SERIES C

1ZC · 16C · 18C · 19C · 25C

TEMPERATURE / PROCESS CONTROLLER

ATHENA®
The Temperature Control Company

Configuration and Operation Manual

Precautions

Warning ⚡ ⚠	**Remove power from the 1ZC controller before removing the terminal strip from the controller.** **Remove power from the 1ZC controller before removing the bezel and circuit board assembly from the case.** **Do not power up the 1ZC controller while the bezel and circuit board assembly is out of the case.** **Remove power from a controller before cleaning the exterior of the controller.** **Failure to observe these precautions can result in exposure to a potentially lethal shock hazard.** **All wiring should be done by an experienced technician and be installed in accordance with national and local electrical codes. To avoid serious personal injury and damage to equipment, follow all warnings and cautions provided in the controller installation manuals.**

Caution ➤	**If a controller shows signs of having been damaged during shipping, do not power up or install the controller. Save all packing materials and report any damage to the carrier immediately.** **When the controller is powered up, the outputs may be activated. Consider the effects on your process before powering up the controller.** **We recommend placing the controller in standby mode until you have configured the controller for your application.** ➢ **For instructions for putting a 16C, 18C, or 25C controller in standby mode using the controller front panel, see 2.4.3 in this manual.** ➢ **For instructions for putting a 1ZC controller in standby mode using a personal computer, see the manual supplied with the host software.**

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Table of Contents

1. Introduction

1.1 About this Manual

1.1.1 What It Contains

This manual contains all the information needed to configure and operate the 1ZC, 16C, 18C, and 25C controllers. (The 19C is functionally identical to the 18C.)

This manual contains:

- in this section, an overview of the controllers' capabilities

- a description of the user interface and instructions for using the display and keypad on the 16C, 18C, and 25C controllers; see Section 2

- quick-start instructions for setting up the 16C, 18C, and 25C controllers for PID control, using many of the factory defaults; see Section 3

- general information about configuration parameters; see Section 4

- detailed information about every configuration parameter used by the controllers; see Sections 5 through 14

- numbers used to identify the parameters in Multi-Comm messages; see Section 15

- tuning instructions (for automatic and manual tuning); see Section 16

- instructions for changing the security access level; see Section 17

- calibration instructions; see Section 18; the controller is calibrated at the factory for the sensor type specified when you ordered the controller. However, if you later change the type of sensor, you may need to re-calibrate. The circumstance that dictates re-calibration is explained in 5.2.

- error messages and codes displayed on the front panel of 16C, 18C, and 25C controllers; see Section 19

- frequently asked questions; see Section 20

Instructions for wiring and mounting the controllers are in the installation manual supplied with each controller.

Guidelines for using a MODBUS host to communicate with the Series C controllers are in *Using the MODBUS Protocol with Athena Series C (1ZC, 16C, 18C, and 25C) Controllers*. That manual also contains the MODBUS register mapping for all values stored in the controllers' databases.

Instructions for configuring and monitoring the 1ZC, 16C, 18C, and 25C controllers using an RS-232 or RS-485 interface, and Athena Multi-Comm software are in the *Multi-Comm User's Guide.*

1.1.2 What to Read

This manual contains a comprehensive discussion of all the controller functions. Some of the information may not apply to your situation.

If you are a process operator, read Sections 1, 2, and 19. If the controller does not behave as you expect, read Section 20.

If you are a process engineer responsible for configuring the controller, have used Athena Series C controllers before, and plan to use PID control, read Sections 3, 16, and 17.

If you are a process engineer responsible for configuring the controller and have never set up an Athena Series C controller before, look at Section 1 through 17, reading anything that applies to your control strategy.

If you are a programmer responsible for programming a MODBUS host to communicate with the controllers, read Section 1 and those portions of Sections 4 through 17 that apply to your control strategy.

1.2   Features and Benefits of Series C Controllers

1.2.1 PID and On/Off Control

The 1ZC, 16C, 18C, and 25C controllers can be equipped with one or two outputs to implement PID and on/off control. All also support a manual mode that overrides automatic control. In manual mode you control the outputs by entering a fixed output percentage value. Transfer from PID to manual is "bumpless". Information about the advantages of each of these two supported control types is in 1.5.

When PID control is selected, you can take advantage of the controllers' Autotune feature for easy tuning of the proportional, integral, and derivative components of the control algorithm.

1.2.2 Convenient User Interface

The panel-mounted 16C, 18C, and 25C are all equipped with a bright two-line LED display that is easy to read over wide viewing angles.[1] During normal operations the process value is always on display. The setpoint can also be displayed at all times. If you prefer, the setpoint can be "blanked", that is, it can be turned off after a configurable time period. Pressing any key displays the setpoint again.

The 16C, 18C, and 25C keypad consists of four keys:

☰ mode/enter – used to access the displays used to change the mode or security access level, as well as to write values to the controller's database and step through items within a configuration menu

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[1] The compact 1ZC does not include a display. It does have LEDs to signal which functions are active. The 1ZC is designed to be mounted on DIN rails in a cabinet. It is configured and its process value is read using a personal computer. See *Using the MODBUS Protocol with Athena Series C Controllers* or the *Multi-Comm User's Guide*.

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⟳**menu access** – used to access the menu system; within the menu system it is used to move from menu to menu

⋀ **up** and ⋁ **down** – used to change numeric values and to scroll through lists of configuration choices

The front panel of the 16C, 18C, and 25C controllers includes LEDs that are used for alarm annunciation, as well as to signal which controller functions are active. See Section 2 for more information about the user interface.

1.2.3 Alarm Annunciation

In addition to the front panel LEDs for alarm annunciation on the 16C, 18C, and 25C controllers, all the models (including the 1ZC) can be configured to use one or more outputs for annunciation of high or low process alarms, deviation alarms, inverse band alarms, and normal band alarms. See 1.7 for more details about alarm capabilities.

1.2.4 Ease of Configuration

The 1ZC, 16C, 18C, and 25C controllers all use the same configuration parameters, so if you know how to configure one of the controllers, you know how to configure all of them. The 16C, 18C, and 25C can all be configured using the front panel display and keypad to access the hierarchy of menus as described in Section 4. Parameters that do not apply to your control strategy will not be displayed. For example, if you choose on/off control as the function for an output, then only parameters relating to on/off control will be displayed for that output.

All the controllers can be configured using a personal computer. See 1.2.6 below for the communication protocols supported.

1.2.5 Ramp/Soak Recipes

The 1ZC, 16C, 18C, and 25C can all be configured to execute ramp/soak recipes on demand. A recipe consists of up to eight segments. For each segment you can configure a unique ramp time, soak level (setpoint), and soak time.

If your process is not responsive enough to achieve the setpoint within the ramp time (or maintain the soak level for the entire soak time), you can use the recipe "holdback" parameter to "stop the clock" on the ramp time (and soak time) if the setpoint differs too much from the process value.

Execution of a recipe can be started, paused, resumed, and terminated using the front panel (or an optional contact/digital input) on the 16C, 18C, and 25C, or using a serial communications interface on any of the controllers (including the 1ZC model).

Alternatively, all these controllers can be configured to execute a single gradual ramp to setpoint at startup or on demand. Holdback can also be applied to this operation. See Section 11 for more information about ramp/soak capabilities.

1.2.6 Serial Communications

The 1ZC model always supports an RS-485 serial communications interface. The 16C, 18C, and 25C are all available with an optional RS-485 serial communication interface. (When ordering the controller you can select processor board firmware for either MODBUS protocol or Athena Plus protocol to work with the RS-485 interface.) An RS-232 serial communication interface is available as an option for the 16C, 18C, and 25C models. (An RS-232 interface can be used with Athena Plus protocol, but not MODBUS).

Athena Multi-Comm software can be used to communicate with the controllers equipped with an RS-485 or RS-232 interface and firmware for the Athena Plus protocol as described in the *Multi-Comm User's Guide.*

Guidelines for using a MODBUS host to communicate with the Series C controllers are in *Using the MODBUS Protocol with Athena Series C (1ZC, 16C, 18C, and 25C) Controllers.*

1.3 Modes of Operation

1.3.1 Control Modes

Unless both standard outputs are set to off or ALR (alarm), the 1ZC, 16C, 18C, and 25C controllers support several modes of operation for control, as well as a special mode used to tune the unit automatically for PID control.[2]

The table below summarizes the control modes and shows the display used to select each. Instructions for using the keypad to display and change the mode are in 2.4. The operational display for each mode is in 2.2.1.

Control Mode	Selection Display	Description
normal	CtrL nor	When the controller is in normal mode, the outputs are based on the controller's calculations in accordance with the configured control strategy, dependent on the input received.
standby	CtrL StbY	When the controller is placed in standby mode, the controller does not calculate any outputs until the controller is taken out of standby. While in standby, the control outputs are in their unactivated state (open or closed, depending on the type of relay). Analog outputs are set to their minimums in standby mode.
manual (fixed output percentage)	CtrL FOP	When the controller is placed in manual mode, then, regardless of the configured control strategy and the input received, the outputs used are the fixed percentages specified by the operator using the percent 1 and percent 2 values. See 2.4.5 for the procedure.
Autotune	CtrL Atun	When Autotune is selected, the PID outputs are put under the control of the Autotune algorithm, and dependent on the input received. Autotune is not always available. The controller and the process must be prepared before the controller is placed in Autotune mode. See 16.2 for details.
ramp/soak start	CtrL r.S	If the controller's ramp/soak parameters have been used to enable the controller to execute a single-setpoint ramp or a multi-step recipe, then this choice is available. When ramp/soak start is selected from the list of available modes, the single-setpoint ramp or multi-step ramp will be executed, based on the values stored in the controllers ramp/soak parameters. The outputs will be calculated by the controller to achieve the recipe setpoint. The recipe setpoint will be manipulated by the controller in accordance with the ramp and soak segments configured using the controller's ramp/soak parameters. See Section 11 for details.
ramp/soak hold	CtrL rS.H	If the controller is running a multi-step recipe based on the ramp/soak parameter values (that is, if $r.S$ is alternating with the display of the PV), then the ramp/soak hold choice is available on the list of modes. When this choice is selected, the setpoint is held at the level reached when the recipe was put on hold.
resume ramp/soak	CtrL rS.r	If a recipe is currently being held (that is, if $rS.H$ is alternating with the display of the PV), then the resume ramp/soak recipe choice is available on the list of modes. When this choice is selected, the controller resumes execution of the recipe.

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[2] When both standard outputs are off or used for alarm annunciation, the instrument functions as a non-controlling indicator. When the outputs are not used for control, the operating modes are not applicable (they are all related to the behavior of outputs), so no mode is displayed when you press the ▤ key.

1.3.2 Configuration

In addition to the operating displays associated with the control modes described in 1.3.1 above, the 16C, 18C, and 25C can display configuration parameters. The parameters are grouped by purpose and organized in menus. Instructions for viewing and changing configuration parameter values are in 2.4.8.

Attention ➤	**Before accessing the menu system (or changing a parameter value using a remote host), we recommend putting the controller in standby mode as described in 2.4.3 (or in the manual supplied with the host software).**

1.4   Security

The 16C, 18C, and 25C controllers can be configured to limit the values that can be changed using the keypad. For example, the access level can be set to allow operators to change only the setpoint or the manual mode output percentage.

A controller can be set to any of the access levels in the table below. The sequence of levels in the table is from most restrictive to least restrictive. New 16C, 18C, and 25C controllers are shipped with the access level set to cnF9 (configuration).

Instructions for changing the access level are in Section 17.

Displayed Abbreviation	Access Level	Description
Loc.0	keypad lockout	**Highest security level; no access.** While the access level is "keypad lockout", no controller values can be changed, not even the setpoint. To escape, press the ↻ key for approximately ten seconds, until Loc.0 is displayed, then press ▲.
SP	setpoint only	**Setpoint or manual outputs can be adjusted; no access to mode or menus.** When the access level is "setpoint only", the keypad can be used to change the setpoint or the manual mode output percentage. However, the operator will not be able to change the controller from normal (automatic) mode to manual, and vice versa.
SPPL	setpoint plus mode	**Setpoint or manual outputs can be adjusted; mode can be changed; no access to menus.** When the access level is "setpoint plus mode", the keypad can be used to change the setpoint, manual mode output percentage, and control mode, including executing recipes, and switching from normal (automatic) to manual, and vice versa. (See 1.3.1 for a description of all control modes.)
USEr	user	**All the "setpoint plus mode" functions, and limited access to menus.** When the access level is "user", the keypad can be used to do all the functions available in "setpoint plus mode". At the "user" level, the keypad can also be used to view and change the values on the control menu (tuning parameters), adjust the Autotune damping parameter, and view and change all the ramp/soak parameters.
CnF9	configuration	**All the "user" functions, and access to all menus except calibration.** When the access level is "configuration", the keypad can be used to perform all controller functions and access all menus, except the calibration menu.
FACt	factory	**Access to everything.** When the access level is "factory", the keypad can be used to do all controller functions, including re-calibrating the controller. The controllers are calibrated at the factory. Usually the controllers will never need re-calibration. See 5.2 for the circumstance that dictates re-calibration. **Do not leave the controller set to this access level after you have re-calibrated the controller.**

1.5   Control Types Supported

1.5.1 Overview

The 1ZC, 16C, 18C, and 25C controllers support PID and on/off control. Autotuning is available for PID control. The type of control for each of the two standard outputs[3] is specified using the output menu output type parameter. The two outputs can be set for different types of control. For 1ZC and 16C controllers, one or both standard outputs can be used for alarm annunciation instead of control. (See 1.6 for more information about alarm annunciation.)

The advantages and disadvantages of both types of control are described briefly below.

1.5.2 PID Control

When Proportional-Integral-Derivative (PID) control is used, the controller modulates output power by adjusting the output power percentage within a proportional band. Power is proportionally reduced as the process temperature gets closer to the setpoint temperature. The integral action affects the output based on the duration of the process value's variation from the setpoint, and the derivative action affects the output based on the rate of change of the process value.

PID control has the following advantages:

- minimizes overshoot

- enhances stability

- compensates for process lag

The proportional band, derivative action (rate), and integral action (auto reset) parameters are automatically adjusted by the Autotune operation described in Section 16.

PID control is appropriate for processes with the following characteristics:

- temperature lags exist

- load changes are present

- overshoots need to be minimized

- very accurate control is required

PID is not appropriate for:

- underpowered processes

- processes that use compressors, blowers, or other mechanical devices that cannot tolerate constant cycling

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[3] If your application does not require two outputs, the controller could have been ordered with only one output (output 1).

1.5.3 On/Off Control

On/off control has two states, fully off and fully on.

On/off control can be used where:

- process is underpowered and has very little heater storage capacity

- some temperature oscillation is permissible

- electromechanical systems (compressors) make rapid cycling undesireable

To prevent rapid cycling, the controllers allow you to configure a deadband and a hysteresis value for on/off control.

1.5.3.1 Use of Hysteresis

If you are using a single output for control, then use the hysteresis parameter to reduce frequency of cycling.

The hysteresis value represents a temperature value that the controller uses to separate the on and off transitions of the individual outputs. (You configure the Output 1 and Output 2 hysteresis values independently.)

For example, in the diagram below, the setpoint is 100 and the hysteresis value is 10. In this case the output would be on from startup until the process value reaches 105 (the setpoint plus half the hysteresis value). After overshoot, the PV falls, but the controller does not turn the output on again until the temperature falls to 95 (the setpoint minus half the hysteresis value).
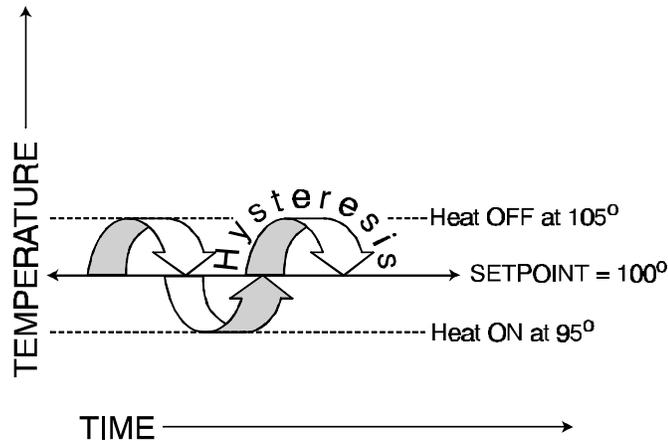
1.5.3.2 Use of Deadband

The controllers also permit you to specify a deadband value for each on/off output. In an application where the controller's two outputs are used to control heating and cooling of the same process, this has the effect of defining a band around the setpoint in which neither the heating nor the cooling output is on. This avoids having the heating and cooling devices working against one another.[4]

To allow you to optimize the control of your process, the heating deadband and the cooling deadband can be different values. When the deadband value is applied to an output, it has the effect of shifting the setpoint and the hysteresis for that output. In the diagram below we call the setpoint the controller actually uses the "effective setpoint". When a deadband is configured, the value of this effective setpoint is different from the value of the displayed setpoint.

For a heating (reverse-acting) output, a positive deadband (value greater than zero) moves the effective setpoint used by the controller below the displayed setpoint. For cooling (direct-acting outputs), a positive deadband moves the effective setpoint used by the controller above the setpoint displayed.[5]

In the diagram below, the setpoint is 100, the hysteresis for each output is 10, and a deadband of 10 has also been configured for each output. (These are probably not realistic values for most processes, but we're using these values to demonstrate the controllers' behavior when hysteresis and deadband are configured for both heating and cooling outputs.)
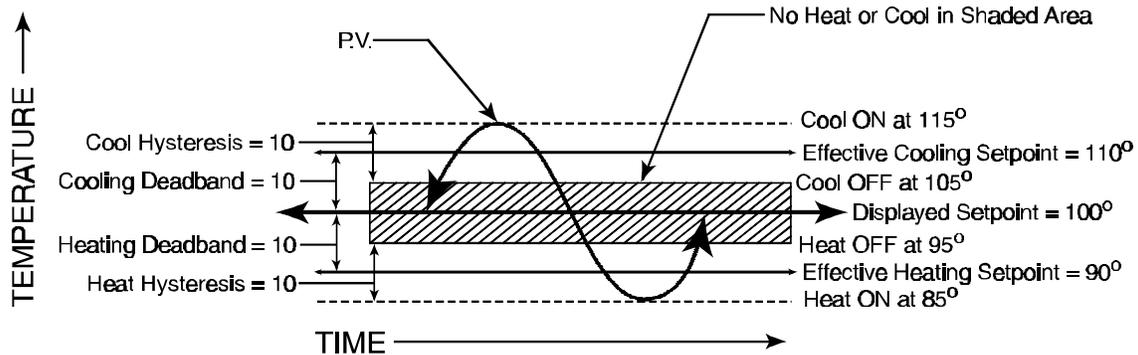
The heating output is on until the process value reaches 95 (setpoint minus heating deadband plus one half heating hysteresis), but the overshoot does not trigger the cooling output until the temperature reaches 115 (setpoint plus the cooling deadband plus half the cooling hysteresis).

The cooling output stays on until the PV reaches 105 (setpoint plus cooling deadband minus one half cooling hysteresis). The heating output does not come on until the PV has dropped to 85 (setpoint minus heating deadband minus one half heating hysteresis). The heating output goes off when the PV gets to 95 (setpoint minus heating deadband plus one half heating hysteresis).

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[4] However, if your application sometimes requires use of heating and cooling simultaneously, you can specify a negative deadband value. The range of valid deadband values is affected by input type; see 8.2.2 for details.

[5] A negative deadband value has the opposite effect.

1.6   Setpoint

1.6.1   Introduction

The value of the PV and the setpoint currently being used ("active setpoint") are always displayed when a 16C, 18C, or 25C controller is operating in normal mode.   The setpoint used (and displayed) is not always entered by the operator as described in 2.4.2.

- The active setpoint can come from a recipe; see 1.6.2.

- The active setpoint can be written to the controller from a host computer; see 1.6.3.

- A second setpoint can be used when an external device triggers an optional switch in the controller; see 1.6.4.

- The setpoint can come from an external device by means of an optional analog input; see 1.6.5.

For the algorithm used by the controller to determine which setpoint is the "active" setpoint, that is, the setpoint being used now, see 1.6.6.

1.6.2   Setpoint from a Recipe

The 1ZC, 16C, 18C, and 25C controllers can each be configured to execute a single ramp to setpoint, or a multi-step ramp and soak recipe (eight steps maximum). As execution of the ramp or recipe progresses, the setpoint is changed by the controller as specified in the recipe. Starting, pausing, and terminating recipe execution is described in 2.4.6. Instructions for configuring recipes are in Section 11.   The setpoint range applied to recipe soak levels is configured using the setpoint low and high limit parameters described in 5.6.2 and 5.7.2.

Athena Multi-Comm software can be used to configure Multi-Comm recipes that have any number of steps. (The recipes are stored on the Multi-Comm host computer, not in the controllers.) If a controller is connected to a Multi-Comm host computer via an RS-232 or RS-485 connection, the operator can execute a Multi-Comm recipe under the direction of the host, which sends the controller setpoint values in accordance with the recipe. Instructions for configuring Multi-Comm recipes are in the *Multi-Comm User's Guide*.

1.6.3   Setpoint from a Host Computer

If a controller is connected to a Multi-Comm host computer via an RS-232 or RS-485 connection, or to a MODBUS master via an RS-485 network, the setpoint in the controller may have been written to the controller by the host computer. The setpoint range applied to setpoints that are configurable using a host computer is configured using the setpoint low and high limit parameters described in 5.6.2 and 5.7.2.

Host computers can write a new setpoint to either RAM or the EEPROM (or to both). The controller uses the setpoint stored in RAM. If the setpoint is also stored on the EEPROM, the setpoint will be retained, even when power to the controller is turned off. The setpoint stored on the EEPROM will be written to RAM when the controller is powered up.

However, a host computer can wear out the EEPROM by writing to it too many times. <u>Do not write the setpoint to the EEPROM when you are writing a temporary setpoint to the controller</u>, such as when you are ramping to a final setpoint under the direction of a MODBUS master.

1.6.4 Second Setpoint

The 16C, 18C, and 25C controllers are available with an optional contact/digital input switch. If a controller is equipped with the optional contact/digital input, then an external device can trigger the use of a second setpoint. (See 14.8.2 for information about selecting the function of the contact/digital input.) The operator cannot use the front panel of the controller to switch to the second setpoint. However, once an external device has switched the controller to use the second setpoint, the operator can change the value of the second setpoint by means of the front panel. If the controller is on a network, the value of the second setpoint can also be changed by a host computer. The setpoint range for the second setpoint is configured using the setpoint low and high limit parameters described in 5.6.2 and 5.7.2.

1.6.5 Remote Analog Setpoint

Use of a remote analog setpoint (RAS) is supported by only controllers that contain the optional RAS card. If use of the remote analog setpoint is enabled (by the contact on the RAS card being closed by an external signal), then the RAS value currently being received by the controller is used as the active setpoint. The scaling of the RAS input is configured using the remote analog setpoint low and high scale parameters as described in 14.9.2

1.6.6 What Determines Which is the Active Setpoint

The active setpoint is the setpoint value currently being used for control. This is also the setpoint currently being displayed. As described above, this setpoint can come from one of several sources. The logic flow that determines which setpoint value is used is shown below.

If a single setpoint ramp or multi-step ramp/soak recipe is active,

then the active setpoint equals the recipe setpoint.

Else if using the remote analog setpoint is enabled,

then the active setpoint equals the remote analog setpoint.

Else if using the second setpoint is enabled,

then the active setpoint equals the second setpoint.

Else active setpoint equals setpoint entered by means of the front panel (or written to the controller by a host).

1.7 Alarm Annunciation

1.7.1 Using LEDs

The 16C, 18C, and 25C controllers all have two alarm LEDs on the front panel. Each of these LEDs is associated with an alarm. Each alarm can be configured to be activated (light the LED) when a specific condition exists. The Alr (alarm) menu is used to configure the alarms associated with the LEDs.

- **process alarm** – Activated when the process variable reaches the alarm value (alarm setpoint parameter value), independent of the PV's relationship to the process setpoint. A high process alarm activates at and above the alarm setpoint. A low process alarm activates at and below the alarm setpoint. For example, if you want an alarm to alert the operator when the PV goes up to 200, then configure the alarm as a high process alarm, and specify the alarm setpoint as 200.

