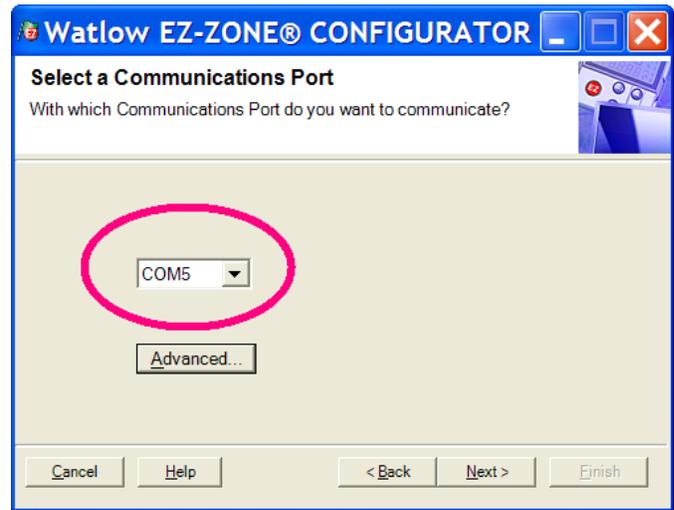
If the PC is already physically connected to the EZ-ZONE PM control click the next button to go on-line.

Note:

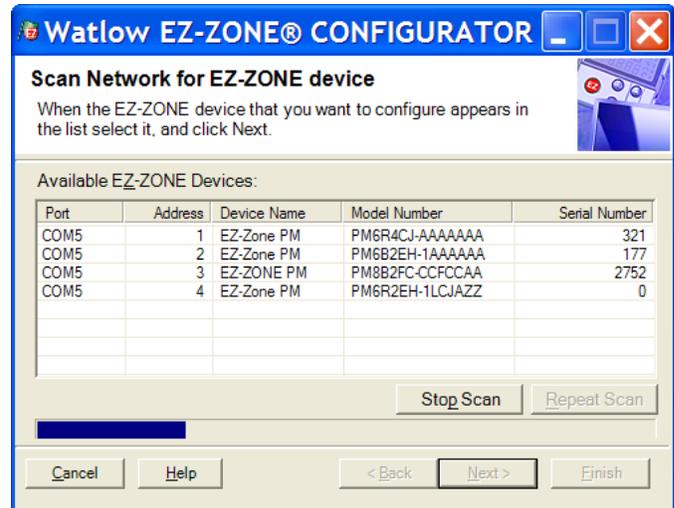
When establishing communications from PC to the EZ-ZONE PM control an interface converter will be required. The Standard Bus network uses EIA-485 as the interface. Most PCs today would require a USB to EIA-485 converter. However, some PCs may still be equipped with EIA-232 ports, therefore an EIA-232 to EIA-485 converter would be required.

As can be seen in the above screen shot the software provides the user with the option of downloading a previously saved configuration as well as the ability to create a configuration off-line to download later. The screen shots that follow will take the user on-line.

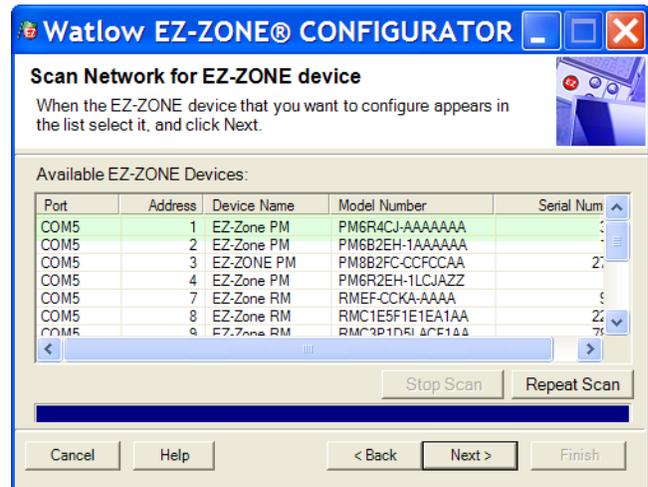
After clicking the next button above it is necessary to define the communications port on the PC to use.