- **deviation alarm** – Activated when the process variable deviates from the process setpoint by the amount specified using the alarm setpoint parameter value. A high deviation alarm activates when the PV is above the process setpoint by the amount specified using the alarm value. A low deviation alarm activates when the PV is below the process setpoint by the amount specified using the alarm value. For example, if you want an alarm to alert the operator when the PV is 50 below the setpoint, then configure the alarm as a low deviation alarm, and specify the alarm value (using the alarm setpoint parameter) as 50.

- **inverse band alarm** – Activated when the process value is within a specified band centered around the setpoint. For example, if you want the alarm to alert the operator when the PV is 10 units (or less) above or below the process setpoint, then configure the alarm as an inverse band alarm, and specify 10 for the alarm setpoint parameter value.

- **normal band alarm** – Activated when the process value is outside a specified band centered around the setpoint. For example, if you want the alarm to alert the operator when the PV is 10 units (or more) above or below the process setpoint, then configure the alarm as a normal band alarm, and specify 10 for the alarm setpoint parameter value.

The type of alarm (process high, process low, deviation high, deviation low, inverse band, or normal band) is referred to as the **alarm operation**. The alarm menu contains an alarm operation parameter for each of the two alarms associated with the LEDs on the front panel of the 16C, 18C, and 25C controllers.

For each alarm there is also an **alarm action** parameter. This parameter is the first in the alarm menu for each of the two alarms, and is used to specify how the alarm will be used. The choices are:

- **off** – The alarm will not be used.

- **normal** – The alarm will light the LED when the alarm state occurs and turn off the LED when the alarm state has cleared.

- **latching** – Once the alarm lights the LED, the LED will remain lit until the operator presses the ▤ key, even if the alarm condition has cleared before the operator presses the key.

- **event** – This special use of an alarm indicates that the controller has reached a particular point in a ramp/soak recipe. Setting the alarm action to "event" reserves the alarm for use by a ramp/soak recipe. However, the specific recipe event(s) that will trigger the alarm are configured using the r-S (ramp/soak) menu as described in Section 11.

1.7.2 Using an Output to Trigger an External Device

1.7.2.1 Introduction

The 1ZC, 16C, 18C, and 25C models can all be configured to use one or two outputs connected to external devices to annunciate alarms. However, which outputs can be used for alarms depends on the model and the hardware options selected.

1.7.2.2 Using Alarm Outputs

The 16C, 18C, and 25C controllers can all be ordered with two dedicated alarm outputs.[6] The operation and action of these outputs is tied to the alarm menu parameters that affect alarm annunciation using the LEDs.

For example, suppose a controller is configured to light LED A1 if the PV falls 20 units below the process setpoint. If the controller is equipped with optional alarm outputs that are normally open relays, then when the PV falls too much and the LED is lit, the alarm 1 relay contact will be closed.

If the alarm action is configured as "normal", then when the alarm condition clears, the contact will go back to the normal state. If the alarm action is configured as "latched", the contact will remain in the abnormal state until the operator presses the ▬ key. The dedicated alarm outputs will match the LED's behavior if the alarm is configured to signal recipe events.

1.7.2.3 Using One or Two Standard Outputs

The 1ZC and 16C models can be configured to use their standard outputs for alarm annunciation. This feature allows users of the compact 1ZC controller to use an external device to annunciate alarms, even though the 1ZC is not available with optional alarm outputs. Even though the 16C is available with dedicated alarm outputs, the ability to annunciate alarms using the standard outputs is also available on 16C controllers to accommodate users who network their controllers. Because of its compact size, the 16C can accommodate optional alarm outputs only if the case does not contain serial communication hardware. The larger 18C and 25C controllers can accommodate both the optional serial communications and dedicated optional alarm hardware, so use of standard outputs for alarm annunciation is not available in these larger models.)

When standard outputs are used for alarm annunciation, the alarms are configured using alarm parameters on the OutP (output) menu. These output menu alarm parameters provide the same configuration choices for alarm operation and action as the alarm menu parameters described in 1.7.1, with the exception of the "event" alarm action. Standard alarm outputs cannot be used to signal recipe events.

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[6] Refer to the Athena catalog (or the model number breakdown in the installation manuals supplied with the controllers) for details on the types of outputs available.

Alarms configured using the output menu and alarms configured using the alarm menu are independent of one another. For example, suppose you have a 16C controller that is equipped with two standard outputs (one analog, the other a relay) and an alarm output card with two more relays. You could use the output menu to configure the analog output for PID control and the relay output as a latched process alarm. In addition, you could use the alarm menu to configure LED A1 to light and optional alarm output relay 1 to go to the alarm state for a high deviation alarm, while A2 and optional alarm output 2 could annunciate a low deviation alarm condition.

1.8   Configuration Sequence Matters

The Athena Series C controllers are versatile instruments that are capable of using many types of input values and implementing several types of control strategies. To support this versatility, the Series C controllers are capable of storing values for many configuration parameters. Interrelationships exist between the parameters. Therefore, it is important that you configure the parameters in the correct sequence.

If you plan to use a thermocouple or RTD input and if you do not plan to use degrees Fahrenheit (the default unit of measure), the first step is always to specify the unit to be used (Celsius or Kelvin) using the **dSPL** (display) menu **Unit** parameter.[7] The controller uses this unit of measure for internal operations, as well as for external communications. When you change the units of measure for temperature inputs, the controller recalculates any values that have already been specified. For example, if you want the setpoint to be 100 °C, then you must change the units from the default F to C <u>before</u> you write the setpoint of 100 to the controller. If you change the units <u>after</u> you write the setpoint of 100 to the controller, the controller will convert the 100 °F setpoint to 37.8 °C. In this case, you would have to reconfigure the setpoint to 100 °C to implement the control needed by your process.

After the unit of measure has been changed, if necessary, from degrees Fahrenheit to your choice of Celsius or Kelvin, the next step is always to specify the type of input that each controller will receive. That means that you must specify the type of thermocouple or RTD that will provide the input to the controller, or, in the case of a linear input, the range and units of the input (0 to 20 mA, 0 to 5 V, 1 to 5 V, etc.) The type of input specified affects how the controller processes the input signal and calculates the output needed to achieve the setpoint.

With the exception of the unit of measure, generally the parameters should be configured in the sequence in which they are presented in the menus.

In addition to being aware of the sequence in which parameters should be configured, you should also remember that not all parameters apply to all applications. For example, if you specify that the input type is a thermocouple or RTD, then you will not see the low scale and high scale parameters in the input menu. However, if you use a linear input, then you <u>must</u> specify scaling values, or accept the factory defaults (-1999 to 9999).[8]

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[7] The input type parameter is configured at the factory to match the type of calibration specified when the controller was ordered (see 5.5.1). If the controller was calibrated and configured at the factory for a linear input type, the units of measure parameter will not be included in the display menu until you change the input type. When changing the input from a linear to a temperature input (or vice versa), the input jumper settings must also be changed as described in 5.3, and the controller must be re-calibrated as described in Section 18 (unless the "calibrate all" option was specified when the controller was ordered).

[8] The database values in new ("out of the box") 1ZC, 16C, 18C, and 25C controllers are always the default values shown in the tables Sections 5 through 14, except in the case of the input type parameter, which is configured at the factory to match the type of calibration ordered. (If "calibrate all" was specified, the input type is set to J thermocouple at the factory.) Instructions for using the controller front panel to return all database values (including input type) in the 16C, 18C, and 25C controllers to their default values are in 12.5.

1.9   What Happens When You Power Up the Controller

1.9.1   Outputs

When the controller is powered up, under some circumstances the outputs may be activated. If the controller has been configured, this is good. However, if the controller is new (not yet configured), then we recommend placing the controller in standby mode until you have configured the controller for your application.

For instructions for putting a 16C, 18C, or 25C controller in standby, see 2.4.3.

To put a 1ZC in standby mode, issue the appropriate command from a MODBUS master or the Multi-Comm host computer.

1.9.2   Display

When a 16C, 18C, or 25C controller is first powered up, all segments of both lines of the LED display will be lit briefly while the controller goes through a series of self-diagnostics. Next the top line briefly displays the type of controller, while the lower line displays a firmware version number.[9] Next, the top line will display 0000, while the lower line displays the type of communication protocol the controller supports. Finally, the process variable (PV) and process setpoint value (SV) are displayed. This is the normal operator display. See 2.2 for more information about the controller displays.

1.9.3   Setpoint

Once the controller has been configured, its behavior at startup depends on the choices made during configuration.

The controller can be configured to ramp gradually up to the setpoint after the controller is powered up.

If this single-setpoint ramp function has not been enabled as described in 11.3, then the controller's control algorithm will use the outputs to achieve the configured setpoint using the configured control strategy as quickly as possible. See 1.6 for information about the possible sources of the active setpoint.

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[9] It is a good idea to make a note of this number. If you phone for technical support you will be asked for this version information, as well as for the complete model number of the controller in question.

1.10 Configuration and Startup Activities

The following table summarizes the configuration and startup tasks to be accomplished once the controllers are mounted and wired as described in the installation manuals supplied with the instruments. As described in 1.8, configuration sequence does matter, because there are interdependencies among parameters. We recommend configuring the controllers in the sequence shown below.

Step	Action	Where Described
1	Power up the controller.	---
2	Put the controller in standby mode.[10]	2.4.3
3	If you plan to use a temperature input (thermocouple or RTD) and do <u>not</u> plan to use the default units of measure Fahrenheit, select the units of measure.	6.2.3
3	Specify the input type. If the input is linear, scale the input.	5.5
4	*Optional* – Specify the number of decimal places to be stored and displayed and the display refresh rate. If you do not configure these display parameters, the controller will use the defaults listed in Section 6.	6
5	Choose how the outputs will be used and configure the parameters that apply to the output function.	7
6	For on/off control, customize the output operation using the hysteresis (heating only or cooling only) and deadband (heating and cooling).	8.2
	For Autotuning, prepare the process and initiate the operation.	16.2
	For manual tuning of PID, specify a manual offset and other tuning values.	8.3 and 16.3
7	*Optional* – Configure alarms.	7.5
8	*Optional* – Configure single-setpoint ramp or multi-segment recipe.	11
9	*Recommended* – Specify the loop break time, and configure failsafe outputs to be used if the controller detects a problem with the input.	12
10	*Optional* – Configure any parameters related to hardware options, such as the scale for a remote analog setpoint, or the function of an auxiliary analog output.[11]	14
11	Adjust the setpoint.	2.4.2
12	Put the controller in normal (automatic) mode.	2.4.4
13	Change the security access level to the most restrictive level that is appropriate for your site.	17

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[10] To put a 1ZC in standby mode, issue the appropriate command from a MODBUS master or the Multi-Comm host computer.

[11] If the controller will be configured using a serial interface, the communication option parameters can be configured first, permitting you to configure the other parameters using a personal computer. Details of communication setups appropriate for the serial interfaces are in the *Multi-Comm User's Guide* and *Using the MODBUS Protocol with Athena Series C Controllers*.

2. User Interface

2.1 Overview

The panel-mounted 16C, 18C, and 25C are all equipped with a bright two-line LED display that is easy to read over wide viewing angles.[12]   During normal operations the process value is always on display. The setpoint can also be displayed at all times. If you prefer, the setpoint can be "blanked", that is, it can be turned off after a configurable time period. Pressing any key displays the setpoint again. Information about the other information that can be displayed is in 2.2.

The 16C, 18C, and 25C keypad consists of four keys:

≡ **mode/enter** – used to access the displays used to change the mode or security access level, as well as to write values to the controller's database and step through items within a configuration menu

⟳ **menu access** – used to access the menu system; within the menu system it is used to move from menu to menu

⬑ **up** and ⬎ **down** – used to change numeric values and to scroll through lists of configuration choices

Instructions for using these keys to operate the controller are in 2.4.

The front panel of the 16C, 18C, and 25C controllers includes LEDs that are used for alarm annunciation, as well as to signal which controller functions are active. See 2.3 for more information about these LEDs.

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[12] The compact 1ZC does not include a display. It does have LEDs to signal which functions are active. The 1ZC is designed to be mounted on a DIN rail in a cabinet. It is configured and its process value is read using a personal computer. See the *Multi-Comm User's Guide* and *Using the MODBUS Protocol with Athena Series C Controllers* for information about reading values from and writing values to the 1ZC controllers.

2.2   Display

2.2.1   When in a Control Mode

What is displayed when the controller is in one of the control modes described in 1.3.1 depends on the mode and whether the controller detects any problems with the input or with its own operation. The table below summarizes the various combinations of numeric values and abbreviations displayed when the controller is operating.

	What's Displayed	Example
	Top Line	**Top Line**
Circumstance	**Lower Line**	**Lower Line**
normal mode, no problems detected	process value	155.5
	setpoint (see Note 1 below)	157.0
standby mode	process value alternating with StbY	StbY
	setpoint (see Note 1 below)	157.0
manual mode	process value	155.5
	output 1 fixed output percent value alternating with Pct1 or output 2 fixed output percent value alternating with PcT2 (Use the ↻ key to toggle between Pct1 and Pct2.)	Pct1
Autotune mode	process value alternating with tunE	tunE
	setpoint value (see Note 1 below)	157.0
recipe running under the direction of the controller, using ramp/soak parameter values (See Note 2 below)	process value alternating with rS followed by the ramp or soak segment number	rS.r1
	setpoint (ramps as the recipe is executed) (see Note 1 below)	145.0
ramp/soak recipe on hold	process value alternating with rS-H	rS-H
	setpoint value (held at value it had when recipe was put on hold) (see Note 1 below)	152.0
controller detects a possible open loop (input has not changed for time period longer than the configured loop break time) (see 12.2)	process value will alternate with LPbr	LPbr
	setpoint value (see Note 1 below)	157.0
controller detects an open sensor, or the input is out of the supported sensor range	ErHi displayed	ErHi
	setpoint value (see Note 1 below)	157.0
controller detects a reversed sensor, or the input is out of the supported sensor range	ErLo displayed	ErLo
	setpoint value (see Note 1 below)	157.0

Circumstance	What's Displayed		Example	
	Top Line		**Top Line**	
	Lower Line		**Lower Line**	
controller detects a problem with its own operation	Err displayed		Err	
	numeric code displayed; see 19.3.2 for the codes		0100	

Note 1: The controller can be configured to limit the length of time the setpoint is displayed. If the setpoint display blanking parameter is set to a value other than OFF, the setpoint will be displayed for only the configured number of seconds. At the end of that time period, the setpoint display will become blank and remain blank until the operator presses any key. The setpoint will again be displayed for the configured number of seconds (see 6.2.4 or 6.3.3).

Note 2: If a MODBUS master or Multi-Comm host is running a recipe based on values stored in the host (as opposed to a recipe based on ramp/soak parameter values stored in the controller's database), the display will show only the PV and SV values. No other message will alternate with either value.

2.2.2 During Configuration

2.2.2.1 Introduction

When the ⟳ key has been used to display a menu, you can configure the controller.

➤ It is recommended that you put the controller in standby mode as described in 2.4.3 before going into configuration to change parameter values. Putting the controller in standby will ensure that the outputs are off.

During configuration the top line of the display contains a menu name. The second line of the display contains a parameter name, alternating with the current value. For example, when the input menu input type parameter is accessed the display will show

InP	alternating	InP
tYPE	with	Rtd

2.2.2.2 Menus Available

To access the menus containing the configuration parameters, press the ⟳ key until a text string is displayed on the top line of the display (approximately three seconds). The table below lists all the menus available.

Which of these menus is displayed depends on the access level set for the controller (as described in 1.4). When a controller is first powered up the menus are displayed in the sequence in which they are listed in the table. However, if you exit configuration, then access the menus again, you will re-enter the cycle where you left it.

For example, if the OutP (output) menu 02.tY (output 2 type) parameter is on display when you exit configuration (or are timed out), then when you next access the menus, the OutP menu 02.tY parameter will the first one displayed.

To see all the parameters in all the menus, go to the referenced section of this manual.

Displayed Abbreviation	Menu Name	Access Levels	Described In
InP	input	cnF9 (configuration) and FACt (factory)	5
dSPL	display	cnF9 (configuration) and FACt (factory)	6
OutP	output	cnF9 (configuration) and FACt (factory)	7
CtrL	control	USEr (user) and cnF9 (configuration) and FACt (factory)	8
AIr	alarm	cnF9 (configuration) and FACt (factory)	9
tunE	Autotune damping	USEr (user) and cnF9 (configuration) and FACt (factory)	10
r-S	ramp/soak	USEr (user) and cnF9 (configuration) and FACt (factory)	11
SUPr	supervisor	cnF9 (configuration) and FACt (factory)	12
CAL	calibration	FACt (factory) only	13
Optn	option	cnF9 (configuration) and FACt (factory)	14.4
SErL	serial (used only if the controller contains a serial communication option card)	cnF9 (configuration) and FACt (factory)	14.5 and 14.6
C-dI	contact/digital input (used only if the controller contains an optional contact/digital input card)	cnF9 (configuration) and FACt (factory)	14.7
rAS	remote analog setpoint (used only if the controller contains an optional remote analog setpoint card)	cnF9 (configuration) and FACt (factory)	14.8
Aout	auxiliary analog output (used only if the controller contains an optional auxiliary analog output card)	cnF9 (configuration) and FACt (factory)	14.7

2.3 LEDs

2.3.1 On 16C, 18C, 25C Controllers

The 16C, 18C, and 25C front panels all contain six LEDs that light under specific circumstances. See the illustration below for the function of each LED.

OUTPUT 1
Active when lit.

OUT PUT 2
Active when lit.

ALARM 1
State exists when lit. The condition that triggers this alarm is configurable using ALr (alarm) menu.

ALARM 2
State exists when lit. The condition that triggers this alarm is configurable using ALr (alarm) menu.

SPECIAL FUNCTION 1
Active when lit. When using Modbus, this LED lights when controller is receiving a message from host. When using Multi-Comm, this LED lights when controller detects any network traffic.

SPECIAL FUNCTION 2
Active when lit. When using Multi-Comm or Modbus, this LED lights when controller is sending a reply to host.

⟳ MENU ACCESS KEY
Used during operation to enter and exit the menu system. In manual mode this key is used to toggle between display of fixed output percentage 1 and fixed output percentage 2. During setup this key is used to move between menus.

PROCESS VALUE
input. Unit of Measurement for temperature inputs (°F, °C, or °K) is configurable using $dSPL$ menu.

SETPOINT VALUE
currently being used for control. Depending on the controller's hardware and configuration, this active setpoint may be the setpoint entered by the operator, a second setpoint configured using a remote host, a recipe setpoint, or a remote setpoint from an external analog signal.

≡ MODE ENTER KEY
Used during operation to view controller mode and to clear latched alarms. During setup this key is used to select configuration values.

⋎ DOWN KEY
Used during operation to decrease setpoint value in normal (auto) mode and to decrease the displayed fixed output percentage in manual mode. During setup this key is used to decrease a displayed configuration value or to scroll through a list of choices.

⋏ UP KEY
Used during operation to increase setpoint value in normal (auto) mode and to decrease the displayed fixed output percentage in manual mode. During setup this key is used to increase a displayed configuration value or to scroll through a list of choices.

2.3.2 On 1ZC Controller

The end of the 1ZC controller contains six LEDs (above the terminal strip) that light under specific circumstances. See the illustration and table below for the function of each LED.

LED	Location	Function
sensor error	above terminal 2	Lit when the sensor is disconnected, or the input signal is out of range, or the loop break time is exceeded. While the sensor error LED is lit, the outputs are in the state you configured using the failsafe output parameters as described in 12.2.
RXD (receive)	above terminal 4	When using MODBUS this LED is lit while the controller receives a message from the host. When using Multi-Comm, this LED is lit whenever the controller detects network traffic.
TXD (transmit)	above terminal 5	When using MODBUS or Multi-Comm, this LED is lit while the controller sends a message to the host.
output 1	between terminals 6 and 7	Lit while output 1 is energized.
output 2	between terminals 8 and 9	Lit while output 2 is energized.
power/run	between terminals 10 and 11	Blinks while power is applied and while unit is running (heartbeat).

2.4 Using the Keypad

2.4.1 Key Functions

The 16C, 18C, and 25C controllers have four keys. The functions of the keys are described below. The rest of this subsection contains instructions for changing the setpoint, viewing and changing the controller's mode, changing values in the controller's database, etc. using these keys.

Key	Name	Function
↻	menu access	**Accessing the configuration menus and security access code** – Pressing and holding this key for approximately three seconds accesses the configuration menus. Once a menu name is on display, this key is used to step through the available menus. When the controller is in manual mode, this key is used to toggle between the display of the output 1 percent and the output 2 percent. When the normal operating display (PV and SV) is on display, pressing and holding this key for approximately ten seconds shows the current security access level. The level can then be changed.
⌃	up	**Increasing the value on display or cycling up through a list of choices** – Pressing and releasing this key increases the numerical value on the operator display or configuration display one unit. Pressing and holding it increases the value more rapidly. When a string of characters representing a configuration parameter choice or a mode choice is on display, pressing this key displays the previous choice on the list.
⌄	down	**Decreasing the value on display or cycling down through a list of choices** – Pressing and releasing this key decreases the numerical value on the operator display or configuration display one unit. Pressing and holding it decreases the value more rapidly. When a string of characters representing a configuration parameter choice or a mode choice is on display, pressing this key displays the next choice on the list.
≡	mode/enter	**Viewing the mode or selecting the currently displayed configuration choice or value** – While the controller is in use (controlling a process loop), this key is used to view the current operational mode. (See 1.3.1 for available control modes.) When a configuration menu has been accessed, this key is used to step through the parameters within a menu, and to write the currently displayed choice or value to the controller's database.
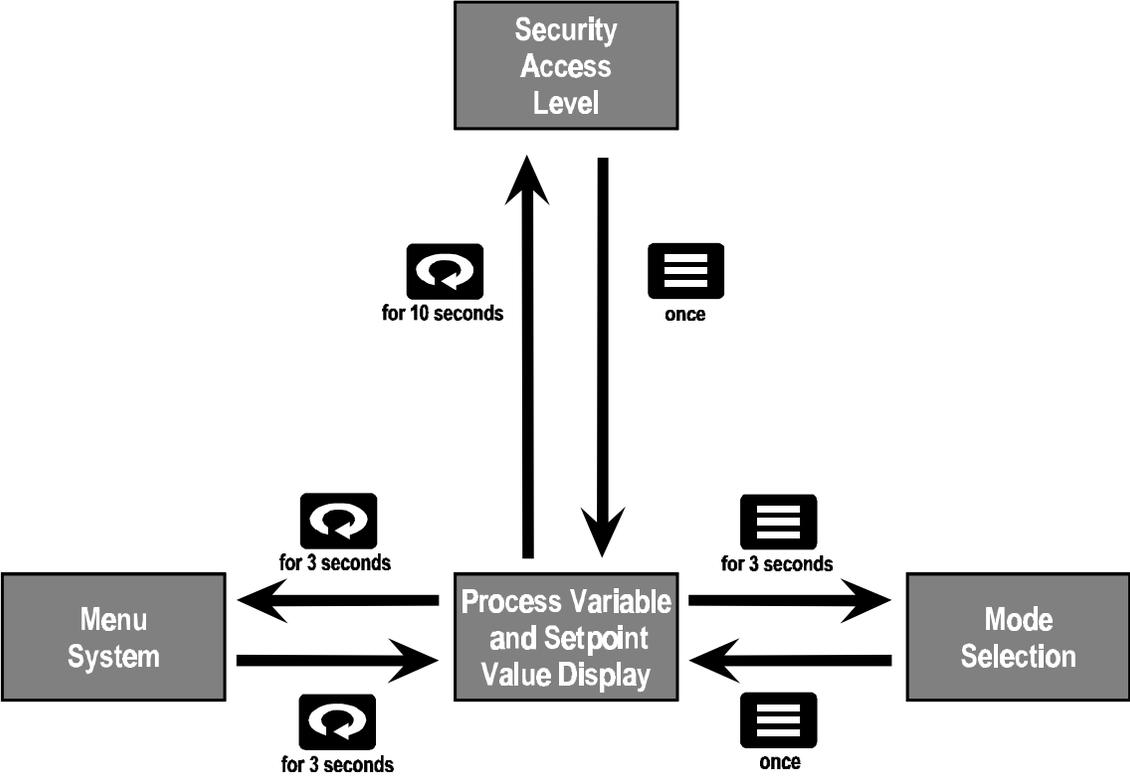
2.4.2 Displaying and Changing the Setpoint

The setpoint can be changed only when the controller is in normal (automatic) mode or standby mode. (If the PV is alternating with StbY (standby), you can change the setpoint, but the change will not take effect until you put the controller back into normal mode.)

To view the current setpoint, if it is not on display because setpoint display blanking is enabled:

Press any key briefly. The setpoint will be displayed on the lower line.

To change the setpoint:

Use the ⬆ and ⬇ keys to change the displayed value.

See 1.6 for the possible sources of the setpoint being displayed by the controller (the "active setpoint").

See 5.6.2 (temperature input) or 5.7.3 (linear input) for information about the SP.LL and SP.HL parameters used to configure the range of setpoints that can be entered using the front panel.

2.4.3 Putting Controller in Standby Mode

To put the controller in standby mode:

1. Press the ☰ key until CtrL is displayed on the top line (after approximately three seconds) and the current mode on the lower line. (All modes are described in 1.3.1.)
   For example, if the controller is in normal (automatic) mode, pressing the ☰ key for approximately three seconds will display:

       CtrL
       nor

2. Press the ⬆ or ⬇ key to cycle through the modes until StbY is on the lower line. The display will show:

       CtrL
       StbY

3. Press the ☰ key again (briefly). The display will show StbY alternating with the process value on the top line, and the setpoint displayed steadily on the lower line. For example, if the PV is 105 and the SV is 110 you will see:

StbY	alternating	105
110	with	110

2.4.4 Returning Controller to Normal Operation

1. Press the ▤ key until `CtrL` is displayed on the top line and the current mode's abbreviation is on the lower line. For example, if the controller is in standby the display will show:

    > `CtrL`
    > `StbY`

2. Press the ▲ or ▼ key to cycle through the modes until `nor` is on the lower line. The display will show:

    > `CtrL`
    > `nor`

3. Press the ▤ key again (briefly). The display will show the process value on the top line and the setpoint on the lower line. For example, if the PV is 105 and the SV is 110 you will see:

    > `105`
    > `110`

2.4.5 Putting Controller into Manual Mode and Changing the Output Values

To put the controller in manual mode:

1. Press the ▤ key until `CtrL` is displayed on the top line and the current mode on the lower line. (All modes are described in 1.3.1.) For example, if the controller is in normal (automatic) mode, pressing the ▤ key for approximately three seconds will display:

    > `CtrL`
    > `nor`

2. Press the ▲ or ▼ key to cycle through the modes until `FOP` (fixed output percentage) is on the lower line. The display will show:

    > `CtrL`
    > `FOP`

3. Press the ▤ key again (briefly). The display will show the process variable on the top line. On the lower line `Pct1` (percent 1) will alternate with the current fixed output percent. When you switch the controller to manual, the most recent output percentages used in normal (auto) mode will continue to be used. This provides "bumpless" transfer.

    For example, if the PV is 105 and output 1 was most recently at 50% in normal mode, you would see:

`105`	alternating	`105`
`Pct1`	with	`50`

4. Use the ▲ and ▼ keys to change the manual output 1 value displayed to the desired percentage.

5. To write the output 1 percentage to the controller's database, press the ⟳ key (briefly). The controller will begin to use the specified fixed output percentage. (The transition from automatic PID to the manual percentage will be "bumpless".) The lower line display will change to Pct2, alternating with the current value for output 2.

6. Use the ⬆ and ⬇ keys to change the manual output 2 value displayed to the desired percentage.

7. To write the output 2 percentage to the controller's database, press the ⟳ key (briefly). The controller will begin to use the specified fixed output percentage.

8. The controller will remain in manual mode until you press and hold the ☰ key to display CtrL and FOP, then change to one of the other modes as described above and below.

2.4.6 Starting, Pausing, and Terminating Recipe Execution

To start execution of the single-setpoint ramp[13] or a multi-step recipe:

1. Press the ▤ key until CtrL is displayed on the top line and the current mode on the lower line. (All modes are described in 1.3.1.) For example, if the controller is in normal (automatic) mode, pressing the ▤ key for approximately three seconds will display:

   CtrL
   nor

2. Press the ⬆ or ⬇ key to cycle through the modes. If a single-setpoint ramp or multi-step recipe has been configured as described in Section 11, r.S (ramp/soak) will be one of the mode choices on the lower line. The display will show:

   CtrL
     r.S

3. Press the ▤ key again (briefly).

   - If the controller is configured to execute a single-setpoint ramp, the display will show rS on the top line, alternating with the process variable.

   - If the controller is configured to execute a multi-step ramp, the display will show rS.r1   (ramp/soak ramp 1) on the top line, alternating with the process value.

   In either case, the lower line will display the setpoint, which has been changed by the controller to match the process value. For example, if the PV is 105, you would see:

rS.s1	alternating	105
105	with	105

As the single-setpoint ramp or multi-step segment 1 ramp time passes, the setpoint will be ramped toward the target value.

   - In the case of a single-setpoint ramp, this is the normal setpoint.

   - In the case of a multi-step recipe, this will be soak level 1 value.

What happens when the target setpoint is reached depends on several factors.[14]

   - In the case of a single-setpoint ramp, the display will change to the normal operating display with the PV on the top line and the SV on the lower line, unless the termination state parameter was used to specify that the controller should be placed in standby when the ramp up to setpoint has been completed.[15]

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[13] If single-setpoint ramp is enabled, then the ramp will be executed automatically at startup; see 11.1.

[14] Whether the process value actually matches the setpoint when the ramp time has elapsed depends on how you have configured your recipe. If you have not used the holdback feature and have not configured the ramp time realistically for your process, the PV may not match the SV when the ramp time has elapsed. Read Section 11, then enable holdback or fix your ramp time so that the PV has time to catch up to the SV.

[15] This is also what happens if a single-setpoint ramp is executed automatically at startup.

- In the case of a multi-step recipe, the top line of the display will change to rS.S1 (ramp/soak soak 1). The recipe will continue to execute, maintaining the setpoint at soak level 1 for the duration of soak time 1. The recipe will then begin to execute the next segment, and the display will change to rS.r2, alternating with the process variable on the top line, and the setpoint on the lower line.

To pause a recipe or single-setpoint ramp during its execution:

1. Press the ▤ key until CtrL is displayed on the top line. The lower line will show rS.H (ramp/soak hold).

2. Press the ▤ key once to go into recipe hold mode. The top line of the diplay will show rS-H alternating with the process value, while the lower line displays the setpoint. The setpoint will remain at this level until you take the recipe out of hold.

To resume execution of a held recipe:

1. Press the ▤ key until CtrL is displayed on the top line. The lower line will show FOP (fixed output percentage).

2. Use the ▲ or ▼ key to display r.S r (ramp/soak run/resume).

3. Press the ▤ key once to resume execution of the recipe. The top line of the display will again show the current ramp or soak segment number, alternating with the process value, while the lower line displays the setpoint.

To terminate execution of the recipe:

1. Press the ▤ key until CtrL is displayed on the top line. If the recipe is active, the lower line will show rS. H (ramp/soak hold).

2. Instead of pressing the ▤ key to select ramp/soak hold, use the ▲ or ▼ key to display nor (normal) or FOP (manual mode).

3. Press the ▤ key once to terminate execution of the recipe.

   - If you selected normal mode, the top line of the display will show the process variable. The lower line will show the setpoint. This setpoint will be at whatever value the recipe had reached while executing. This is different from what happens if a recipe completes execution normally. In that case, the setpoint value will be determined by the termination state configured using the ramp/soak menu as described in 11.4.2.

   - If you selected manual mode, the top line of the display will show the process variable. The lower line will show Pct1 alternating with the current fixed output percentage.

2.4.7 Clearing Latched Alarms

To clear all latched alarms:

Press the ▬ key once (briefly). All alarms currently latched will be unlatched <u>if the alarm condition has been cleared</u>.

2.4.8   Working in Configuration Mode

2.4.8.1 Entering and Exiting Configuration Mode

We recommend that you put the controller into standby mode as described in 2.4.3, before entering the menu system.

To enter configuration mode:

Access the configuration menus by pressing and holding the ↺ key until a string of letters is displayed on the top line (approximately three seconds). The letters displayed are an abbreviated name of a menu.

When a controller is first powered up, the menus are displayed in the sequence shown on page 2-5, beginning with the InP (input) menu. However, once you leave the menu system (or are timed out), the controller "remembers" where you were. When you next press and hold the ↺ key, the controller will display the menu that was on display when you left the menu system. Pressing the ☰ key will display the parameter accessed most recently.

To exit configuration mode:

Return to the normal operating display by pressing and holding the ↺ key until the process variable is displayed on the top line and the setpoint on the lower line.

2.4.8.2 Procedure for Viewing and Changing a Configuration Parameter Value

To view a parameter's current value:

1. Access configuration mode by pressing and holding the ↺ key until a string of letters is displayed on the top line (approximately three seconds). The letters displayed are an abbreviated name of a menu.

2. Press the ↺ key repeatedly to step through the available menus.

3. Once the name of the menu of interest is on the top line of the display, press the ☰ key once (briefly) to display the first parameter in the menu (or the parameter most recently accessed in the last configuration session). The abbreviated name of the parameter will be on the lower line, alternating with the current value for the parameter stored in the controller's database.

4. To step through the parameters in the displayed menu, press the ☰ key repeatedly.

5. When the parameter of interest is on display, stop pressing the ☰ key. The abbreviated parameter name will alternate with the value or choice currently stored in the controller's database.

6. To change the current choice or numeric value, use the ⬆ and ⬇ keys.

7. When the desired choice or numeric value is on display, press the ☰ key once. The displayed choice or value will be written to the controller's database. The next parameter in the menu (or the first parameter if you were at the end of the menu) will be displayed.

At this point you can:

- use the ▲ and ▼ keys to change the value of the newly displayed parameter, or

- if you like the current value of the parameter on display, you can press the ☰ key to leave the displayed value unchanged and go on through the parameters in the menu), or

- press the ↻ key once to go to the next menu, then use the ☰ key to step through the parameters in that menu, or

- press the ↻ key repeatedly to display menus later in the cycle, or

- press and hold the ↻ key until the normal operating display returns to view.

If you do not press any key, eventually you will be timed out of the menu system. The controller will revert to the operational display that was in view before you entered the menu system.

2.4.8.3 Configuration Example

Suppose that once the controller is in operation you want to turn off setpoint blanking and change the alarm 2 setpoint.

1. Press and hold the ☰ key (approximately three seconds) until CtrL is displayed on the top line and the current mode on the lower line.

2. Press the ▲ or ▼ key until StbY is displayed.

3. Press the ☰ key again.   The display will show StbY alternating with the process value on the top line. The setpoint will be displayed on the lower line.

4. Press and hold the ↻ key until the abbreviated name of a menu is displayed on the top line of the display.

    - If no one has used the menu system since the controller was powered up, the InP (input) menu will be displayed first.

    - If someone has already accessed the menu system since startup, the menu displayed will be the last one used.

5. To turn off setpoint blanking, press the ↻ key until the dSPL (display) menu name is on the top line.

6. Press the ☰ key until the bLAn (setpoint blanking) parameter is displayed on the lower line. The display of bLAn will alternate with the display of the current value. (When setpoint blanking is on, a numeric value represents the number of seconds that the setpoint will be displayed after a key press. When the time elapses, the setpoint display will become blank.)

7. Press the ▼ key until OFF is displayed for bLAn.

---

8. To write this new setting to the controller's database, press the ☰ key once. The new setting will be saved and dEC.P (decimal position) will be displayed on the lower line. (The blanking parameter is the last in the display menu, so the controller goes to the top of the menu and shows you the first display parameter, decimal position.)

9. Because you do not plan to change any other display parameters at the present time, press the ↻ key to go to the next menu OutP (output).

10. Because you do not plan to change any output parameters during this configuration session, press the ↻ key again. The name of the next menu in the cycle CtrL (control) will be displayed.

11. You do not need to change any control parameters right now, so press the ↻ key again. The top line will show AIr (alarm).

12. Because the alarm 2 setpoint that you want to change is on the alarm menu, press the ☰ key to display the first parameter in the alarm menu. This is A1.AA (alarm 1 alarm action).

13. Press the ☰ key repeatedly until you see the parameter that you want to change: A2.SP (alarm 2 setpoint). The current value will alternate with the A2.SP label.

14. Use the ⬆ and ⬇ keys to change the alarm 2 setpoint to the new value.

15. Press the ☰ key once to save the change. Because the A2.SP parameter is at the end of the menu, the first parameter in the alarm menu will be displayed again.

16. The two changes you wanted to make have been accomplished, so you can press and hold the ↻ key to return to the normal operating display.

If you do not press and hold the ↻ key, after a brief interval the controller will automatically go back to the normal operating display (PV and SV).

If you do not press the ☰ key after you change a parameter value, and you are subsequently timed out of the menu system, the change will not be saved to the controller's database.

3. Configuring the Controller – Quick Setup Instructions for PID Control

3.1 Introduction

If you are familiar with the 16C, 18C, and 25C controllers and plan to use PID control (the default), the instructions in this section will serve as a quick refresher. The instructions in this section assume that:

- the controller is already mounted and wired correctly in accordance with the guidelines and diagrams in the installation manual supplied with each controller

- the controller is new, still set to its factory defaults, including access level

- the correct sensor type was specified when the controller was ordered (or "calibrate all" was specified[16]), so that the controller has already been calibrated for the type of sensor you plan to use, and the input jumpers settings on the microprocessor board are correct. (Refer to 5.2 and 5.3 for details about input type compatibility with the calibration and jumper settings.)

<u>Before following the instructions in this section, read the precautions at the front of this manual</u>.

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[16] To determine whether the controller in hand was calibrated at the factory for all input types, check the model number on the label on the controller. The meaning of each character in the model number is in the installation manual supplied with the controller. If you specified "calibrate all", then the input type and input jumpers are set at the factory to receive input from a J thermocouple.

3.2 Quick Instructions

The instructions below guide you through the minimum tasks needed to configure the controller for PID control. Unless you change the value of a configuration parameter, the controller will use the factory defaults. The parameters modified using the instructions below are only a few of the parameters available to customize the controller's operation for your application.

If you want to learn about all the parameters available, read Sections 4 through 14. Sections 5 through 14 also contain the default values for all configuration parameters in every menu.

1. Put the controller in standby mode.

    a) Apply power.

    b) After self-check display stops, press and hold the ▤ key (approximately three seconds) until CtrL is displayed on the top line and the current mode on the lower line.

    c) Press the ▲ or ▼ key until StbY is displayed.

    d) Press the ▤ key again. The display will show StbY alternating with the process value on the top line. The setpoint will be displayed on the lower line.

2. Specify the input type, unless the factory setting will be used.[17]

    a) Press and hold the ↻ key until InP is displayed on the top line (approximately three seconds). (If the name of a menu other than input is displayed, repeatedly press the ↻ key until you see InP.[18])

    b) When InP is displayed, press the ▤ key once to make tYPE appear on the lower line. The choice that is currently stored in the controller's database for this parameter will alternate with the display of tYPE.

    c) Use the ▲ or ▼ key to step through the list of choices until the desired input type is on display. (If the type you plan to choose is different from the input category specified when you ordered the controller, refer to Section 5 to see if you must recalibrate and/or change input jumper settings.)

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[17] The input type is set at the factory to match the calibration type specified when the controller was ordered. The factory setting for each calibration type is shown in 5.5.1. If you change the input type from the factory setting, you may also have to change the input jumper settings. See 5.3 for details.

[18] If you do not see InP when you access the menus (or do not see tYPE first in the input menu), someone has accessed the menu system since the controller was powered up. At power up the menus are displayed in the sequence shown on page 2-5. However, once you enter and leave the menu system, the controller "remembers" where you left. When you next access the menus, the menu parameter that was displayed when you left (or were timed out) will again be displayed. Repeatedly pressing the ↻ key will cycle through the menus. Repeatedly pressing the ▤ key while a menu name is on display will cycle through the parameters within the menu.

---

d) Press ▤ to write the choice to the controller's database. The next parameter in the menu (bIas) will be displayed. Most applications use the default bias value (zero).

3. Specify the output type for output 1.

a) While still in the menu system, press the ↻ key until OutP (output) is displayed on the top line.

b) Once at the output menu, press ▤ to display the output 1 type parameter O1.tY on the lower line.

c) The output type currently assigned to output 1 will alternate with the display of O1.tY. If the output has been changed from the default Pid, use the ▲ or ▼ key to display Pid.

d) To write Pid to the controller's database, press the ▤ key once. The next parameter, O1.AC (output 1 action) will be displayed.

4. Specify the output 1 action, dir (direct) or rE (reverse), for output 1. Generally, heating applications are reverse-acting and cooling applications are direct-acting.

a) When the O1.AC parameter is on display, use the ▲ or ▼ keys to display the action for your application.

b) Press the ▤ key once to write the action choice to the database. The next parameter, O1.CY (output 1 cycle time) will be displayed.

5. Specify the output 1 cycle time.

a) When the O1.CY parameter is on display, use the ▲ and ▼ keys to display the appropriate time for your application <u>and the output hardware</u> (see below).

The output hardware is specified when the controller is ordered. The location of the output characters in the model number is shown in the installation manual supplied with the controller. The controller's model number is on its label.

Model Number Output Hardware Character	Valid Cycle Times in Seconds
B	15 to 120
E	0.2 (See Note 1 below.)
F	0.2 (See Note 1 below.)
G	0.2 (See Note 1 below.)
S	0.2 (See Note 1 below.)
T	15 to 120 (See Note 2 below.)
V	0.2 (See Note 1 below.)
X	0.2 (See Note 1 below.)
Y	15 to 120

Note 1: The cycle time for analog outputs must be set to 0.2 for the controller to drive the analog signal properly.
Note 2: "T" outputs directly driving non-inductive loads (small heaters) can have cycle times as low as 0.2 seconds.

b) Press the ▬ key to write the cycle time value to the controller's database and display the next parameter 01.LL (output 1 low limit). Most applications use the default value.

c) Press the ▬ key to accept the output 1 low limit default and display the next parameter 01.HL (output 1 high limit). Most applications use the default value.

6. Specify the output type for output 2.

   Important: If only one output is PID, change output 2 from the default Pid, to one of the other choices: on.oF (on/off), AIr (alarm), or OFF.

   a) Press the ▬ key to display the 02.tY (output 2 type) parameter, alternating with its current setting.

   b) The default for output 2 is PID. If PID is not right for your application, use the ▲ or ▼ arrow key to display the desired output type.

   c) Press the ▬ key to make this selection. What parameter you see next depends on the output 2 type you selected.

      • If you use PID or on/off control for output 2, you will see 02.AC (output 2 action). Go on to step 7 below.

      • If you set output 2 to off, you will again see the 01.tY (output 1 type) parameter. Go to step 9.

      • If you plan to use output 2 for alarm annunciation (available on 16C only), you will see 02.AA (output 2 alarm action). Read 7.5 and configure the output alarm parameters before returning to step 9 in this section.

7. Specify the output 2 action for PID or on/off control.

   a) When the 02.AC parameter is on display, use the ▲ or ▼ keys to display the action for your application.

   b) Press the ▬ key once to write the action choice to the database. What parameter you see next depends on the choice you make for the output 2 type.

      • If output 2 is PID, the next parameter, 02.CY (output 2 cycle time) will be displayed.

      • If output 2 is on/off, configuration of output 2 has been completed, and 01.tY will again be displayed. Go to step 9.

8. Specify the output 2 cycle time for PID control.

   a) When the 02.CY parameter is on display, use the ▲ and ▼ keys to display the appropriate time for your application and the output hardware (see step 5a above).

   b) Press the ▬ key to write the value to the controller's database and display the next parameter 02.LL (output 2 low limit). Most applications use the default value.

9. Make your choice of Autotune damping setting. Use this parameter to specify how aggressively the conroller will perform Autotune.

   a) Press the ↻ key repeatedly until *tune* is displayed on the top line.

   b) Display the current setting for the Autotune damping parameter by pressing the ≡ key. The parameter abbreviation *dPn9* will alternate with the current setting, *Lo* (low), *nL*, (normal) or *Hi* (high).

   c) Use the ▲ or ▼ key to display the appropriate setting for your application.

      • Low provides fastest recovery, but with the possibility of overshoot.

      • High provides little or no overshoot, but with slower recovery.

      • Normal is a compromise between fast recovery and overshoot.

10. Autotune the controller while the setpoint is at least 1% of the sensor span above or below the process value. This will set the tuning parameters: proportional band, derivative action (rate) and integral action (auto reset). (More detailed instructions for Autotuning are in 16.2.)

    a) Press and hold the ↻ key (approximately three seconds) until the top line of the display shows *StbY* alternating with the process value and the lower line displays the setpoint.

    b) Use the ▲ and ▼ keys to change the setpoint to a value that will be used by your application.

    c) Press and hold the ≡ key until the top line displays *CtrL* and the lower line displays *StbY*.

    d) Use the ▲ or ▼ key to step through the modes until *Atun* is displayed.

    e) Press the ≡ key to start the autotuning operation. The display will flash *tune*.

    f) Do not press any keys while the Autotune is in progress, unless you want to stop the autotuning by putting the controller into standby or manual mode. When the controller has completed autotuning successfully, the flashing *tune* will disappear. The display will revert to the normal mode operating display, with the process value on the top line and the setpoint on the lower line.

       If the Autotune was unsuccessful, the top line will briefly display *Er* plus a two-digit error code, then go back to flashing *StbY*. Refer to Section 16 for the Autotune error codes. Fix the problem and try tuning again.

Once Autotune has been completed successfully, and the PV and SV are on display, the controller is controlling the process.

Monitor the process. If unacceptable overshoot occurs, change the Autotune damping setting to high and repeat the Autotune. If the process response is sluggish, change the damping setting to low and repeat the Autotune.

Once setup is complete, we recommend changing the security access level to the most restrictive level suitable for your application. See Section 17 for details.

4. General Information About Configuration Parameters

4.1   Information in This Section

This section contains general information about the configuration parameters used by the 1ZC, 16C, 18C, and 25C controllers.[19]   Sections 5 through 14 contain information about functional groups of parameters. Each section describes the parameters in a single configuration menu. If you have used Athena Series C controllers before, and plan to use PID control (the default), then these sections probably contain more information than you need. Go back to Section 3. It contains instructions for doing the minimum to get a 16C, 18C, or 25C controller up and running using PID control (and most of the other configuration defaults).

However, if you are a new user of Athena Series C controllers, or plan to use an option you have not used before, then refer to this section, as well as Sections 5 through 14, for the information you need.

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[19] The parameters apply to 1ZC controllers, even though they have no display and no keypad. Model 1ZC controllers (as well as 16C, 18C, and 25C models) can be configured using a host computer and serial communication, with configuration software such as the Athena Multi-Comm application (using Athena Plus protocol) or MODBUS-compliant software. For a controller to use Athena Plus protocol to communicate with a Multi-Comm host or to use MODBUS to respond to a MODBUS master, the controller must support serial communications and contain the appropriate communication firmware. To determine what option(s) a new controller supports, compare the model number on the controller label with the model number information in the installation manual supplied with the controller.

4.2　How to Use Sections 5 through 14

<u>You do not have to read the all of Sections 5 through 14</u>. You can skip any sections marked "optional" that do not apply to your control strategy. You can also skip some parts of some of the required sections. The path you take as you read will be determined by your control strategy.

For example, in Section 5 everyone needs to know about the information in 5.1, 5.2, 5.3, 5.4, and 5.5, so there are no stop signs to interrupt your reading. However, when you get to the end of 5.5 you will see:

What's next after you have specified the input type?

If you chose an RTD or thermocouple input type, go to 5.6.
If you chose a linear input type go to 5.7.