The available options allow the user to select "Try them all" or to use a specific known communications port. After installation of your converter if you are not sure which communications port was allocated select "Try them all" and then click next. The screen to follow shows that the software is scanning for devices on the network and that progress is being made.

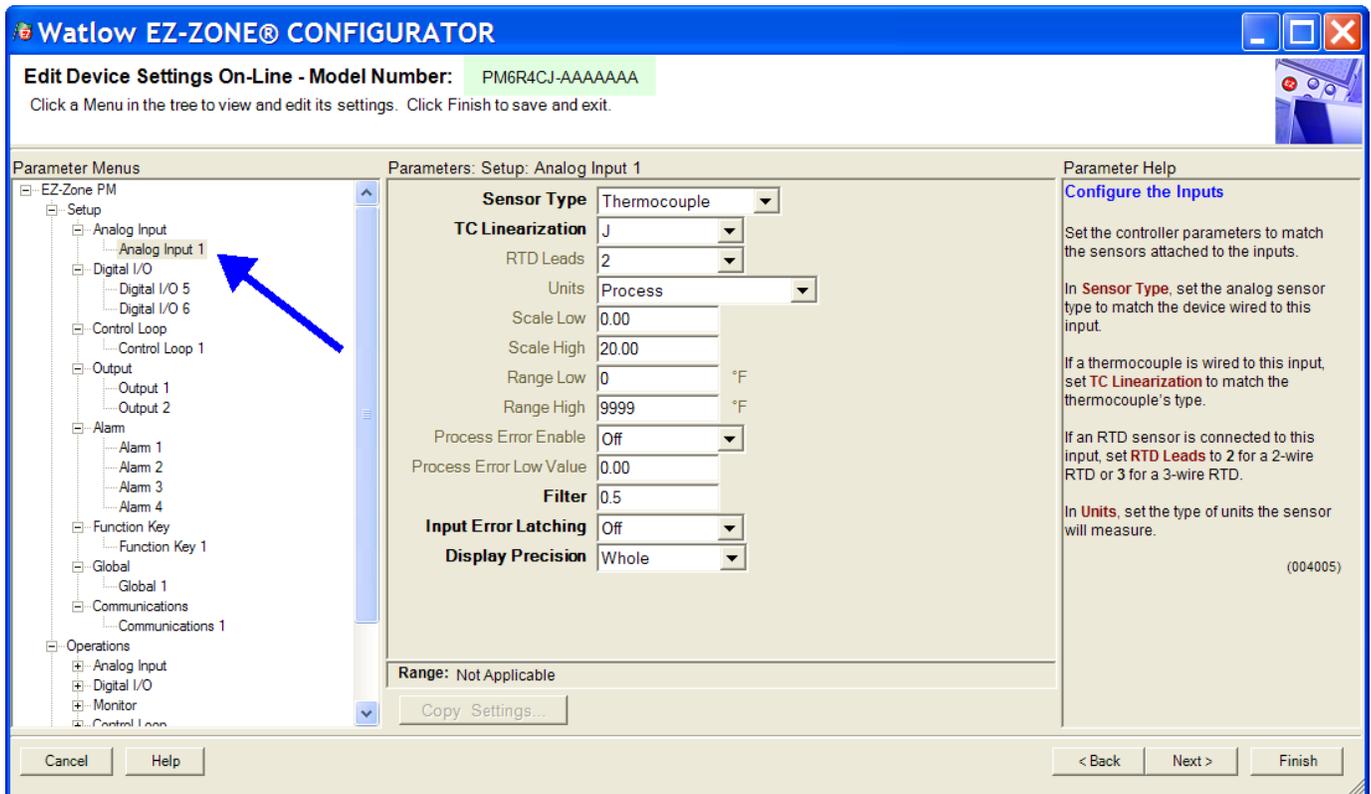


When complete the software will display all of the available devices found on the network as shown below.