This means that you should look at <u>either</u> 5.6 or 5.7, but you <u>do not</u> have to read both. If a parameter applies to both temperature and linear input types, the parameter description will be repeated in 5.6 <u>and</u> 5.7.

4.3   Information Provided About Each Parameter

4.3.1 Summary

Each menu consists of a functional group of parameters. For each parameter the following information is provided:

- **parameter name (and number)** – See 4.6 for information about the purpose of this number (or alphanumeric designation).

- **abbreviated name as displayed**

- **controller models that use the parameter** – Note that "all" in the "used by" paragraph means that the parameter can apply to the 1ZC, 16C, 18C, and 25C. However, even though a parameter <u>can</u> be used by a controller does not mean that every control strategy uses the parameter. Read the "when displayed" information and the description to find any special information about the applicability of a particular parameter.

- **when displayed** – This paragraph indicates whether the parameter applies to all control strategies ("always") or only under certain circumstances (which are identified).

- **choices** or **range** – If you must make a selection from a list, all the choices are listed in the sequence in which they appear (on a 16C controller) if you scroll through the list using the ▼ key. If you must specify a numerical value, then the range of valid values is defined. <u>For some parameters the range is reduced if a linear input is used.</u> See 4.3.2 for details.

- **factory default value** – The default value is shown for each configuration parameter. The configuration parameters in 16C, 18C, and 25C controllers can be returned to their default values using the procedure in 12.5.[20]

- **description** – The purpose of the parameter and any special information you need to know to use this parameter is provided.

- **effect on other parameters** – For some parameters, additional information is included. If applicable, this paragraph tells how the value selected for a parameter affects other parameters.

4.3.2 Effect of Linear Input on Numerical Ranges

If the controller uses a linear input and the dSLP (display) menu dEC.p (decimal position) parameter is not set to 0 (zero), the number of decimal places specified is always imposed on the parameter's value. <u>This has the effect of reducing the range of valid values for many parameters when a linear input is used</u>. The parameters affected are denoted by a cross-reference to this sub-section.

For example, suppose the range of valid values for a parameter is –1999 to 9999.

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[20] With the exception of the 1ZC controller ID (address), the defaults in all Series C controllers can be returned to the factory defaults using a MODBUS write function. See *Using the MODBUS Protocol with Athena Series C Controllers* for more information.

- If a linear input is used and the decimal position is 1, then the range for the parameter is reduced to −199.9 to 999.9.

- If a linear input is used and the decimal position is 2, then the range is −19.99 to 99.99.

- If a linear input is used and the decimal position is 3 (the maximum for linear inputs), then the range is −1.999 to 9.999.

In contrast, when a thermocouple or RTD input is used, the decimal position specified using the dEC.p parameter in the dSLP (display) menu is a maximum. This means that the controller applies the specified number of decimal places only if doing so does not limit the value of the parameter. For example, suppose the range of valid values for a parameter is −1999 to 9999.

- If an RTD or thermocouple input is used and the decimal position is 1, then the range for the parameter is still −1999 to 9999. If you configure a value of 1000, no decimal places will be displayed, despite the Decimal Position setting of 1.

- If an RTD or thermocouple input is used and the decimal position is 2 (the maximum for temperature inputs), then the range for the parameter is still −1999 to 9999. If you configure a value of 1000, no decimal places will be displayed, despite the decimal position setting of 2.

4.4   Menu and Parameter Display Sequence

The menus and parameters are displayed in the sequence shown below. When the controller is powered up, the menu sequence starts with the InP (input) menu. Within the menus, the parameters are displayed in the sequence shown below.   However, not all parameters apply to every control strategy.

If a parameter does not apply to a particular control strategy, then that parameter will not be displayed. For example, if you specify that the output 2 type is OFF, then the other parameters used to configure output 2 will not be displayed.

When you have gone into the menu system and then exited the menus, the controller "remembers" where you were. The next time someone accesses the menu system, the controller will display the menu from which you left. When the ☰ key is pressed, the parameter displayed will not be the first one in the menu. Instead, the last parameter accessed during the most recent configuration session (since power up) will be displayed. For example, if you exited the menu system (or were timed out) when the dSPL (display) menu's Unit parameter was on display, then the next time the menu system is accessed, the dSPL menu Unit parameter will be the first parameter displayed.

Displayed Abbreviation (menu name)	Parameters		Access Levels	Described In
InP (input)	tYPE bIAS SCL.L SCL.H SP.LL SP.HL I.FIL		cnF9 (configuration) and FACt (factory)	5
dSPL (display)	dEC.P d.FIL Unit bLAn		cnF9 (configuration) and FACt (factory)	6
OutP (output)	01.tY 01.Ac 01.cY 01.LL 01.HL 01.AA 01.A0 01.dL 01.IH 01.SP	02.tY 02.Ac 02.cY 02.LL 02.HL 02.AA 02.A0 02.dL 02.IH 02.SP	cnF9 (configuration) and FACt (factory)	7
CtrL (control)	db.1 HYS.1 db.2 HYS.2 Pb1 Pb2 dEr OFFS Int		USEr (user) and cnF9 (configuration) and FaCt (factory)	8

Displayed Abbreviation (menu name)	Parameters		Access Levels	Described In
AІr (alarm)	A1.AA A1.A0 A1.d1 A1.IH A1.SP	A2.AA A2.A0 A2.d1 A2.IH A2.SP	cnF9 (configuration) and FACt (factory)	9
tune (Autotune damping)	dPnG		USEr (user) and cnF9 (configuration) and FACt (factory)	10
r-S (ramp/soak)	r.0Pt S.Srt HLd.b tEr.S rcY.n PF.re rt1 re1 SL1 St1 SE1 . . . rt8 re8 SL8 St8 SE8		USEr (user) and cnF9 (configuration) and FACt (factory)	11
SUPr (supervisor)	FS.01 FS.02 L.br.t HI.rd L0.rd Ld.dp		cnF9 (configuration) and FACt (factory)	12
CAL (calibration)	CALo CAHi		FACt (factory) only	13
0ptn (option)	CARd		cnF9 (configuration) and FACt (factory)	14.4
SerL (serial) see Note 1	Idno bAUd dAtF (Athena Plus only) trdL (Athena Plus only) PAr (MODBUS only) nnod (MODBUS only)		cnF9 (configuration) and FACt (factory)	14.5 and 14.6
C-dI (contact/digital input) see Note 2	Func		cnF9 (configuration) and FACt (factory)	14.7

Displayed Abbreviation (menu name)	Parameters	Access Levels	Described In
rAS (remote analog setpoint) see Note 3	SCL.L SCL.H	cnF9 (configuration) and FACt (factory)	14.8
A.out (auxiliary analog output) See Note 4	SCL.L SCL.H Out.U	cnF9 (configuration) and FACt (factory)	14.7

Note 1: The serial menu is used only if the controller supports serial communications.

Note 2: The contact/digital input menu is used only if the controller hardware supports this option.

Note 3: The remote analog setpoint menu is used only if the controller contains an optional remote analog setpoint card.

Note 4: The auxiliary analog output menu is used only if the controller contains an optional auxiliary analog output card.

4.5   Using Factory Defaults

Sections 5 through 14 include the factory default value for every parameter. If you want to use the default for a particular parameter, you do not have to take any action.

For example, suppose you want to use the defaults for the setpoint low limit and the setpoint high limit in the input menu. Also, you know that the defaults for every parameter in the display menu are OK for your application.

In this case, when you work your way through the input menu and get to the setpoint limits, you can press the ☰ key as each setpoint limit parameter is displayed to accept the current value and move past them to the input filter parameter.

After using the ⬆ and ⬇ keys to specify an input filter value, you press the ☰ key to write the new value to the database. The first parameter in the input menu (Type) will again be displayed.

You press the ↻ key to display the abbreviated name of the next menu. It is dSPL (display). If you know you are satisfied to use the defaults for all the display menu parameters, you do not have to press the ☰ key to cycle through the display parameters.

You can immediately press the ↻ key again to move on to the OutP (output) menu.

4.6   Parameter Identifiers Used by Multi-Comm Software

Throughout Sections 5 through 14 a two-digit number (or number and letter combination) appears in parenthesis after the name of the parameter. This is the number used to identify the parameter in the Athena Plus protocol. These numbers are included in Multi-Comm messages about parameters that cannot be loaded when Athena's Multi-Comm software is used to download a set of parameters to a Series C controller. A list of all the Athena Plus protocol parameter numbers, cross-referenced to the names and descriptions, is in Section 15.

5. Input Parameters – Required

5.1 Introduction

If you plan to use a thermocouple or RTD input and a unit of measure other than Fahrenheit (the default), the first step is changing the unit of measure to Celsius or Kelvin.

Otherwise, the first step when configuring a controller is specifying the input type using the InP (input) menu, then specifying the bias (if any) to be applied to the input, scaling the input (linear types only), specifying the setpoint range, and setting an input filter value (if any).

This menu is available only when the security access level is set to CnF9 (configuration) or FACt (factory).[21]

5.2 Calibration Must Be Appropriate for Input Type

You do not have to calibrate every new controller. When a controller was ordered, you specified an input type for which the unit was calibrated at the factory. This is not the specific type chosen with the input menu tYPE (type) parameter, such as J thermocouple, or 0 to 20 mA linear. In the context of ordering the controller, "type" refers to these choices:

- RTD
- compressed RTD
- thermocouple
- millivolt linear
- volt linear
- current linear input.

The controller was calibrated at the factory for the type of input specified. If you use the controller with a different type of input, you must recalibrate as described in Section 18 unless you ordered the "Calibrate All" input option.[22]

For example, if you specified when you ordered the controller that you planned to use a thermocouple as the sensor, then you can use the input menu tYPE (type) parameter to choose any thermocouple type: B, C, E, J, K, N, NNM, R, S, T, or Platinel II. The controller will be calibrated appropriately at the factory. However, if you ordered thermocouple calibration, but decide to use the controller with an RTD sensor, then you should recalibrate before using the controller.

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[21] The access level in all new 16C, 18C, and 25C controllers is set to CnF9 at the factory. If you cannot see the input menu, the access level has been changed to a more restrictive level. Instructions for changing the access level are in Section 17.

[22] To determine whether the controller in hand was calibrated at the factory for all input types, check the model number on the label on the controller. The meaning of each character in the model number is in the installation manual supplied with the controller.

5.3   Input Jumper Settings Must Match Input Type

Depending on the type of input, you might also have to change jumper settings. In 1ZC, 16C, 18C, and 25C controllers, the input jumpers must be set according to the type of input jumper category.

- input jumper category 1 – temperature input (RTD or thermocouple) or low voltage input (≤100 mV)

- input jumper category 2 – high voltage input (>100 mV)

- input jumper category 3 – current (milliamp) input

If you switch within a category, you do not have to change the jumper. For example, if you change from RTD to thermocouple input, you do not have to change the jumper.

However, if you change from one category to another, you must set the input jumpers accordingly. For example, if you change from RTD to current input, you must change the jumper settings.

The input jumpers are set at the factory to match the type of input calibration specified when the controller was ordered.[23] If the "calibrate all" option was ordered, the input jumpers will be set for a temperature input. If you plan to use the controller with an input that does not match the factory settings, you must set the input jumpers correctly before any configuration parameters are configured.

The location of the 16C, 18C, and 25C input jumpers JMP01 and JMP 02 on the processor board (board on the left when facing controller) is shown below.

MODEL 16C PROCESSOR BOARD

JMP02   JMP01
INPUT JUMPERS
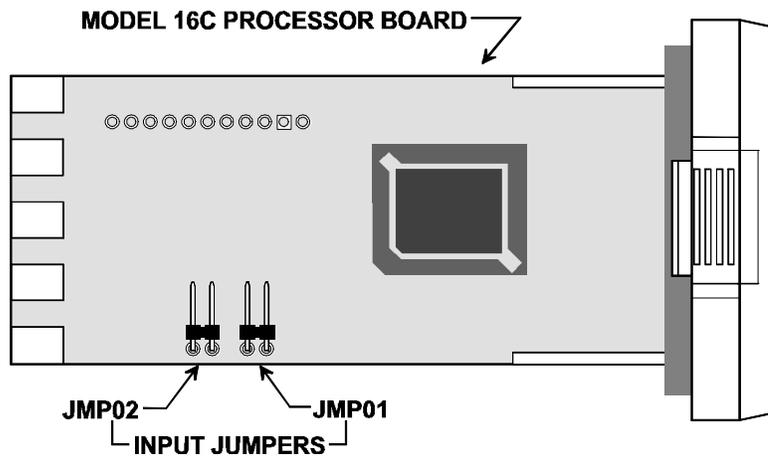
16C, 18C, and 25C Input Jumper Locations

---

[23] To determine the type of input for which the controller in hand was calibrated (and for which the input jumpers were set) at the factory, check the model number on the label on the controller. The meaning of each character in the model number is in the installation manual supplied with the controller.

The location of the 1ZC input jumpers is shown below.

INPUT JUMPERS

JMP4
JMP3

JMP1
JMP2
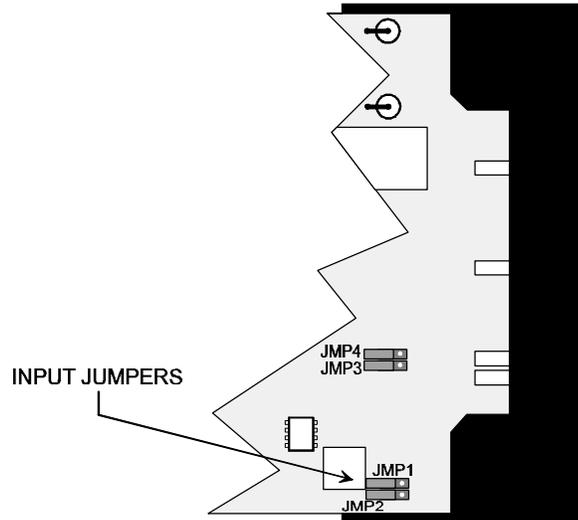
1ZC Input Jumper Locations

The jumper settings are summarized in the table below.

Input Jumper Category	JMP01	JMP02
Category 1 – thermocouple, RTD, and low voltage ≤ 100 mV)	out	out
Category 2 – high voltage >100 mV	in	out
Category 3 – current (milliamp)	in	in

5.4   Input Menu Parameter List

The InP (input) menu is shown in the table below. Descriptions of the individual parameters are later in the subsection.

Item	Parameter Name	When Displayed
tYPE	Input Type	always
bIAS	Input Bias	always
SCL.L	Linear Input Scaling Low Limit	only for linear input types (millivolt, voltage, or milliamp)
SCL.H	Linear Input Scaling High Limit	
SP.LL	Setpoint Low Limit	always
SP.HL	Setpoint High Limit	always
I.FIL	Input Filter	always

The process of configuring the input parameters is diagramed below.

```
                    ╭──────────────╮
                   (    START       )
                    ╰──────────────╯
                            │
                            ▼
                  ┌──────────────────┐
                  │ Select Input Type │
                  │                    │
                  │      tYPE          │
                  └──────────────────┘
                            │
                            ▼
                  ┌──────────────────┐
                  │   Apply Bias       │
                  │                    │
                  │      b IAS         │
                  │          See Note 1│
                  └──────────────────┘
                            │
                            ▼
  ┌──────────────┐       ╱◇╲
  │ Scale the Input│  Yes ╱     ╲   Is Input a
  │               │◄─────  Linear Type?  
  │    SC.LL      │       ╲     ╱
  │    SC.HL      │        ╲◇╱
  └──────────────┘          │ No
          │                 ▼
          │        ┌──────────────────┐
          └───────►│ Define Range for  │
                   │    Setpoint        │
                   │                    │
                   │      SP.LL         │
                   │      SP.HL         │
                   └──────────────────┘
                            │
                            ▼
                  ┌──────────────────┐
                  │ Specify Input Filter│
                  │                    │
                  │      I.F iL        │
                  └──────────────────┘
                            │
                            ▼
                    ╭──────────────╮
                   ( COMPLETED      )
                    ╰──────────────╯
```
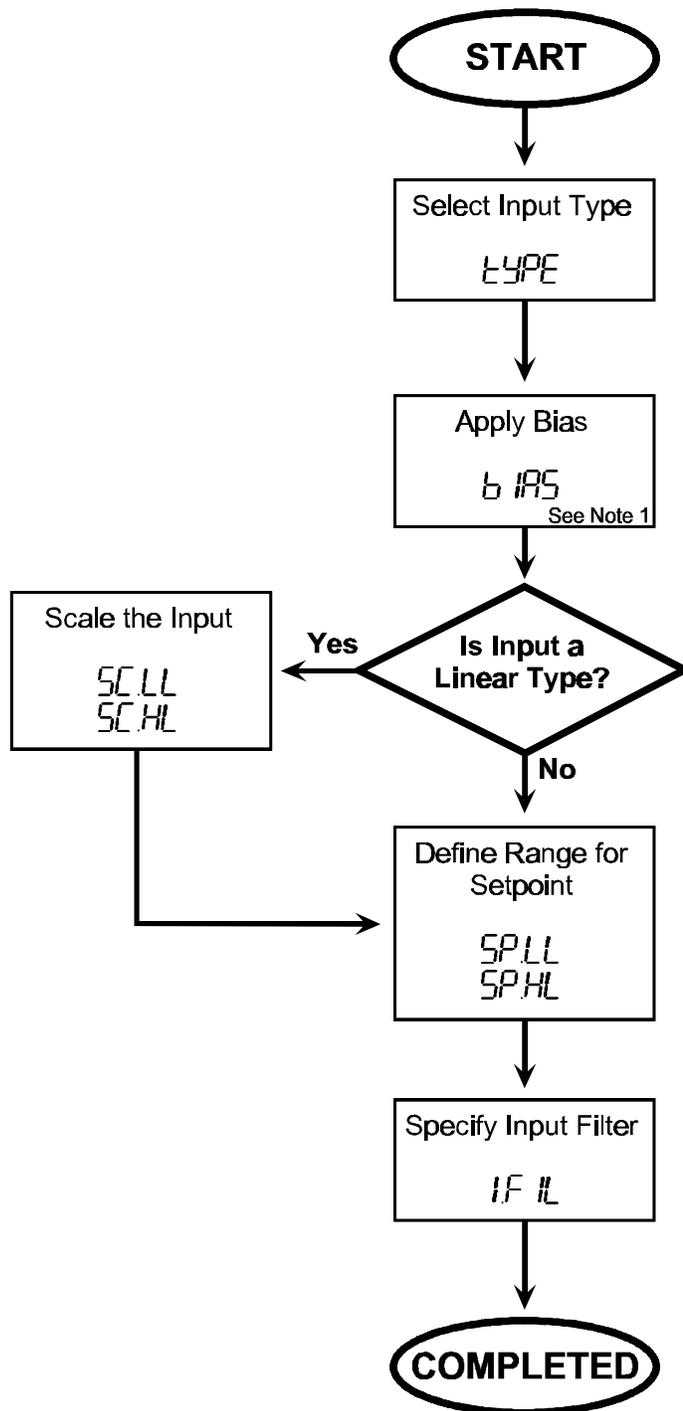
NOTE 1) You can leave the bias set to the default (zero) when setting up the controller. If the need for bias becomes evident later, you can configure the bias value at that time.

5.5   Specifying the Input Type

5.5.1 Parameter Used

After changing the unit of measure for temperature inputs, the next step when configuring a controller is always specifying the input type using the InP (input) menu. <u>The input type is set at the factory to match the calibration type specified when the controller was ordered</u>. (See Note 1 on the next page.) However, the input type can be changed using the tYPE parameter described below. If you change the input type from the factory setting, you may also have to change the input jumper settings. See 5.3 for details.

Parameter Name:	**Input Type** (92)
Name as Displayed:	tYPE
Used By:	all controllers
When Displayed:	always

Choices:		
	J	type J thermocouple
	E	type E thermocouple
	C	type C thermocouple
	b	type B thermocouple
	1-5	1 to 5 V linear
	0-10	0 to 10 V linear
	0-5	0 to 5 V linear
	0-1	0 to 1 V linear
	10.50	10 to 50 mV linear
	0.100	0 to 100 mV linear
	0.50	0 to 50 mV linear
	0.10	0 to 10 mV linear
	4.20A	4 to 20 mA linear
	0.20A	0 to 20 mA linear
	rt.d	100 ohm compressed RTD with decimal support *(notice the decimal point in the parameter choice)*
	rtd	100 ohm platinum RTD *(no decimal point)*
	PL2	Platinel II thermocouple
	t	type T thermocouple
	S	type S thermocouple
	r	type R thermocouple
	nn	Nickel-Nickel-Molybdenum thermocouple
	n	type n thermocouple
	CA	type K thermocouple

Default:	J thermocouple when configuration parameters are set to their defaults using the procedure in 12.5. At the factory, the input type of a new controller is configured to match the calibration type purchased. See Note 1 below.
Description:	The type of input the controller algorithm will expect. The type of input specified affects how the controller processes the input signal and calculates the output needed to achieve the setpoint. For example, the controller will linearize a thermocouple input. This operation is not needed if the input type is already linear.

Effect on Other Parameters: If you select an RTD or thermocouple input, then scaling limits used by linear input types do not apply. The Linear Input Scaling Low Limit (SCL.L) and Linear Input Scaling High Limit (SCL.H) parameters will not be displayed in the input menu.

If you select rt.d (100 ohm compressed RTD with decimal support), the Decimal Position parameter will not be displayed in the display menu. A compressed RTD input always uses one decimal position.

When you change the input type, parameters expressed in engineering units will be recalculated or set to the defaults.

Note 1: The input type is configured at the factory. The type configured depends on the input calibration type ordered. To determine the input calibration ordered for the controller in hand, check the model number on its label. The significance of each character in the model number is in the installation manual supplied with the controller. The table below shows the correlation between the input character and the factory input setting. Not every input calibration character applies to every model.

Input Calibration Model Number Character	Factory Configuration for Input Type
A	type set to J thermocouple; calibrated for all input types
B	type set to J thermocouple; calibrated for thermocouple and RTD
C	type set to 0 to 20 mA linear; calibrated for current linear input
M	type set to 0 to 50 mV linear; calibrated for millivolt linear input
R	type set to RTD; calibrated for RTD input
S	type set to RTD with decimal support; calibrated for RTD input
T	type set to J thermocouple; calibrated for thermocouple input
V	0 to 5 V linear; calibrated for voltage linear input

5.5.2 Procedure for Viewing the Currently Selected Input Type

To view the input type currently set for the controller:

1. Access the configuration menus by pressing the ⟳ key until a string of letters is displayed on the top line (approximately three seconds).

2. If a menu name other than InP is displayed, press the ⟳ key until InP is displayed on the top line.

3. If a parameter name other than tYPE is displayed on the lower line, press the ☰ key repeatedly to step until the tYPE parameter is displayed. The display of the parameter will alternate with the currently configured choice for this parameter. For example, in an out-of-the box controller, tYPE will alternate with the display of J (for J thermocouple).

5.5.3 Procedure for Changing the Input Selection

To change the input type selection:

1. Press the ▼ key or ▲ key to cycle through the input type choices until the input type you want is displayed on the lower line.

2. Press the ☰ key once to write the configuration change to the controller's EEPROM and display the next parameter (bias) in the input menu.

⬢ STOP

What's next after you have specified the input type?

If you chose an RTD or thermocouple input type, go to 5.6.
If you chose a linear input type go to 5.7.

5.6 Configuring Input Parameters for RTD and Thermocouple Input Types

5.6.1 Applying a Bias to the Temperature Input

When using an RTD or thermocouple input, you can specify the bias (if any) to be applied to the input.   Applying bias allows you to compensate for any difference between sensor reading and the point to be measured. The displayed process variable and setpoint will be offset by the value entered here. (You can leave the input bias set to the default zero when setting up the controller. If the need for bias becomes evident later, you can adjust the configured value.)

Parameter Name:	**Input Bias** (86)
Name as Displayed:	bIAS
Used By:	all controllers
When Displayed:	always
Range:	−1000 to 1000 °F −556 to 556 °C and °K
Default:	0
Description:	Applying bias allows you to compensate for any difference (plus or minus) between sensor reading and the location to be measured. The displayed process variable and setpoint will be offset by the value entered here.
Effect on Other Parameters:	No effect on other configuration parameters. However, the bias will be applied to the displayed PV and the active setpoint.

5.6.2 Specifying the Setpoint Range When a Temperature Input is Used

Configure the setpoint range, that is, the range of setpoint values the operator can enter using the 16C, 18C, and 25C front panel. This range will also apply to recipe setpoints, that is, to soak levels specified using the ramp/soak parameters.

The Setpoint Low Limit and the Setpoint High Limit must not be set to the same value.

Parameter Name:	**Setpoint Low Limit** (89)
Name as Displayed:	SP.LL
Used By:	all controllers
When Displayed:	always
Range:	sensor low limit to sensor high limit
Default:	–328 (See Note 1 below.)
Description:	This is the lowest value that can be entered by the operator as a setpoint (before bias is applied). This limit is also applies to ramp/soak recipe soak levels.

Parameter Name:	**Setpoint High Limit** (90)
Name as Displayed:	SP.HL
Used By:	all controllers
When Displayed:	always
Range	sensor low limit to sensor high limit
Default:	1400 (See Note 1 below.)
Description:	This is the highest value that can be entered by the operator as a setpoint (before bias is applied). This limit is also applies to ramp/soak recipe soak levels.

Note 1: The default value depends on the input type. The default value shown applies when the input type is a J thermocouple.

5.6.3 Applying an Input Filter When a Temperature Input is Used

You can configure the controller to average the input over a period of 0.1 to 10 seconds before it uses the input value in the control algorithm calculations.

Parameter Name:	**Input Filter** (91)
Name as Displayed:	I.FIL
Used By:	all controllers
When Displayed:	always
Range:	0.1 to 10.0 seconds
Default:	0.5
Description:	Used to specify the time period over which the controller will average the input before using the input in the control algorithm.

> **STOP**
>
> **If you are using an RTD or thermocouple input type, you have finished configuration of input parameters. The remainder of this chapter does not apply to your application.**
>
> **Go to Section 6 – Display Parameters.**

5.7   Configuring Input Parameters for Linear Inputs

5.7.1 Applying a Bias to the Linear Input

When using a linear input, you can specify the bias (if any) to be applied to the input. Applying bias allows you to compensate for any difference between sensor reading and the point to be measured. The displayed process variable and setpoint will be offset by the value entered here.

Parameter Name:	**Input Bias** (86)
Name as Displayed:	bIas
Used By:	all controllers
When Displayed:	always
Range:	−1000 to 1000 (See Note 1 below.)
Default:	0
Description:	Applying bias allows you to compensate for any difference (plus or minus) between sensor reading and the location to be measured. The displayed process variable and setpoint will be offset by the value entered here.
Effect on Other Parameters:	No effect on other configuration parameters. However, the bias will be applied to the displayed PV and the active setpoint.

Note 1: The range is reduced if a linear input is used and the value of the dSPL (display) menu dEC.P (decimal position) parameter is not 0 (zero). See 4.3.2 for more information about the effect of a linear input on numerical ranges.

5.7.2 Scaling the Linear Input

When a linear input is used, the controller will scale the input based on the range you specify. That means that you enter the PV to be represented by the input when the input signal is at its lowest level, and the PV to be represented by the input at its highest level. The controller divides that range into equal segments to interpret a particular input signal.

For example, suppose you use a 4 to 20 mA input to represent a PV that ranges from 0 to 170 °F. You can configure the Linear Input Scaling Low Limit as 0 and the Linear Input Scaling High Limit as 170 °F. The controller will then be able to calculate that a one mA change in the linear input means that the PV has changed 10 °F. A 0.1 mA change in the input represents a 1 °F change in the PV.

<u>The Linear Input Scaling Low Limit and the Linear Input Scaling High Limit must not be set to the same value</u>.

Parameter Name:	**Linear Input Scaling Low Limit** (87)
Name as Displayed:	SCL.L
Used By:	all controllers
When Displayed:	only when a linear input type has been selected
Range:	−1999 to 9999 (See Note 1 below.)
Default:	−1999
Description:	Used to specify the PV represented by the lowest possible linear input signal.
Effect on Other Parameters:	Limits the valid values for the control menu's deadband and hysteresis parameters applied to on/off outputs, as well as for other parameters. Determines the value displayed for the calibration menu's CALo (calibration low) parameter.

Parameter Name:	**Linear Input Scaling High Limit** (88)
Name as Displayed:	SCL.H
Used By:	all controllers
When Displayed:	only when a linear input type has been selected
Range:	−1999 to 9999 (See Note 1 below.)
Default:	9999
Description:	Used to specify the PV represented by the highest possible linear input signal.
Effect on Other Parameters:	Limits the valid values for the control menu's deadband and hysteresis parameters applied to on/off outputs, as well as for other parameters. Determines the value displayed for the calibration menu's CAHi (calibration high parameter).

Note 1: The range is reduced if a linear input is used and the value of the dSPL (display) menu dEC.P (decimal position) parameter is not 0 (zero). See 4.3.2 for more information about the effect of a linear input on numerical ranges.

5.7.3 Specifying the Setpoint Range When a Linear Input Is Used

The setpoint range, that is, the range of setpoint values the operator can enter using the 16C, 18C, and 25C front panel. This range will also apply to recipe setpoints, that is, to soak levels specified using the ramp/soak parameters.

The Setpoint Low Limit and the Setpoint High Limit must not be set to the same value.

Parameter Name:	**Setpoint Low Limit** (89)
Name as Displayed:	SP.LL
Used By:	all controllers
When Displayed:	always
Range:	limited by the scaling defined for the input using the SCL.L and SCL.H parameters in the InP (input) menu
Default:	depends on input type
Description:	This is the lowest value that can be entered as a setpoint (before bias is applied).

Parameter Name:	**Setpoint High Limit** (90)
Name as Displayed:	SP.HL
Used By:	all controllers
When Displayed:	always
Range	limited by the scaling defined for the input using the SCL.L and SCL.H parameters in the InP (input) menu
Default:	depends on input type
Description:	This is the highest value that can be entered as a setpoint (before bias is applied).

5.7.4 Applying an Input Filter When a Linear Input is Used

You can configure the controller to average the input over a period of 0.1 to 10 seconds before it uses the input value in the control algorithm calculations.

Parameter Name:	**Input Filter** (91)
Name as Displayed:	I.FIL
Used By:	all controllers
When Displayed:	always
Range:	0.1 to 10.0 seconds
Default:	0.5
Description:	Used to specify the time period over which the controller will average the input before using the input in the control algorithm.

6. Display Parameters – Required

6.1 Introduction

The dSPL (display) menu is shown in the table below. Descriptions of the individual parameters are later in the subsection.

This menu is available only when the security access level is set to CnF9 (configuration) or FACt (factory).[24]

Item	Parameter Name	When Displayed
dEC.P	Decimal Position[25]	always
d.FIL	Display Filter	always
Unit	Unit of Measure[26]	for RTD and thermocouple inputs only
bLAn	Setpoint Display Blanking	always

The process of configuring the display parameters is shown on the following page.

---

[24] The access level in all new 16C, 18C, and 25C controllers is set to CnF9 at the factory. If you cannot see the display menu, the access level has been changed to a more restrictive level. Instructions for changing the access level are in Section 17.

[25] Even though the 1ZC has no display, you must configure the appropriate decimal position parameter (or accept the default) because the controller uses this parameter value to determine how many decimal places to store for the PV and SP values.

[26] The controller uses this unit of measure internally and for external communication.

```
                    ┌──────────────┐
                    │    START     │
                    └──────┬───────┘
                           │
                           ▼
              ┌─────────────────────────┐
              │  Select Decimal Position │
              │                         │
              │          dEC.P          │
              └────────────┬────────────┘
                           │
                           ▼
              ┌─────────────────────────┐
              │   Specify Display Filter │
              │                         │
              │          d.F IL         │
              └────────────┬────────────┘
                           │
                           ▼
                        ◇───────◇              ┌──────────────────────────┐
                   Is Input Type    Yes        │  Select Unit of Measure  │
                   RTD or T/C?   ─────────────▶ │                          │
                        ◇───────◇              │          Un it           │
                           │                    └────────────┬─────────────┘
                          No                                 │
                           ▼                                 │
              ┌─────────────────────────┐                    │
              │ Specify Display Time Period│◀─────────────────┘
              │      for Setpoint        │
              │                         │
              │          bLAn           │
              └────────────┬────────────┘
                           │
                           ▼
                    ┌──────────────┐
                    │  COMPLETED   │
                    └──────────────┘
```
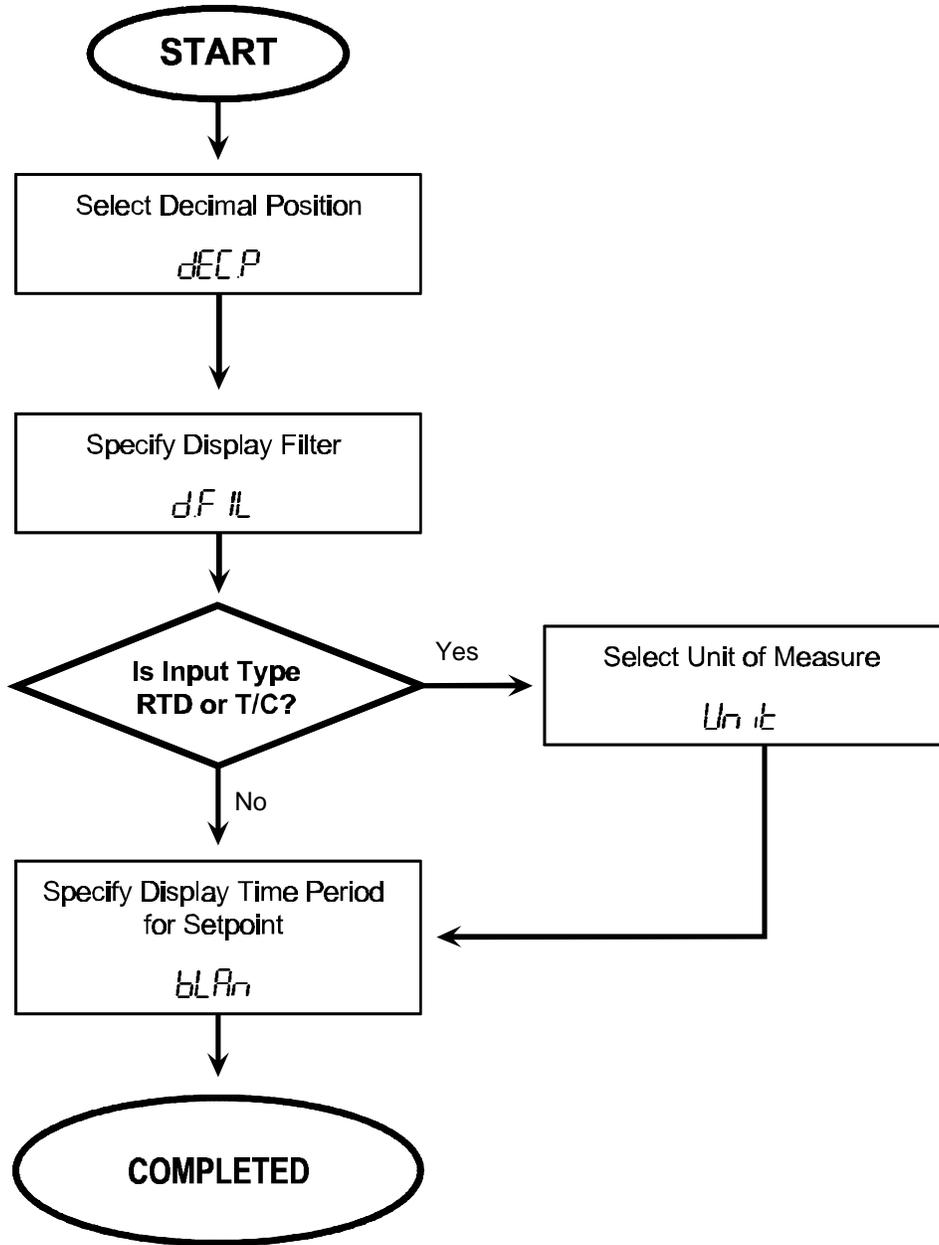
┌──┐
│ **STOP**   **Which display parameters apply to your application?**   │
│   │
│   **If you chose an RTD or thermocouple input type, go to 6.2.** │
│   **If you chose a linear input type go to 6.3.**   │
└──┘

6.2 Configuring Display Parameters for RTD and Thermocouple Input Types

6.2.1 Choosing the Decimal Position When a Temperature Input Is Used

The decimal point location applies to all controller types, including the 1ZC model. Even though the 1ZC has no display, you must configure the decimal position parameter (or accept the default) because the controller uses this parameter value to determine how many decimal places to store for the PV and SV values.

The only exception is when the input type is rt.d (100 ohm compressed RTD with decimal support). In this case, the decimal position is always 1, and the deC.P parameter is not displayed.

Parameter Name:	**Decimal Position** (B6)
Name as Displayed:	dEC.P
Used By:	all controllers
When Displayed:	always (unless the input type is rt.d)
Choices:	0 and 1
Default:	0
Description:	In the case of a controller using a temperature input, this parameter is used to choose the <u>maximum</u> quantity of digits to the right of the decimal point on the display, and in the PV and SV values used in the controller's calculations. No decimal position will be displayed if necessary to accommodate the four-character display.

6.2.2 Specifying the Display Filter When a Temperature Input Is Used

Unlike the input filter, the value entered for the display filter has no effect on control. The input filter slows the rate at which the displayed PV is changed. The display filter is generally used when at least one decimal place is displayed.

Parameter Name:	**Display Filter** (B8)
Name as Displayed:	d.FIL
Used By:	all except 1ZC
When Displayed:	always
Range:	0.1 to 10.0 seconds (See Note 1 below.)
Default:	0.1
Description:	Used to specify the minimum time period between changes of the displayed PV value.

Note 1: The range of valid values for this parameter always includes tenths values, regardless of the deC.P (decimal position) setting.

6.2.3 Choosing the Unit of Measure When a Temperature Input Is Used

The unit of measure applies to all controller types, including the 1ZC model. The unit of measure specified here is used by the controller for internal operations and external communication.

Parameter Name:	**Unit of Measure** (B9)
Name as Displayed:	Unit
Used By:	all controllers
When Displayed:	only when an RTD or thermocouple input type has been selected
Choices:	F Fahrenheit C Celsius CAY Kelvin
Default:	Fahrenheit
Description:	Used to choose the unit of measure used by the controller as it interprets the input and performs output calculations.

6.2.4 Blanking the Display of the Setpoint When a Temperature Input Is Used

If you do not want the setpoint to be displayed all the time (while the controller is operating normally), then use the Setpoint Display Blanking parameter to specify the length of time the setpoint should be displayed before being hidden ("blanked"). The setpoint display will remain blank until any key is pressed. Pressing any key will cause the controller to display the setpoint again. The setpoint will remain on display until the period specified here has elapsed.

Parameter Name:	**Setpoint Display Blanking** (C1)
Name as Displayed:	bLAn
Used By:	all except 1ZC
When Displayed:	always
Range:	OFF off 10 to 9999 seconds
Default:	off
Description:	Used to specify the number of seconds the setpoint should be displayed before the display of the setpoint goes blank.

STOP

If you are using an RTD or thermocouple input type, you have finished configuration of display parameters. The remainder of this chapter does not apply to your application.

Go to Section 7 – Output Parameters.

6.3   Configuring Display Parameters for Linear Input Types

6.3.1 Choosing the Decimal Position When a Linear Input Is Used

The decimal point location applies to all controller types, including the 1ZC model. Even though the 1ZC has no display, you must configure the decimal position parameter (or accept the default) because the controller uses this parameter value to determine how many decimal places to store for the PV and SV values.

Parameter Name:	**Decimal Position** (B7)
Name as Displayed:	dEC.P
Used By:	all controllers
When Displayed:	always
Choices:	0, 1, 2, 3
Default:	0
Description:	In the case of a controller using a linear input, this parameter is used to choose the quantity of digits <u>always displayed</u> to the right of the decimal point on the display, and in the PV and SV values used in the controller's calculations. If the controller uses a linear input and the dEC.p parameter is not set to 0 (zero), the number of decimal places specified is always imposed on the parameter's value. <u>This has the effect of reducing the range of valid values for many parameters when a linear input is used</u>. See 4.3.2 for information about this effect of a linear input on parameter ranges when a non-zero decimal position is used.

6.3.2 Specifying the Display Filter When a Linear Input Is Used

Unlike the input filter, the value entered for the display filter has no effect on control. The input filter slows the rate at which the displayed PV is changed. The display filter is generally used when at least one decimal place is displayed.

Parameter Name:	**Display Filter** (B8)
Name as Displayed:	d.FIL
Used By:	all except 1ZC
When Displayed:	always
Range:	0.1 to 10.0 seconds (See Note 1 below.)
Default:	0.1
Description:	Used to specify the minimum time period between changes of the displayed PV value.

Note 1: The range of valid values for this parameter always includes tenths values, regardless of the deC.P (decimal position) setting.

6.3.3 Blanking the Display of the Setpoint When a Linear Input Is Used

If you do not want the setpoint to be displayed all the time (while the controller is operating normally), then use the Setpoint Display Blanking parameter to specify the length of time the setpoint should be displayed before being hidden ("blanked"). The setpoint display will remain blank until any key is pressed. Pressing any key will cause the controller to display the setpoint again. The setpoint will remain on display until the period specified here has elapsed.

Parameter Name:	**Setpoint Display Blanking** (C1)
Name as Displayed:	bLAn
Used By:	all except 1ZC
When Displayed:	always
Range:	OFF off 10 to 9999 seconds
Default:	off
Description:	Used to specify the number of seconds the setpoint should be displayed before the display of the setpoint goes blank.

7. Output Parameters – Required

7.1 Introduction

The 1ZC, 16C, 18C, and 25C controllers are available with one or two standard outputs (relay, pulsed voltage, or analog, depending on the model ordered). The way that these standard outputs are used is determined by the way you configure the parameters in the `OutP` (output) menu (shown in the table below). An additional analog output can be ordered as an option. Use of this auxiliary output is specified using the option menu described in 14.7.

The output menu is available only when the security access level is set to `CnF9` (configuration) or `FACt` (factory).[27]

Item	Parameter Name	When Displayed
`01.ty`	Output 1 Type	always
`01.Ac`	Output 1 Action	only if Output 1 Type is On/Off or PID
`01.cY`	Output 1 Cycle Time	only if Output 1 Type is PID
`01.LL`	Output 1 Low Limit	
`01.HL`	Output 1 High Limit	
`01.AA`	Output 1 Alarm Action	only if Output 1 Type is Alarm and the controller is a 16C (also applies to 1ZC)
`01.A0`	Output 1 Alarm Operation	
`01.dL`	Output 1 Alarm Delay	
`01.IH`	Output 1 Alarm Inhibit	
`01.SP`	Output 1 Alarm Setpoint	
`02.ty`	Output 2 Type	always (assuming the hardware supports a second output)
`02.Ac`	Output 2 Action	only if Output 2 Type is On/Off or PID
`02.cY`	Output 2 Cycle Time	only if Output 2 Type is PID
`02.LL`	Output 2 Low Limit	
`02.HL`	Output 2 High Limit	
`02.AA`	Output 2 Alarm Action	only if Output 2 Type is Alarm and the controller is a 16C (also applies to 1ZC)
`02.A0`	Output 2 Alarm Operation	
`02.dL`	Output 2 Alarm Delay	
`02.IH`	Output 2 Alarm Inhibit	
`02.SP`	Output 2 Alarm Setpoint	

---

[27] The access level in all new 16C, 18C, and 25C controllers is set to `CnF9` at the factory. If you cannot see the output menu, the access level has been changed to a more restrictive level. Instructions for changing the access level are in Section 17.

The process of configuring the output parameters is shown below.

```
                              ┌─────────┐
                             (  START   )
                              └─────────┘
                                   │
                                   ▼
   If Off              ╱◇╲  If ALr (Alarm)          ╱◇╲           If Off
  ◄────────  Select Output 1 Type  ────────►  Select Alarm Action  ────────►
                 O1tY                              O1AA
                   │                                 │
              If Pid                            If Not Off
              or onoF                                │
                   ▼                                 ▼
          ┌──────────────────┐            ┌──────────────────┐
          │ Select Output    │            │ Select Alarm     │
          │ Action           │            │ Operation        │
          │    O1AC          │            │    D1.AO         │
          └──────────────────┘            └──────────────────┘
                   │                                 │
                   ▼                                 ▼
   No            ╱◇╲                      ┌──────────────────┐
  ◄──────  Is Output Type                 │ Specify Alarm    │
              PID?                        │ Delay            │
              ╲◇╱                         │    O1dL          │
               │                          └──────────────────┘
              Yes                                  │
               ▼                                   ▼
      ┌──────────────────┐           ┌──────────────────┐
      │ Specify Cycle    │           │ Specify Alarm    │
      │ Time             │           │ Inhibit          │
      │    O1CY          │           │    O1.IH         │
      └──────────────────┘           └──────────────────┘
               │                                │
               ▼                                ▼
      ┌──────────────────┐           ┌──────────────────────┐
      │ Specify Output   │           │ Specify Alarm Limit  │
      │ Range            │           │ (Setpoint)           │
      │    O1LL          │           │    O1.SP             │
      │    O1HL          │           └──────────────────────┘
      └──────────────────┘
                         ┌────────────────────────┐
                        ( OUTPUT 1 COMPLETED;       )
                        (  Repeat For Output 2      )
                         └────────────────────────┘
```
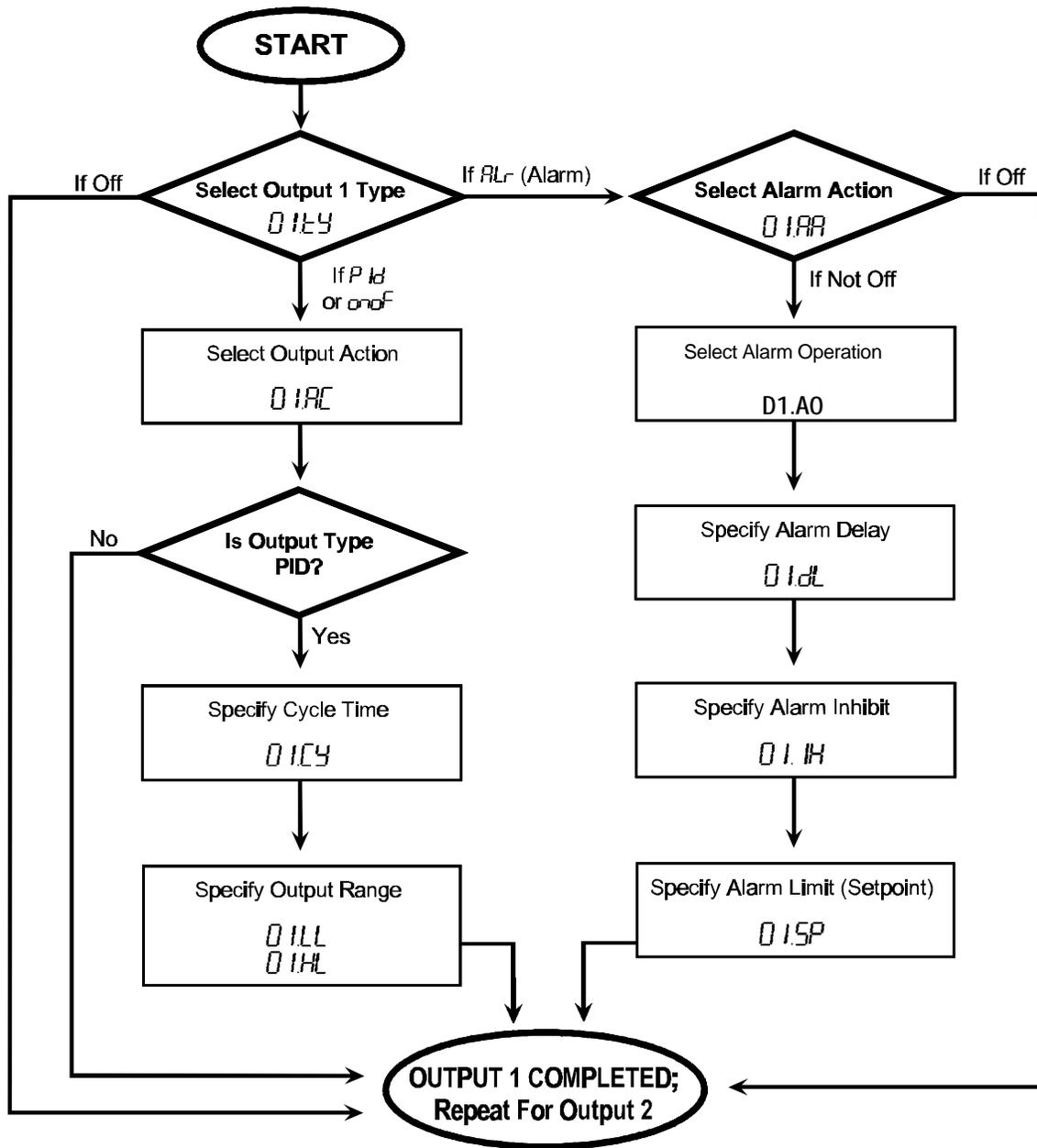
7.2   Specifying the Output Type

The first step in configuring use of the standard outputs is specifying the output type (function). As described in 1.5, the 1ZC, 16C, 18C, and 25C controllers can be used to implement PID or on/off control. Alternatively, model 16C and 1ZC controllers' standard outputs can be used for alarm annunciation as described in 1.6.