In the previous screen shot the PM is shown highlighted to bring greater clarity to the control in focus. Any EZ-ZONE device on the network will appear in this window and would be available for the purpose of configuration or monitoring. After clicking on the control of choice simply click the next button once again. The next screen appears below.

eter will appear in the center column. The grayed out fields in the center column simply mean that this does not apply for the type of sensor selected. As an example, notice that when a thermocouple is selected, RTD Leads does not apply and is therefore grayed out. To speed up the process of configuration notice that at the bottom of the center column there is an



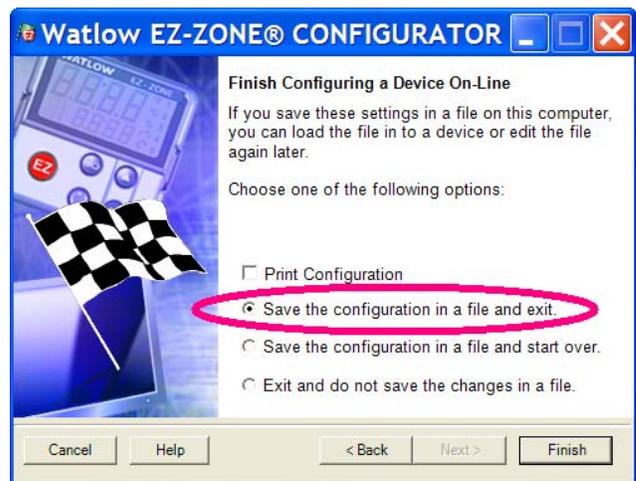
In the screen shot above notice that the device part number is clearly displayed at the top of the page (green highlight added for emphasis). When multiple EZ-ZONE devices are on the network it is important that the part number be noted prior to configuring so as to avoid making unwanted configuration changes to another control.

Looking closely at the left hand column (Parameter Menus) notice that it displays all of the available menus and associated parameters within the control. The menu structure as laid out within this software follows:

- Setup
- Operations
- Factory
- Profile

Navigating from one menu to the next is easy and clearly visible. Simply slide the scroll bar up or down to display the menu and parameter of choice. As an alternative, clicking on the negative symbol next to Setup will collapse the Setup Menu where the Operations Menu will appear next and perhaps deliver more clarity for the area of focus by not displaying unwanted menus and parameters. Once the focus is brought to an individual parameter (single click of mouse) as is the case for Analog Input 1 in the left column, all that can be setup related to that param-

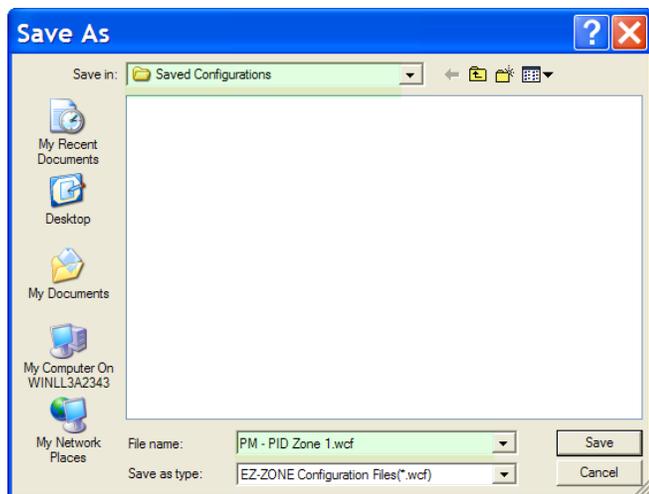
option to copy settings. If Alarm 1 was being configured and the other Alarms are the same simply click on "Copy Settings" where a copy dialog box will appear allowing for quick duplication of all settings. Notice too, that by clicking on any of those items in the center column that context sensitive help will appear for that particular item in the right hand column. Lastly, when the configuration is complete click the "Finish" button at the bottom right of the previous screen shot. The screen that follows this action can be seen below.



Although the PM control now contains the configuration (because the previous discussion focused on doing the configuration on-line) it is suggested that after the configuration process is completed that the user save this file on the PC for future use. If for some reason someone inadvertently changed a setting without understanding the impact, it would be easy and perhaps faster to download a saved configuration back to the control versus trying to figure out what was changed.

Of course, there is an option to exit without saving a copy to the local hard drive.

After selecting Save above click the "Finish" button once again. The screen below will than appear.



When saving the configuration note the location where the file will be placed (Saved in) and enter the file name (File name) as well. The default path for saved files follows:

\\My Documents\Watlow\EZ-Zone Configurator\
Saved Configurations

The user can save the file to any folder of choice.