If the controller was ordered with two standard outputs, then two different output types can be chosen.

The function of the optional auxiliary analog output is not configured using this menu. The auxiliary output function is specified using the Aout menu (see 14.7).

Parameter Name:	**Output 1 Type** (94) and **Output 2 Type**[28] (A5)
Name as Displayed:	01.tY and 02.tY
Used By:	all controllers
When Displayed:	always
Choices:	OFF disabled Alr alarm *16C (and 1ZC) only* onoF On/Off Pid PID
Default:	PID
Description:	Used to choose the function of each standard output.
Effect on Other Parameters:	The choice made here for output 1 or output 2 determines what other parameters are displayed in the output menu for output 1 or output 2.
	The output type selected also affects the parameters displayed in the control menu.
	If an output is disabled or used for alarm annunciation, then that output's failsafe output percentage parameter will not be displayed in the supervisor menu.
	If both outputs are configured for use as alarms, then the ramp/soak menu will not be displayed.

> **What's next after specifying the output type?**
>
> **If you chose OFF for Output 1, specify the type for Output 2.**
>
> **If you chose on/off for an output, go to 7.3.**
> **If you chose PID control for an output, go to 7.4**
> **If you chose alarm for an output, go to 7.5.**

---

[28] All the output 1 parameters applicable to the type selected are displayed before the Output 2 type parameter is displayed.

7.3 Choosing the Output Action for On/Off Control

When the output type is set to on/off, only one other output parameter must be configured: output action.

When an output is used for on/off control, it can be either direct or reverse acting.

- When the on/off output action is configured for reverse action (heating applications), the controller will apply 100% output if the process temperature is <u>below</u> the setpoint and 0% if the PV is at the SV.

- When the on/off output action is configured for direct action (cooling applications), the controller will apply 100% output if the process temperature is <u>above</u> the setpoint and 0% if the PV is at the SV.

Parameter Name:	**Output 1 Action** (95) and **Output 2 Action** (A6)
Name as Displayed:	O1.AC and O2.AC
Used By:	all controllers
When Displayed:	if output type is on/off or PID
Choices:	dir direct rE reverse
Default:	*output 1:* reverse *output 2:* direct
Description:	Used to specify whether the output will be direct-acting or reverse-acting.

If you are using an on/off output, you have finished configuration of that output's parameters. The remainder of this section does not apply to on/off outputs.

If only one output has been configured, go back to 7.2 to specify the type for the other output.

If both outputs have been configured, go to Section 8 – Control Parameters.

7.4   Configuring Output Parameters for PID Control

7.4.1 Choosing the Output Action for PID Control

When an output is used for PID control, it can be either direct or reverse acting.

- When the PID output action is configured for reverse action (heating applications), the proportional band is initially applied <u>below</u> the setpoint.

- When the PID output action is configured for direct action (cooling applications), the proportional band is initially applied <u>above</u> the setpoint.

Parameter Name:	**Output 1 Action** (95) and **Output 2 Action** (A6)
Name as Displayed:	01.AC and 02.AC
Used By:	all controllers
When Displayed:	if output type is on/off or PID
Choices:	dir direct rE reverse
Default:	*output 1:* reverse *output 2:* direct
Description:	Used to specify whether the output will be direct-acting or reverse-acting.

7.4.2 Specifying the Cycle Time for PID Control

When an output is used for PID control, you must specify a cycle time that is appropriate for your application <u>and the output hardware</u> (see below). The cycle time enables you to use a discrete output device, such as a solid state relay, to achieve PID control.

For example, suppose the cycle time is set to 10 seconds and the control algorithm calculates that the output percentage should be 50%. A normally open relay will be closed for 5 seconds and open for 5 seconds in each ten second cycle. If the output percentage changes to 70%, the relay will be closed for 7 seconds and open for 3 seconds in each ten second cycle.

The cycle time parameter <u>must</u> be configured, even if the controller is equipped with analog outputs. In the case of analog outputs, the cycle time entered <u>must</u> be 0.2 seconds. This will have the effect of producing the correctly proportioned analog output signal.

The output hardware is specified when the controller is ordered. The location of the output characters in the model number is shown in the installation manual supplied with the controller. The controller's model number is on its label.

Model Number Output Hardware Character	Valid Cycle Times in Seconds
B	15 to 120
E	0.2 (See Note 1 below.)
F	0.2 (See Note 1 below.)
G	0.2 (See Note 1 below.)
S	0.2 (See Note 1 below.)
T	15 to 120 (See Note 2 below.)
V	0.2 (See Note 1 below.)
X	0.2 (See Note 1 below.)
Y	15 to 120

Note 1: The cycle time for analog outputs must to set to 0.2 for the controller to drive the analog output properly.
Note 2: "T" outputs directly driving non-inductive loads (small heaters) can have cycle times as low as 0.2 seconds.

Parameter Name:	**Output 1 Cycle Time 1** (A2) and **Output 2 Cycle Time** (B3)
Name as Displayed:	01.Cy and 02.Cy
Used By:	all controllers
When Displayed:	if output type is PID
Range:	*see table above*
Default:	5 seconds
Description:	Used to specify the period of time in which the output completes an on-off cycle.

7.4.3 Specify the PID Output Range

If the controlled field device should never be fully off and/or fully on, you can limit the range of the output when PID is used. The range defined here affects both:

- the control algorithm's output when the controller is in normal (automatic) mode, and

- the fixed output percentage the operator can enter when the controller is in manual mode.

For example, suppose the lowest input the controlled device should receive is 30% of the analog output's range (or the discrete output's cycle time), and the maximum input the controlled device should receive is 70% of the analog output's range (or the discrete output's cycle time). In this case you set the O1.LL = 30 and the O1.HL = 70.

- If the controller uses a 0 to 20 mA output, then the lowest output signal sent to the field device in our example is 6 mA (30% of 20 mA), even if the process variable requires no correction. The highest output signal sent to the controller is 14 mA (70% of 20 mA).

- If the controller uses a normally open relay as its output, then the lowest percentage of the cycle time the relay would be closed is 30% of the cycle time, and the highest percentage of the cycle time the relay is closed is 70%. If the cycle time configured with the O1.CY parameter is 10 seconds, then the relay is never closed for less than 3 seconds (30% of 10 seconds), even if the process variable requires no correction. The relay is never closed for more than 7 seconds (70% of 10 seconds).

The limits apply to both normal (automatic) mode and manual mode. In our example, the operator can never turn off the field device using the controller while the output limits are set to 30 and 70, regardless of whether the controller is in auto or manual mode.

The lower and upper output limits should not be set to the same value.

Parameter Name:	**Output 1 Low Limit** (A3) and **Output 2 Low Limit** (B4)
Name as Displayed:	O1.LL and O2.LL
Used By:	all controllers
When Displayed:	if output type is PID
Range:	0 to 100 percent
Default:	0
Description:	Used to specify the lowest percentage used for the output in both manual and normal (automatic) modes.
Effect on Other Parameters:	No effect on other configuration parameters. However, it limits the allowable range for the fixed output percent in manual mode.

Parameter Name:	**Output 1 High Limit** (A4) and **Output 2 High Limit** (B5)
Name as Displayed:	O1.HL and O2.HL
Used By:	all controllers
When Displayed:	if output type is PID
Range:	0 to 100 percent
Default:	100
Description:	Used to specify the highest percentage used for the output in both manual and normal (automatic) modes.
Effect on Other Parameters:	No effect on other configuration parameters. However, it limits the allowable range for the fixed output percent in manual mode.

7.5 Configuring Output Parameters for Alarm Annunciation – 1ZC and 16C Only

7.5.1 Choosing the Alarm Action

The first step in configuring an output to be used for alarm annunciation is to choose the alarm action. The choices are:

- OFF **(off)** – The alarm output will not be used.

- nor **(normal)** – The output will go to the alarm state when the process value triggers the alarm and go out of the alarm state when the alarm condition has been cleared.

- Lat **(latching)** – Once the output goes to the alarm state, the output will remain in the alarm state until the operator presses the ▬ key, even if the alarm condition has been cleared before the operator presses the key.

Parameter Name:	**Output 1 Alarm Action** (96) and **Output 2 Alarm Action** (A7)
Name as Displayed:	01.AA and 02.AA
Used By:	1ZC and 16C only *(16C, 18C, and 25C controllers support the alarm parameters described in Section 9)*
When Displayed:	if output type is alarm
Choices:	OFF off
	nor normal
	Lat latching
Default:	off
Description:	Used to choose the function of the alarm output.
Effect on Other Parameters:	If off is chosen, then no other output alarm parameters are displayed.

7.5.2 Choosing the Alarm Operation

The second step in configuring an output to be used for alarm annunciation is to choose the alarm operation. The choices are:

- **process alarm** – Activated when the process variable reaches the alarm value (alarm setpoint parameter value), independent of the PV's relationship to the process setpoint. A high process alarm activates at and above the alarm setpoint. A low process alarm activates at and below the alarm setpoint. For example, if you want an alarm to alert the operator when the PV goes up to 200, then configure the alarm as a high process alarm, and specify the alarm setpoint as 200.

- **deviation alarm** – Activated when the process variable deviates from the process setpoint by the amount specified using the alarm value (alarm setpoint parameter value). A high deviation alarm activates when the PV is above the process setpoint by the amount specified using the alarm value. A low deviation alarm activates when the PV is below the process setpoint by the amount specified using the alarm value. For example, if you want an alarm to alert the operator when the PV is 50 below the setpoint, then configure the alarm as a low deviation alarm, and specify the alarm value (using the alarm setpoint parameter) as 50.

- **inverse band alarm** – Activated when the process value is <u>within</u> a specified band centered around the setpoint. For example, if you want the alarm to alert the operator when the PV is 10 units (or less) above or below the process setpoint, then configure the alarm as an inverse band alarm, and specify 10 for the alarm setpoint parameter value.

- **normal band alarm** – Activated when the process value is <u>outside</u> a specified band centered around the setpoint. For example, if you want the alarm to alert the operator when the PV is 10 units (or more) above or below the process setpoint, then configure the alarm as a normal band alarm, and specify 10 for the alarm setpoint parameter value.

Parameter Name:	**Output 1 Alarm Operation** (97) and **Output 2 Alarm Operation** (A8)
Name as Displayed:	01.A0 and 02.A0
Used By:	1ZC and 16C *(16C, 18C, and 25C controllers support the alarm parameters described in Section 9)*
When Displayed:	if output type is alarm and output alarm action is not off
Choices:	Pro.L low process alarm Pro.H high process alarm in.b inverse band nor.b normal band de.L low deviation alarm de.H high deviation alarm
Default:	*output 1:* process low *output 2:* process high
Description:	Used to choose the alarm operation.
Effect on Other Parameters:	Determines how the value of the 01.SP or 02.SP (alarm setpoint) parameter is used.

7.5.3 Specifying the Alarm Delay – Optional

If you specify an alarm delay, then when the controller detects an alarm condition, the alarm output will not be activated until the alarm delay time has passed. Use the alarm delay to reduce nuisance alarms for transient conditions that are corrected without any operator action.

Parameter Name:	**Output 1 Alarm Delay** (98) and **Output 2 Alarm Delay** (A9)
Name as Displayed:	01.dL and 02.dL
Used By:	1ZC and 16 C *(16C, 18C, and 25C controllers support the alarm parameters described in Section 9)*
When Displayed:	if output type is alarm and output alarm action is not off
Range:	0 to 9999 seconds
Default:	0
Description:	Used to specify the number of seconds the controller should wait before signaling an alarm condition.

7.5.4 Inhibiting the Alarm– Optional

Unless the output will be used to signal a ramp/soak event, you can configure an inhibit time for the alarm. If you specify an alarm inhibit time, the controller will not activate the alarm output following power up until the alarm inhibit time has elapsed. This is particularly useful for preventing activation of low alarms during startup (before the process has had time to reach operating temperature).

Parameter Name:	**Output 1 Alarm Inhibit** (99) and **Output 2 Alarm Inhibit** (B0)
Name as Displayed:	01.IH and 02.IH
Used By:	1ZC and 16 C *(16C, 18C, and 25C controllers support the alarm parameters described in Section 9)*
When Displayed:	if output type is alarm and output alarm action is not off
Range:	0 to 9999 seconds
Default:	0
Description:	Used to specify the number of seconds the controller should wait after power up before signaling an alarm condition.

7.5.5 Specifying the Alarm Value (Setpoint)

How the alarm setpoint value is used depends on the type of alarm.

- **process alarm** – activated when process value reaches the value specified with the output alarm setpoint parameter

- **deviation alarm** – activated when process value differs from the process setpoint by the value specified with the output alarm setpoint parameter

- **inverse band alarm** – activated when the PV is <u>inside</u> a band centered around the setpoint; the width of the band on either side of the setpoint is specified with the output alarm setpoint parameter

- **normal band alarm** – activated when the PV is <u>outside</u> a band centered around the setpoint; the width of the band on either side of the setpoint is specified with the output alarm setpoint parameter

Parameter Name:	**Output 1 Alarm Setpoint** and **Output 2 Alarm Setpoint** (See Note 2 below)
Name as Displayed:	01.SP and 02.SP
Used By:	1ZC and 16 C *(16C, 18C, and 25C controllers support the alarm parameters described in Section 9)*
When Displayed:	if output type is alarm and output alarm action is not event
Range:	*RTD and thermocouple input types:* sensor low limit to sensor high limit *linear input types:* limited by the scaling defined for the input using the SCL.L and SCL.H parameters in the I nP (input) menu (See Note 1 below.)
Default:	*process alarm:* 77 *deviation, inverse band, normal band:* 1728
Description:	Used to specify the alarm setpoint (process alarm), the alarm limit (deviation alarm), or the width of the alarm band on either side of the setpoint (inverse and normal band alarms)

Note 1: The range is reduced when a linear input is used and the value of the dSPL (display) menu dEC.P (decimal position) parameter is not 0 (zero). See 4.3.2 for more information about the effect of a linear input on numerical ranges.

Note 2: The Athena Plus protocol code numbers used for these parameters depends on the alarm operation as shown in the table.

If alarm operation is:	Output 1 alarm setpoint code is:	Output 2 alarm setpoint code is:
process alarm	A0	B1
deviation alarm	A1	B2
inverse band	A1	B2
normal band	A1	B2

8. Control Parameters – Required If Outputs Are Used for Control

8.1   Introduction

The 1ZC, 16C, 18C, and 25C controllers all support both PID and on/off control. If the controller is equipped with two standard outputs, the outputs can be configured for two different types of control. For information about the types of applications that are suitable for each type of control, see 1.5.

The parameters used to customize the control operation are in the `CtrL` (control) menu. This menu is available only when the security access level is set to `CnF9` (configuration) or `FACt` (factory).[29]

If both outputs are configured for use with alarms or turned off (using the output 1 type and output 2 type parameters), then the `CtrL` (control) menu will not be displayed.

Item	Parameter Name	When Displayed
`db.1`	Deadband for Output 1	only if output 1 type is on/off
`HYS.1`	Hysteresis for Output 1	only if output 1 type is on/off
`db.2`	Deadband for Output 2	only if output 2 type is on/off
`HYS.2`	Hysteresis for Output 2	only if output 2 type is on/off
`Pb1`	Proportional Band 1	only if output 1 type is PID
`Pb2`	Proportional Band 2	only if output 2 type is PID, and output 1 and output 2 are not both set to the same action (see Note 1)
`der`	Derivative (Rate) Action	only if output 1 or output 2 type is PID (see Note 2)
`OFFs`	Offset (Manual Reset)	only if output 1 or output 2 type is PID (see Notes 2 and 3)
`Int`	Integral Action (Auto Reset)	only if output 1 or output 2 type is PID, and the value of `OFFS` = 0 (see Notes 2 and 3)

Note 1: If output 1 and output 2 are both set to PID direct action, or if both outputs are set to PID reverse action, then the controller applies the same proportional band to both outputs. The `Pb.2` parameter is not needed, so it is not displayed when you step through the control menu.
Note 2: If both outputs are PID, then the values specified for `der`, `OFFS`, and `Int` are applied to both outputs.
Note 3: The controller uses either a manual reset value or an integral action value, not both.

---

[29] The access level in all new 16C, 18C, and 25C controllers is set to `CnF9` at the factory. If you cannot see the control menu, the access level has been changed to a more restrictive level. Instructions for changing the access level are in Section 17.

The process of configuring the control parameters is shown below.

```
                                    ┌─────────┐
                                    │  START  │
                                    └─────────┘
                                         │
                                         ▼
   No, it is on / off            ◇ Is Output 1 Type PID? ◇
   ◄─────────────────────────────
                                         │ Yes
                                         ▼
              ┌──────────────────┐   ┌──────────────────────┐
              │ Specify Deadband │   │ Specify Proportional │
              │       db.1       │   │        Band          │
              └──────────────────┘   │   PB1    See Note1   │
                       │             └──────────────────────┘
                       ▼                      │
┌──────────────────────┐  ┌──────────────┐    ▼
│ Specify Proportional │  │   Specify    │ ┌──────────────────┐
│        Band          │◄─│  Hysteresis  │ │Specify Derivative│
│   PB2   See Note 1   │  │    HYS.1     │ │  dEr   See Note1 │
└──────────────────────┘  └──────────────┘ └──────────────────┘
           │          Yes         │                 │
           ▼          See ◇ Is Output 2 ◇           ▼
┌──────────────────┐  Note 3 │ Type PID? │  ┌──────────────────┐
│Specify Derivative│◄────────           ◇  │ Specify Manual   │
│  dEr   See Note1 │                       │    Offset        │
└──────────────────┘         │No, it is on/off│ OFFS  See Note 2│
           │                 ▼              └──────────────────┘
           ▼          ┌──────────────┐              │
┌──────────────────┐  │   Specify    │   Yes        ▼
│ Specify Manual   │  │  Deadband    │◄── ◇ Is Manual Offset ◇ ──► ┌──────────────────┐
│    Offset        │  │    db2       │   ◇     OFF?       ◇        │ Specify Integral │
│ OFFS  See Note 2 │  └──────────────┘                             │      Time        │
└──────────────────┘         │           │No                      │  Int   See Note1 │
           │           No     ▼           ▼                        └──────────────────┘
           ▼        ◇────────┌──────────────┐  ◇ Is Output 2 ◇            │
   ◇ Is Manual Offset ◇      │   Specify    │  ◇  Type PID?  ◇◄───────────┘
   ◇       OFF?       ◇ ──►  │  Hysteresis  │  No,it is
                             │    HYS.2     │  on/off
           │ Yes             └──────────────┘      │ Yes
           ▼                        │              │ See Note 3
┌──────────────────┐                │              ▼
│ Specify Integral │                │        ┌───────────┐
│      Time        │                └───────►│ COMPLETED │
│  Int   See Note1 │                         └───────────┘
└──────────────────┘
```

NOTE 1) If you plan to use AutoTune, you do not need to configure this parameter.

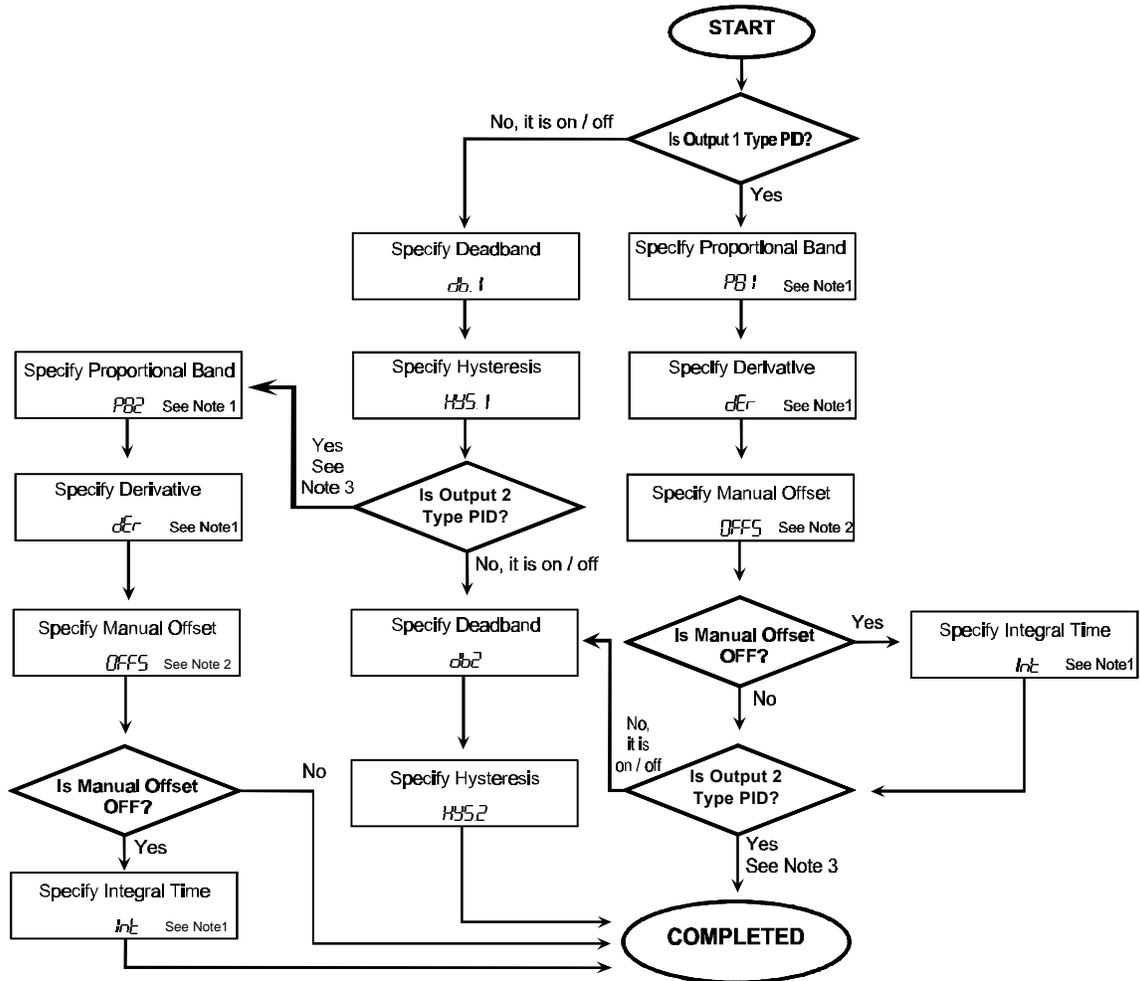NOTE 2) If you are using Int, set this parameter to off.

NOTE 3) If output 1 and output 2 are both set to PID direct action, or if both
          outputs are set to PID reverse action, then the controller applies the
          same proportional band to both outputs. The PB2 parameter is not
          needed, so it is not displayed when you step through the control
          menu.   If both outputs are PID (regardless of action), then the values
          specified for dEr, OFFS, and Int are applied to both outputs.

┌───┐
│ ┌──────┐   │
│ │ STOP │   **Which control parameters apply to your application?**   │
│ └──────┘   │
│   │
│   **If you chose on/off for an output in Section 7, then go to 8.2.** │
│   **If you chose PID control for an output in Section 7, go to 8.3.** │
└───┘

8.2   Configuring Control Parameters for On/Off Control

8.2.1 Introduction

On/off control has two states, fully off and fully on.   To prevent rapid cycling, the controllers allow you to configure a deadband and a hysteresis value as described in 1.5.3.

8.2.2 Specifying the Deadband for On/Off Control

Parameter Name:	**Deadband for Output 1** (20) and **Deadband for Output 2** (37)
Name as Displayed:	db.1 and db.2
Used By:	all controllers
When Displayed:	if output type is on/off
Range:	*RTD and thermocouple input types:* negative sensor span to positive sensor span *linear input types:* limited by the scaling defined for the input using the input menu (See Note 1 below.)
Default:	1
Description:	If a deadband value is applied to an output, it has the effect of shifting the setpoint <u>and the hysteresis</u> for that output. That is, the deadband for each output moves the "off" transition away from the setpoint, and pushes the "on" transition away by an equal amount. For a heating (reverse-acting) output, a positive deadband value moves the setpoint used by the controller below the displayed setpoint. For a cooling (direct-acting) output, a positive deadband value moves the setpoint used by the controller above the setpoint displayed. (A negative deadband value has the opposite effect.)

Note 1: The range is reduced when a linear input is used and the value of the dSPL (display) menu dEC.P (decimal position) parameter is not 0 (zero). See 4.3.2 for more information about the effect of a linear input on numerical ranges.

8.2.3 Applying Hysteresis to On/Off Control

Parameter Name:	**Hysteresis for Output 1** (21) and **Hysteresis for Output 2** (38)
Name as Displayed:	HYS.1 and HYS.2
Used By:	all controllers
When Displayed:	if input type is on/off
Range:	*RTD and thermocouple input types:* 0 to positive sensor span *linear input types:* limited by the scaling defined for the input using the input menu (See Note 1 below.)
Default:	1
Description:	The hysteresis value represents a temperature value that the controller uses to move the "on" and "off" transitions away from the setpoint by an amount equal to half the configured hysteresis value.

Note 1: The range is reduced when a linear input is used and the value of the dSPL (display) menu dEC.P (decimal position) parameter is not 0 (zero). See 4.3.2 for more information about the effect of a linear input on numerical ranges.

If you are configuring control parameters for an on/off output, you are finished configuring the control parameters that apply to that output. The remainder of this section does not apply to on/off outputs.

If both outputs will be used for control, but control parameters for only one output have been configured, configure the control parameters for the second output.

- **If you chose on/off for the second output, configure the deadband and hysteresis for the second output as described here in 8.2.**

- **If you chose PID control for the other output, go to 8.3.**

8.3 Configuring Control Parameters for PID Control

8.3.1 Introduction

When Proportional-Integral-Derivative (PID) control is used, the controller modulates output power by adjusting the output power percentage within a proportional band. Power is proportionally reduced as the process temperature gets closer to the setpoint temperature. The integral action affects the output based on the duration of the process value's variation from the setpoint, and the derivative action affects the output based on the rate of change of the process value.

The values of the PID tuning parameters are automatically adjusted during the Autotune procedure (see 16.2).

<u>Unless you want to tune the controller manually as described in 16.3</u>, do not alter the tuning parameters Proportional Band for Output 1, Proportional Band for Output 2, Derivative (Rate) Action, and Integral Action (Auto Reset). If you enter a non-zero value for the manual offset, the controller will ignore it when you do Autotune. The controller uses only one reset, either auto or manual.

8.3.2 Specifying the Proportional Band for Manual Tuning of PID Control

Parameter Name:	**Proportional Band for Output 1** (22) and **Proportional Band for Output 2** (23)
Name as Displayed:	Pb.1 and Pb.2
Used By:	all controllers
When Displayed:	if output 1 or output 2 type is PID; if both output 1 and output 2 are direct acting or reverse acting, then only Pb.1 is displayed and applied to both outputs.
Range:	*RTD and thermocouple input types:* 0.6 to sensor span *linear input types:* 1 to value of the SCL.H parameter in the InP (input) menu. (See Note 1 below.)
Default:	100
Description:	Used to specify the width of the band above (direct-acting outputs) or below (reverse-acting outputs) the setpoint within which the controller will modulate the output as the process value approaches the setpoint.

Note 1: The range is reduced when a linear input is used and the value of the dSPL (display) menu dEC.P (decimal position) parameter is not 0 (zero). See 4.3.2 for more information about the effect of a linear input on numerical ranges.

8.3.3 Specifying the Derivative (Rate) Action for Manual Tuning of PID Control

Parameter Name:	**Derivative** (30)
Name as Displayed:	dEr
Used By:	all controllers
When Displayed:	if output 1 or output 2 type is PID
Range:	0.0 to 0.9, 1 to 2400 seconds (See Notes 1 and 2 below.)
Default:	0.0
Description:	Used to specify the time period used by the derivative component of the control algorithm when analyzing load changes.

Note 1: The range is reduced when a linear input is used and the value of the dSPL (display) menu dEC.P (decimal position) parameter is not 0 (zero). See 4.3.2 for more information about the effect of a linear input on numerical ranges.

Note 2: This parameter is a special case. Even if the value of the dSPL (display) menu dEC.P (decimal position) parameter is 2 or 3 (which is permitted when a linear input is used), the maximum number of decimal places applied to the PID derivative (rate) action is 1 (the tenths position).

8.3.4 Specifying the Offset (Manual Reset) for Manual Tuning of PID Control

Parameter Name:	**Offset (Manual Reset)** (34)
Name as Displayed:	OFFS
Used By:	all controllers
When Displayed:	if output 1 or output 2 type is PID
Range:	−100 to 100 percent (See Note 1 below.)
Default:	0
Description:	Used to specify a fixed amount that the proportional band will be offset up (positive) or down (negative). The result is an increase or decrease of power applied at the setpoint to compensate for proportional control offset error.

Note 1: The range is reduced when a linear input is used and the value of the dSPL (display) menu dEC.P (decimal position) parameter is not 0 (zero). See 4.3.2 for more information about the effect of a linear input on numerical ranges.

8.3.5 Integral Action (Automatic Reset) Calculated Automatically During Autotune for PID Control

This parameter is not used in manual tuning. If you assign a non-zero value to the manual offset OFFS parameter, then this parameter Int will not be displayed.

Parameter Name:	**Integral Action (Automatic Reset)** (32)
Name as Displayed:	Int
Used By:	all controllers
When Displayed:	if output 1 or output 2 type is PID
Range:	0.0 to 0.9, 1 to 9600 seconds (See Notes 1 and 2 below.)
Default:	0.0
Description:	Used by the Autotune operation to store the automatic reset value.

Note 1: The range is reduced when a linear input is used and the value of the dSPL (display) menu dEC.P (decimal position) parameter is not 0 (zero). See 4.3.2 for more information about the effect of a linear input on numerical ranges.

Note 2: This parameter is a special case. Even if the value of the dSPL (display) menu dEC.P (decimal position) parameter is 2 or 3 (which is permitted when a linear input is used), the maximum number of decimal places applied to the integral offset (automatic reset) action is 1 (the tenths position).

9. Alarm Parameters – Optional

9.1 Introduction

The 16C, 18C, and 25C controllers all have two alarm LEDs on the front panel. Each of these LEDs is associated with an alarm. Each alarm can be configured to be activated (light the LED) when a specific condition exists. Alarm configuration is done using the AIr (alarm) menu. This menu is available only when the security access level is set to CnF9 (configuration) or FACt (factory).[30]

The 16C, 18C, and 25C controllers can all be ordered with two dedicated optional alarm outputs.[31] The operation and action of these alarm outputs is tied to the alarm menu parameters that affect alarm annunciation using the LEDs.

See 1.6 for a more detailed discussion of your options for alarm annunciation using the 1ZC, 16C, 18C, and 25C controllers, and the types of alarm actions supported.

Item	Parameter Name	When Displayed
A1.AA	Alarm 1 Action	always
A1.A0	Alarm 1 Operation	if alarm 1 action is not off or event
A1.dI	Alarm 1 Delay	if alarm 1 action is not off or event
A1.IH	Alarm 1 Inhibit	if alarm 1 action is not off or event
A1.SP	Alarm 1 Setpoint	if alarm 1 action is not off or event
A2.AA	Alarm 2 Action	always
A2.A0	Alarm 2 Operation	if alarm 2 action is not off or event
A2.dI	Alarm 2 Delay	if alarm 2 action is not off or event
A2.IH	Alarm 2 Inhibit	if alarm 2 action is not off or event
A2.SP	Alarm 2 Setpoint	if alarm 2 action is not off or event

---

[30] The access level in all new 16C, 18C, and 25C controllers is set to CnF9 at the factory. If you cannot see the alarm menu, the access level has been changed to a more restrictive level. Instructions for changing the access level are in Section 17.

[31] Refer to the Athena catalog (or the model number breakdown in the installation manuals supplied with the controllers) for details on the types of outputs available.

The process of configuring the alarm parameters is shown below.

```
                           ┌─────────────┐
                           │    START    │
                           └──────┬──────┘
                                  │
                                  ▼
If Off or Event            ╱─────────────╲
◄──────────────────────── ╱  Select Alarm 1 ╲
│                         ╲     Action      ╱
│                          ╲───────────────╱
│                                  │
│                                  │ If Normal or Latching
│                                  ▼
│                         ┌──────────────────┐
│                         │ Select Alarm Operation │
│                         │                  │
│                         │      A1AO        │
│                         └────────┬─────────┘
│                                  │
│                                  ▼
│                         ┌──────────────────┐
│                         │ Specify Alarm Delay │
│                         │                  │
│                         │      A1d1        │
│                         └────────┬─────────┘
│                                  │
│                                  ▼
│                         ┌──────────────────┐
│                         │ Specify Alarm Inhibit │
│                         │                  │
│                         │      A1.IH       │
│                         └────────┬─────────┘
│                                  │
│                                  ▼
│                         ┌──────────────────────────┐
│                         │ Specify Alarm Limit (Setpoint) │
│                         │                          │
│                         │         A1SP             │
│                         └────────────┬─────────────┘
│                                      │
│                                      ▼
│                           ╱───────────────────╲
└─────────────────────────►│  ALARM 1 COMPLETED;  │
                           │  Repeat For Alarm 2   │
                            ╲───────────────────╱
```
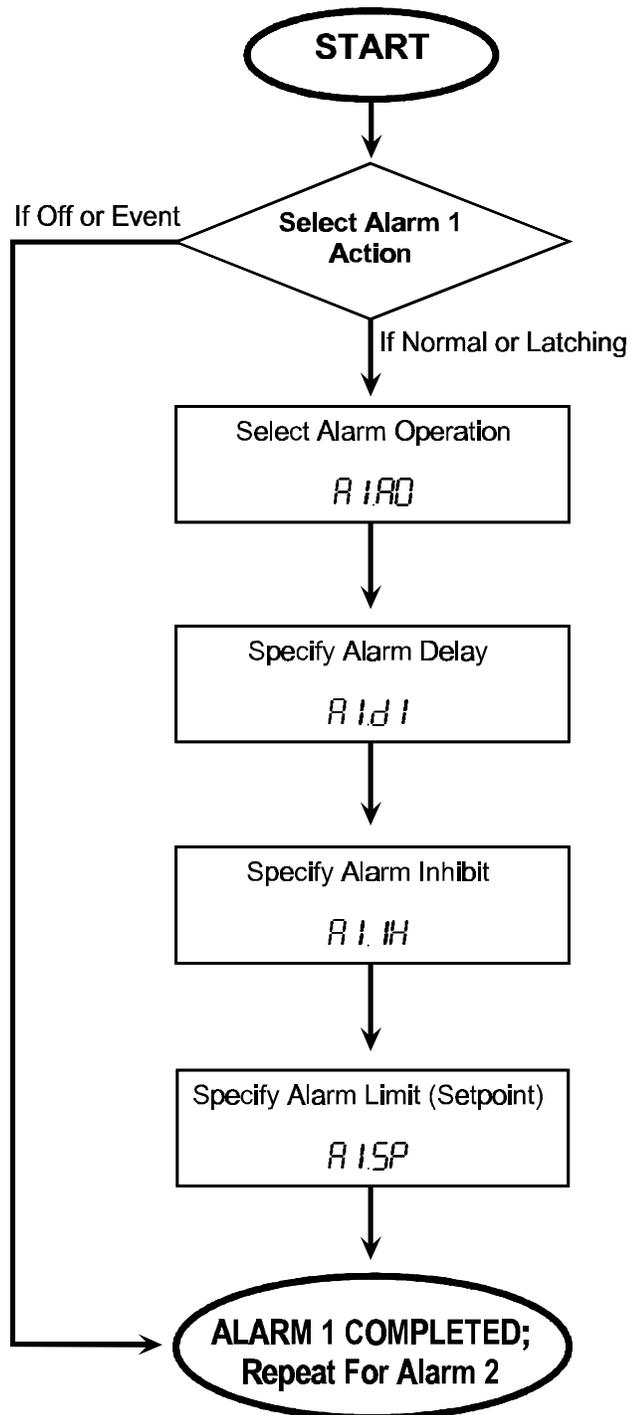
9.2   Configuring Alarm Parameters

9.2.1 Choosing the Alarm Action

The first step in configuring an alarm is to choose the alarm action. The choices are:

- OFF **(off)** – The alarm will not be used.

- nor **(normal)** – The LED will be lit (and the optional alarm output activated) when the process value triggers the alarm and be turned off when the alarm condition has been cleared.

- Lat **(latching)** – Once the LED is lit (and optional alarm output activated), the LED will remain lit (and the output will remain in the alarm state) until the operator presses the ▤ key, even if the alarm condition has cleared before the operator presses the key.

- Eunt **(event)** – This special use of an alarm LED (and optional alarm output) indicates that the controller has reached a particular point in a ramp/soak recipe. Setting the alarm action to "event" reserves the alarm for use by a ramp/soak recipe. However, the specific recipe event(s) that will trigger the alarm are configured using the r-S (ramp/soak) menu as described in 11.4.

Parameter Name:	**Alarm 1 Action** (C2) and **Alarm 2 Action**[32] (C8)
Name as Displayed:	A1.AA and A2.AA
Used By:	all except 1ZC
When Displayed:	always
Choices:	OFF off nor normal Lat latching Eunt event
Default:	off
Description:	Used to choose the function of the alarm.
Effect on Other Parameters:	If event is chosen, then no other alarm parameters are displayed, and the ramp event and soak event parameters as described in 11.4.are available for configuration.

---

[32] All the alarm 1 parameters are displayed before the alarm 2 action parameter is displayed.

9.2.2 Choosing the Alarm Operation

Unless the output will be used to signal ramp/soak recipe event, the second step in configuring an alarm is to choose the alarm operation. The choices are:

- **process alarm** – Activated when the process variable reaches the alarm value (alarm setpoint parameter value), independent of the PV's relationship to the process setpoint. A high process alarm activates at and above the alarm setpoint. A low process alarm activates at and below the alarm setpoint. For example, if you want an alarm to alert the operator when the PV goes up to 200, then configure the alarm as a high process alarm, and specify the alarm setpoint as 200.

- **deviation alarm** – Activated when the process variable deviates from the process setpoint by the amount specified using the alarm value (alarm setpoint parameter value). A high deviation alarm activates when the PV is above the process setpoint by the amount specified using the alarm value. A low deviation alarm activates when the PV is below the process setpoint by the amount specified using the alarm value. For example, if you want an alarm to alert the operator when the PV is 50 below the setpoint, then configure the alarm as a low deviation alarm, and specify the alarm value (using the alarm setpoint parameter) as 50.

- **inverse band alarm** – Activated when the process value is <u>within</u> a specified band centered around the setpoint. For example, if you want the alarm to alert the operator when the PV is 10 units (or less) above or below the process setpoint, then configure the alarm as an inverse band alarm, and specify 10 for the alarm setpoint parameter value.

- **normal band alarm** – Activated when the process value is <u>outside</u> a specified band centered around the setpoint. For example, if you want the alarm to alert the operator when the PV is 10 units (or more) above or below the process setpoint, then configure the alarm as a normal band alarm, and specify 10 for the alarm setpoint parameter value.

Parameter Name:	**Alarm 1 Operation** (C3) and **Alarm 2 Operation** (C9)
Name as Displayed:	A1.AO and A2.AO
Used By:	all except 1ZC
When Displayed:	if alarm action is not event
Choices:	Pro.L low process alarm Pro.H high process alarm in.b inverse band nor.b normal band de.L low deviation alarm de.H high deviation alarm
Default:	*alarm 1:* process high *alarm 2:* process low
Description:	Used to choose the alarm operation.
Effect on Other Parameters:	Determines how the value of the A1.SP or A2.SP (alarm setpoint) parameter is used.

9.2.3 Specifying the Alarm Delay – Optional

Unless the alarm will be used to signal ramp/soak recipe event, you can configure an alarm delay. If you specify an alarm delay, then when the controller detects an alarm condition, the alarm will not be activated until the alarm delay time has passed. Use the alarm delay to reduce nuisance alarms for transient conditions that are corrected without any operator action.

Parameter Name:	**Alarm 1 Delay** (C4) and **Alarm 2 Delay** (D0)
Name as Displayed:	A1.dL and A2.dL
Used By:	all except 1ZC
When Displayed:	if alarm action is not event
Range:	0 to 9999 seconds
Default:	0
Description:	Used to specify the number of seconds the controller should wait before signaling an alarm condition.

9.2.4 Inhibiting the Alarm– Optional

Unless the alarm will be used to signal a ramp/soak event, you can configure an inhibit time for the alarm. If you specify an alarm inhibit time, the controller will not activate the alarm following power up until the alarm inhibit time has elapsed. This is particularly useful for preventing activation of low alarms during startup (before the process has had time to reach operating temperature).

Parameter Name:	**Alarm 1 Inhibit** (C5) and **Alarm 2 Alarm Inhibit** (D1)
Name as Displayed:	A1.IH and A2.IH
Used By:	all except 1ZC
When Displayed:	if alarm action is not event
Range:	0 to 9999 seconds
Default:	0
Description:	Used to specify the number of seconds the controller should wait after power up before signaling an alarm condition.

9.2.5 Specifying the Alarm Value (Setpoint)

How the alarm setpoint value is used depends on the type of alarm.

- **process alarm** – activated when process value reaches the value specified with the alarm setpoint parameter

- **deviation alarm** – activated when process value differs from the process setpoint by the value specified with the alarm setpoint parameter

- **inverse band alarm** – activated when the PV is <u>inside</u> a band centered around the setpoint; the width of the band above and below the setpoint is specified with the alarm setpoint parameter

- **normal band alarm** – activated when the PV is <u>outside</u> a band centered around the setpoint; the width of the band above and below the setpoint is specified with the alarm setpoint parameter

Parameter Name:	**Alarm 1 Setpoint** and **Alarm 2 Setpoint** (See Note 2 below)
Name as Displayed:	A1.SP and A2.SP
Used By:	all except 1ZC
When Displayed:	if alarm action is not event
Range:	*RTD and thermocouple input types:* sensor low limit to sensor high limit *linear input types:* limited by the scaling defined for the input using the SCL.L and SCL.H parameters in the InP (input) menu (See Note 1 below.)
Default:	*process alarm:* 77 *deviation, inverse band, normal band:* 1728
Description:	Used to specify the alarm setpoint (process alarm), the alarm limit (deviation alarm), or the width of the alarm band (inverse and normal band alarms)

Note 1: The range is reduced when a linear input is used and the value of the dSPL (display) menu dEC.P (decimal position) parameter is not 0 (zero). See 4.3.2 for more information about the effect of a linear input on numerical ranges.

Note 2: The Athena Plus protocol code numbers used for these parameters depends on the alarm operation as shown in the table.

If alarm operation is:	Alarm 1 setpoint code is:	Alarm 2 setpoint code is:
process alarm	C6	D2
deviation alarm	C7	D3
inverse band	C7	D3
normal band	C7	D3

10. Autotune Damping Parameter – Recommended

10.1 Introduction

The 1ZC, 16C, 18C, and 25C controllers all support Autotune for PID control. The tunE (Autotune damping) menu contains a single parameter used to control how aggressively the controller performs its Autotuning operation.

The choices are:

- **low** – provides fastest recovery, but with the possibility of overshoot

- **high** – provides little or no overshoot, but with slower recovery

- **normal** – a compromise between fast recovery and overshoot

This menu is available only if at least one output is set to PID control. In addition, for this menu to be accessible, the security access level is set to USEr, (user), CnF9 (configuration) or FACt (factory).[33]

10.2 Configuring the Autotune Damping Parameter

Parameter Name:	**Autotune Damping** (39)
Name as Displayed:	dPnG
Used By:	all controllers
When Displayed:	The tune menu is displayed only if at least one output type is PID. If the menu is displayed, then this parameter is displayed.
Choices:	Lo low nL normal Hi high
Default:	normal
Description:	Used to choose how aggressively the controller performs Autotune.
Effect on Other Parameters:	Affects the automatic tuning implemented using the parameters in the control menu.

---

[33] The access level in all new 16C, 18C, and 25C controllers is set to CnF9 at the factory. If you cannot see the Autotune damping menu, the access level has been changed to a more restrictive level. Instructions for changing the access level are in Section 17.

11. Ramp/Soak Recipe Parameters – Optional

11.1 Introduction

The 1ZC, 16C, 18C, and 25C can all be configured to execute ramp/soak recipes on demand. A recipe consists of up to eight segments. For each segment you can configure a unique ramp time, soak level (setpoint), and soak time. As the controller executes a segment, the controller gradually (over the period of the ramp time) changes the currently used setpoint up or down until the setpoint reaches the soak level. During the duration of the soak time, the controller maintains the setpoint at the specified soak level. When the soak time has elapsed, the controller executes the next segment of the recipe.

If at least one front panel alarm was configured for "events", then you can activate and deactivate an alarm based on the recipe reaching particular events in its execution, such as the start of a numbered soak period.

If your process is not responsive enough to achieve the setpoint within the ramp time (or maintain the soak level for the entire soak time), you can use the recipe "holdback" parameter to "stop the clock" on the ramp time (and soak time) if the setpoint differs too much from the process value.

Execution of a recipe can be started, paused, resumed, and terminated using the front panel (or an optional contact/digital input) on the 16C, 18C, and 25C, or on any of the controllers (including the 1ZC) using the optional serial communications interface.

Alternatively, all these controllers can be configured to execute a single gradual ramp to setpoint at startup or on demand.

If both outputs are configured for use with alarms or turned off (using the output type parameters), then the ramp/soak menu will not be displayed. However, if at least one output is available for control, then the r-S (ramp/soak) menu will be available if the security access level is set to USEr, (user), CnF9 (configuration) or FACt (factory).[34]

---

[34] The access level in all new 16C, 18C, and 25C controllers is set to CnF9 at the factory. If you cannot see the ramp/soak menu, the access level has been changed to a more restrictive level. Instructions for changing the access level are in Section 17.

Item	Parameter Name	When Displayed
r.0pt	Recipe Option	always (assuming the menu is displayed because an output is available for control)
s.s.r.t	Single-Setpoint Ramp Time	if recipe option is single-setpoint ramp
HLd.b	Recipe Holdback	always
tEr.S	Recipe Termination State	always
rcY.n	Recipe Recycle Number	if recipe option is eight-segment r/s recipe
PF.rE	Resume from Power Failure	if recipe option is eight-segment r/s recipe
rt1	Ramp Time 1	if recipe option is eight-segment r/s recipe
rE1	Ramp Event 1	if recipe option is eight-segment r/s recipe and at least one alarm has been reserved for use by the ramp/soak function[35]
SL1	Soak Level 1	if recipe option is eight-segment r/s recipe
St1	Soak Time 1	if recipe option is eight-segment r/s recipe
sE1	Soak Event 1	if recipe option is eight-segment r/s recipe and at least one alarm has been reserved for use by the ramp/soak function
↓	↓	
rt8	Ramp Time 8	if recipe option is eight-segment r/s recipe
rE8	Ramp Event 8	if recipe option is eight-segment r/s recipe and at least one alarm has been reserved for use by the ramp/soak function
SL8	Soak Level 8	if recipe option is eight-segment r/s recipe
St8	Soak Time 8	if recipe option is eight-segment r/s recipe
SE8	Soak Event 8	if recipe option is eight-segment r/s recipe and at least one alarm has been reserved for use by the ramp/soak function

---

[35] Use the alarm 1 action and/or alarm 2 action in the alarm menu to reserve alarm(s) for use by the ramp/soak function.

The process of configuring the ramp/soak parameters is shown below.

```
                          ┌──────────┐
                          │  START   │
                          └────┬─────┘
                               │
                               ▼
                          ◇ r.OPt ◇
If disabled, no other ramp/soak ◄── Select Recipe ──► If single setpoint ramp
parameters are displayed.      Option
                               │
                         If eight segment
                         ramp/soak recipe
```

HLdb
Specify the holdback.

SSrt
Specify ramp time.

tErS
Select what happens at the
conclusion of recipe execution.

HLdb
Specify the holdback.

rcYn
Specify the additional number of times
the recipe will execute after the first.

tErS
Select what happens at the
end of the ramp time.

PFrE
Choose what will happen to an
active recipe after a power failure.

rt1
Specify the ramp time for first segment.

rE1
If an alarm has been reserved for recipe
use, choose what will happen to the
alarm at the start of ramp time.

SL1
Specify the setpoint for the first soak.

St1
Specify the duration of the first soak.

SE1
If an alarm has been reserved for recipe
use, choose what will happen to the
alarm at the start of soak time.

This pattern can repeat to a total of
eight recipe segments
(rt8, rE8, SL8, St8, SE8)
Each "segment" consists of a
numbered set of ramp time,
ramp event, soak level, soak time,
and soak event parameters.

11.2 Specifying the Recipe Option

Parameter Name:	Recipe Option (40)
Name as Displayed:	r.0pt
Used By:	all controllers
When Displayed:	if at least one output type is on/off or PID
Choices:	dis disabled
	8.r.S eight-segment ramp/soak recipe
	S.SP.r single-setpoint ramp
Default:	disabled
Description:	Used to choose the ramp/soak function (if any) to be used.
Effect on Other Parameters:	The choice made here affects what other parameters are displayed in the ramp/soak menu.

STOP

What's next after specifying the recipe option?

If you chose "disabled", go to Section 12 to configure the Supervisor menu parameters.
If you chose "single-setpoint ramp", go to 11.3.
If you chose "eight-segment ramp/soak recipe, go to 11.4.

11.3 Configuring Single-Setpoint Ramp Parameters

11.3.1 Specifying the Ramp Time for a Single-Setpoint Ramp

Parameter Name:	**Single-Setpoint Ramp Time** (41)
Name as Displayed:	S.S.r.t
Used By:	all controllers
When Displayed:	if the recipe option is single-setpoint ramp
Range:	1 to 9999 minutes
Default:	1
Description:	Used to specify the time period over which the setpoint will be ramped at start up from the starting process value to the configured setpoint.

11.3.2 Specifying the Optional Recipe Holdback for a Single Setpoint Ramp

Parameter Name:	**Recipe Holdback** (83)
Name as Displayed:	HLd.b
Used By:	all controllers
When Displayed:	always
Range:	*thermocouple and RTD input types:* off 0.1 to 100 °F 0.1 to 55.6 °C or °K *linear input types:* off 1 to 100 (See Note 1 below.)
Default:	10
Description:	Used to specify the maximum number of units that the controller will allow the setpoint to differ from the process value before "stopping the clock" on the ramp time. The controller will "hold back" the SV until the PV differs from the SV by no more than the holdback value.
Effect on Other Parameters:	When a holdback has been configured, the single-setpoint ramp time is used as a minimum ramp time.

Note 1: The range is reduced when a linear input is used and the value of the dSPL (display) menu dEC.P (decimal position) parameter is not 0 (zero). See 4.3.2 for more information about the effect of a linear input on numerical ranges.

11.3.3 Specifying What Happens at the Conclusion of the Single-Setpoint Ramp Time

Parameter Name:	**Termination State** (84)
Name as Displayed:	tEr.S
Used By:	all controllers
When Displayed:	always
Choices:	dEFt normal mode using default setpoint (setpoint displayed on front panel)
	LASt normal mode using last setpoint reached (same as default for single-setpoint ramp option)
	StbY put controller in standby mode
Default:	put controller in standby mode
Description:	Used to specify what happens at the conclusion of the ramp time.
Effect on Other Parameters:	No effect on other configuration parameters. Does affect setpoint and controller mode of operation. Applied only if the ramp is allowed to run to completion. If the operator terminates the ramp up to setpoint by changing the controller mode, the setpoint used will be the setpoint in effect when the operator changed the mode.

STOP

If you are using the single-setpoint ramp option, you are finished configuring the recipe parameters. The remainder of this section does not apply to the single-setpoint ramp option.

Go to Section 12 – Supervisor Parameters.

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11.4 Configuring Multi-Step Ramp/Soak Parameters

11.4.1 Introduction

When the eight-segment ramp/soak recipe option has been selected, several parameters can be configured that apply to the entire recipe. These include:

- recipe holdback that prevents the setpoint from getting too far ahead of the process value

- termination state that determines what happens when execution of the recipe has been completed

- recipe recycle number used to specify the number of additional times the recipe should be executed once started; this can also be use to set the recipe for continuous execution

- resume from power failure parameter which controls whether execution of a recipe is resumed after a power failure

After these parameters that apply to the entire recipe have been configured, you configure up to eight individual segments.[36] Each consists of a ramp time, a soak level (setpoint) and a soak time. In addition, if at least one alarm has been reserved for recipe event annunciation, you can specify that an available alarm will go on or off when a ramp time or soak time starts.

The following diagram shows the first few segments of a recipe and the configuration used to implement the segments.

---

[36] To configure fewer than eight segments, leave the values of all parameters associated with the un-needed segments set to OFF or zero.
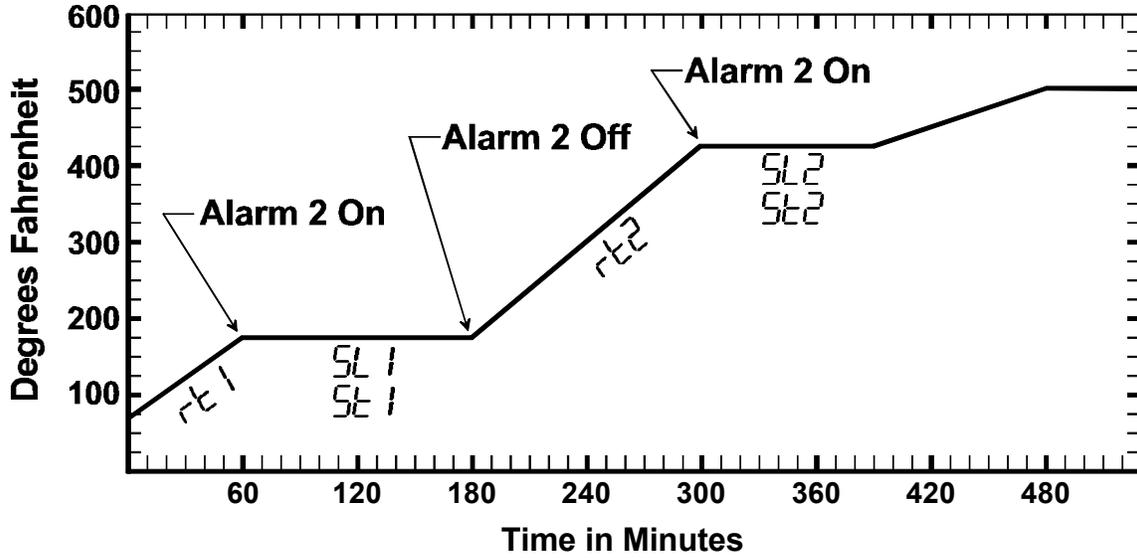
$$rt1 \ = \ 60 \qquad rt2 \ = \ 120$$
$$rE1 \ = \ d15 \qquad rE2 \ = \ A2OF$$
$$SL1 \ = \ 175 \qquad SL2 \ = \ 425$$
$$St1 \ = \ 120 \qquad St2 \ = \ 90$$
$$SE1 \ = \ A2On \qquad SE2 \ = \ A2On$$

11.4.2 Parameters That Apply to the Entire Multi-Step Ramp/Soak Recipe

11.4.2.1   Specifying the Optional Recipe Holdback

Parameter Name:	**Recipe Holdback** (83)
Name as Displayed:	HLd.b
Used By:	all controllers
When Displayed:	always
Range:	*thermocouple and RTD input types:* off 0.1 to 100 °F 0.1 to 55.6 °C or °K *linear input types:* off 1 to 100 (See Note 1 below.)
Default:	10
Description:	Used to specify the maximum number of units that the controller will allow the setpoint to differ from the process value before "stopping the clock" on the ramp time or soak time. The controller will "hold back" the SV until the PV differs from the SV by no more than the holdback value.
Effect on Other Parameters:	When a holdback has been configured, the ramp times and soak times are used as minimum times.

Note 1: The range is reduced when a linear input is used and the value of the dSPL (display) menu dEC.P (decimal position) parameter is not 0 (zero). See 4.3.2 for more information about the effect of a linear input on numerical ranges.

11.4.2.2   Specifying What Happens at the Conclusion of the Multi-Step Recipe Execution

Parameter Name:	**Termination State** (84)	
Name as Displayed:	tEr.S	
Used By:	all controllers	
When Displayed:	always	
Choices:	dEFt	normal mode using default setpoint (setpoint displayed on front panel)
	LASt	normal mode using last setpoint reached in the recipe
	StbY	put controller in standby mode
Default:	put controller in standby mode	
Description:	Used to specify what happens at the conclusion of the ramp time.	
Effect on Other Parameters:	No effect on other configuration parameters. Does affect setpoint and controller mode of operation. Applied only if the recipe runs to completion. If the operator terminates the recipe execution by changing the controller mode, the setpoint used will be the setpoint in effect when the operator changed the mode.	

11.4.2.3 **Specifying the Number of Additional Times the Multi-Step Recipe Will Repeat Once Started**

Parameter Name: **Recipe Recycle Number** (82)

Name as Displayed: rcY.n

Used By: all controllers

When Displayed: if the recipe option is eight-segment r/s recipe

Range: 0 to 99

cont   continuous (once the recipe has been started by an operator; recipe execution does not start automatically at power up)

Default: 0

Description: Used to specify the number of additional times the recipe will be executed once started. If set to zero, the recipe will execute once each time the operator starts it. If set to 1, the recipe will execute twice. If set to 2, the recipe will execute three times, etc.

11.4.2.4 **Specifying What Will Happen to the Multi-Step Recipe After a Power Failure**

Parameter Name: **Resume from Power Failure** (85)

Name as Displayed: Pf.rE

Used By: all controllers

When Displayed: if the recipe option is eight-segment r/s recipe

Choices: Off   off

On   on

Default: off

Description: Used to indicate whether the recipe execution should resume after a power failure. If this parameter is set to ON, then when power is restored, execution of the recipe will resume at the point reached before the power failure. If this parameter is set to OFF, execution of the recipe will not be resumed when power is restored. If the operator subsequently runs the recipe, execution will start with segment 1.

11.4.3 Configuring Individual Recipe Segments

11.4.3.1   Specifying the Ramp Time for Each Step of a Multi-Step Recipe

Parameter Name:	**Ramp Time 1**, **Ramp Time 2**, etc. through **Ramp Time 8** (42 through 49)
Name as Displayed:	rt1, rt2 through rt8
Used By:	all controllers
When Displayed:	if the recipe option is eight-segment r/s recipe
Range:	0 to 9999 minutes
Default:	0
Description:	Used to specify the length of the ramp time for each segment. Each segment can use a unique ramp time.
Effect on Other Parameters:	No effect on other configuration parameters. Does affect the setpoint used by the controller.

11.4.3.2   Linking a Ramp Period to an Alarm

Parameter Name:	**Ramp Event 1**, **Ramp Event 2** etc. through **Ramp Event 8** (50 through 57)
Name as Displayed:	rE1, rE2 through rE8
Used By:	all controllers
When Displayed:	if the recipe option is eight-segment r/s recipe, and at least one alarm is reserved for recipe events using the Alr (alarm) menu
Choices:	dis disabled A1.0n alarm 1 on *if alarm 1 is reserved for recipe use* A1.0F alarm 1 off *if alarm 1 is reserved for recipe use* A2.0n alarm 2 on *if alarm 2 is reserved for recipe use* A2.0F alarm 2 off *if alarm 2 is reserved for recipe use*
Default:	disabled
Description:	Used to link the chosen alarm action with the start of the ramp time with the same segment number.

11.4.3.3 **Specifying the Setpoint for Each Soak in a Multi-Step Recipe**

Parameter Name:	**Soak Level 1**, **Soak Level 2** etc. through **Soak Level 8** (58 though 65)
Name as Displayed:	SL1, SL2 through SL8
Used By:	all controllers
When Displayed:	if the recipe option is eight-segment r/s recipe
Range:	SPL.L to SPH.L (setpoint low limit to setpoint high limit from input menu) (See Note 1 below.)
Default:	77
Description:	Used to specify the setpoint for the soak for each segment. Each segment can use a unique soak level.
Effect on Other Parameters:	No effect on other configuration parameters. Does affect the setpoint used by the controller.

Note 1: The range is reduced if the value of the dSPL (display) menu dEC.P (decimal position) parameter is not 0 (zero). See 4.3.2 for more information about the effect of a linear input on numerical ranges.

11.4.3.4 **Specifying the Length of Each Soak in a Multi-Step Recipe**

Parameter Name:	**Soak Time 1**, **Soak Time 2** through **Soak Time 8** (66 through 73)
Name as Displayed:	St1, St2 through St8
Used By:	all controllers
When Displayed:	if the recipe option is eight-segment r/s recipe
Range:	0 to 9999 minutes
Default:	0
Description:	Used to specify the length of the soak time for each segment. Each segment can use a unique soak time.

11.4.3.5   **Linking a Soak Period to an Alarm**

Parameter Name:	**Soak Event 1**, **Soak Event 2** etc. through **Soak Event 8** (74 through 81)
Name as Displayed:	SE1, SE2 through SE8
Used By:	all controllers
When Displayed:	if the recipe option is eight-segment r/s recipe, and at least one alarm is reserved for recipe use using the AI r (alarm) menu
Choices:	dis disabled A1.0n alarm 1 on *if alarm 1 is reserved for recipe use* A1.0F alarm 1 off *if alarm 1 is reserved for recipe use* A2.0n alarm 2 on *if alarm 2 is reserved for recipe use* A2.0F alarm 2 off *if alarm 2 is reserved for recipe use*
Default:	disabled
Description:	Used to link the chosen alarm action with the start of the soak time with the same segment number.

12. Supervisor Parameters – Recommended

12.1 Introduction

You can use the SUPr (supervisor) menu to specify the output percentages to be used if the controller detects a problem with the process input (failsafe values), and the length of the time period during which the input should change in response to output action if the input is working normally (loop break time).

You can also use this menu to see the highest and lowest process value received by the controller since the controller was powered up.

The supervisor menu can also be used to set the values of all the configuration parameters back to their factory defaults in 16C, 18C, and 25C models. The calibration of the controller will not be affected when the defaults are set back to their factory defaults.

The supervisor menu is available only when the security access level is set to CnF9 (configuration) or FACt (factory).[37]

Item	Parameter Name	When Displayed
FS.01	Output 1 Failsafe Output Percentage	if output 1 type is PID or on/off
FS.02	Output 2 Failsafe Output Percentage	if output 2 type is PID or on/off
L.br.t	Loop Break Time	always
HI.rd	Highest Reading	always
L0.rd	Lowest Reading	always
Ld.dp	Load Default Parameter Values	always

---

[37] The access level in all new 16C, 18C, and 25C controllers is set to CnF9 at the factory. If you cannot see the supervisor menu, the access level has been changed to a more restrictive level. Instructions for changing the access level are in Section 17.

12.2 Specifying What Happens When an Input Is Bad

The failsafe output percentages are used when the controller detects a problem with the input: open sensor, reversed sensor, or loop break time exceeded. You cannot rely on the controller using these output percentages if the controller's internal circuitry fails.

Parameter Name:	**Output 1 Failsafe Output Percentage** (E1) and **Output 2 Failsafe Output Percentage** (E2)
Name as Displayed:	FS.01 and FS.02
Used By:	all controllers
When Displayed:	if output type is PID or on/off
Range:	0 to 100% (output high limits 01.HL and 02.HL are ignored when the controller is in the failsafe state)
Default:	0
Description:	Used to specify the fixed output percentage the controller will use if it detects a problem with the input.

12.3 Defining the Loop Break Time

The loop break time parameter is used to specify the length of the time period during which the input should change in response to output action if the input is working normally. The controller will use this loop break time as a criterion for going into failsafe state and sending the outputs to the failsafe output percentages.

Parameter Name:	Loop Break Time (E3)
Name as Displayed:	L.br.t
Used By:	all controllers
When Displayed:	always
Range:	off, 4 to 9600 seconds
Default:	off
Description:	Used to specify the time period during which the input should change in response to output action if the input sensor is working correctly.

12.4 Viewing the Highest and Lowest Process Value Received Since Last Reset

The highest and lowest process values received since the last reset are read-only values. To reset the values, press the ▲ or ▼ key.

Parameter Name:	**Highest Reading** (E4) and **Lowest Reading** (E5)
Name as Displayed:	HI.rd and L0.rd
Used By:	all controllers
When Displayed:	always
Range:	*RTD and thermocouple input types:* sensor low limit to sensor high limit *linear input types:* limited by the scaling defined for the input using the SCL.L and SCL.H parameters in the InP (input) menu
Default:	*highest reading:* –3566 *lowest reading:* 18030
Description:	Used to view read-only values that are the highest and lowest process values received by the controller since the values were reset.

12.5 Resetting All Parameters to the Defaults

Using this function returns <u>all</u> configuration parameter values to their defaults in 16C, 18C, and 25C controllers. There is no parallel function in the 1ZC controller.

Parameter Name:	**Load Default Parameter Values** (see Note 1 below)
Name as Displayed:	Ld.dP
Used By:	all except 1ZC
When Displayed:	always
	yes loads all the defaults no does not load the defaults **Beware!** If you press the ▲ or ▼ key while LddP is on display, regardless of whether it is alternating with no or yES, the default values will be written to all configuration parameters. The display will show dflt on the top line and L0Ad on the lower line. After a second, the display will change to L0Ad done. At this point, all the parameters have been set back to the defaults. Press the ☰ or ↺ key to clear the Load done display and to begin to reconfigure the controller.
Default:	n/a
Description:	Used to reset all configuration parameters to their default values.
Effect on Other Parameters:	Resets all configuration parameters to their default values. (The calibration of the controller will not be affected when the defaults are set back to their factory defaults.)

Note 1: There is no parameter ID designation for this parameter in the Athena Plus protocol. The Athena Plus protocol uses a special function to reset parameter values.

13. Calibration Function – Not Required for Configuration

13.1 Introduction

The CaL (calibration) menu does not contain configuration parameters. Instead it is used to display the values for which a simulated input should be applied to the controller input terminals during calibration of the zero offset (CALo) and the span adjustment (CAHi). It is also used to initiate the calibration operation after the controller has been prepared as described in Section 18.

Read Section 18 before trying to calibrate the controller.

The calibration menu is available only when the security access level is set to FACt (factory).[38]

13.2 Calibration Is Not Usually Required

You do not have to calibrate every new controller. When a controller was ordered, you specified an input type for which the unit was calibrated at the factory. This is not the specific type chosen with the input menu tYPE (type) parameter, such as J thermocouple, or 0 to 20 mA linear. In the context of ordering the controller, "type" refers to these choices:

- RTD
- compressed RTD
- thermocouple
- millivolt linear
- volt linear
- current linear input

The controller was calibrated at the factory for the type of input specified. If you use the controller with a different type of input, you must recalibrate as described in Section 18 unless you ordered the "Calibrate All" input option.[39]

For example, if you specified when you ordered the controller that you planned to use a thermocouple as the sensor, then you can use the input menu tYPE (type) parameter to choose any thermocouple type: B, C, E, J, K, N, NNM, R, S, T, or Platinel II. The controller will be calibrated appropriately at the factory. However, if you ordered thermocouple calibration, but decide to use the controller with an RTD sensor, then you should recalibrate before using the controller.

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[38] The access level in all new 16C, 18C, and 25C controllers is set to CnF9 at the factory. Instructions for changing the access level are in Section 17.

[39] To determine whether the controller in hand was calibrated at the factory for all input types, check the model number on the label on the controller. The meaning of each character in the model number is in the installation manual supplied with the controller.

13.3 Menu Items

Parameter Name: **Calibration Low** (see Note 1 below)

Name as Displayed: CALo

Used By: all

When Displayed: always

Description: Displays the temperature input value that should be simulated during low calibration.

Beware! Pressing the ▲ or ▼ key while this is on display will clear the controller's existing zero offset and initiate the low calibration, even if you have not prepared the controller as described in Section 18. <u>If the controller has not been prepared correctly before you initiate calibration, the resulting calibration will be invalid</u>.

Parameter Name: **Calibration High** (see Note 1 below)

Name as Displayed: CAHi

Used By: all

When Displayed: always

Description: Displays the temperature input value that should be simulated during high calibration.

Beware! Pressing the ▲ or ▼ key while this is on display will clear the controller's existing span adjustment and initiate the high calibration, even if you have not prepared the controller as described in Section 18. <u>If the controller has not been prepared correctly before you initiate calibration, the resulting calibration will be invalid</u>.

Note 1: The Athena Plus protocol does not permit you to read this value.

14. Option Parameters – Required if Using Options

14.1 Introduction

Every 1ZC controller supports RS-485 serial communications. The 16C, 18C, and 25C models can support a variety of options, including serial communications. The available options are described briefly below. Use of most of these options requires that you configure a few parameters. These parameters are arranged in menus, one for each option.

However, the menu for a specific option is not displayed unless the `Card` parameter in the `Optn` (option) menu has been used to specify correctly the type of options supported. The `Optn` (option) menu `Card` parameter is configured at the factory. However, if you use the procedure in 12.5 to load all parameter defaults, then you must use the front panel of the controller to configure the `Card` parameter in the `Optn` (option) menu. This prepares the controller to receive the appropriate option parameter values. The only exception is in the case of an 18C or 25C equipped with only the serial communication option. The 18C and 25C models are always ready to receive serial communication parameter values.

The options menus are available if the security access level is set to `CnF9` (configuration) or `FACt` (factory).[40]

14.2 Options Supported

Every 1ZC controller supports RS-485 serial communications. Two communication protocols are supported, MODBUS and Athena Plus protocol, each with its own firmware on the processor board and its own configuration menu (see 14.5 and 14.6). The 16C, 18C, and 25C can also all be equipped with optional RS-232 or RS-485 serial communications hardware, and the appropriate communication firmware for Athena Plus protocol (RS-232 and RS-485) or MODBUS (RS-485 only).

Other options are also available for the 16C, 18C, and 25C.

- Two alarm outputs are available; the action of these outputs follows the action of the A1 and A2 front panel LEDs and are configured using the `ALr` menu (see Section 9).

---

[40] The access level in all new 16C, 18C, and 25C controllers is set to `CnF9` at the factory. If you cannot see the option menus, the access level has been changed to a more restrictive level. Instructions for changing the access level are in Section 17.

- A contact/digital input can be used to trigger use of a second setpoint (see 1.6.4), or to toggle the controller's mode from normal to standby, or to toggle between running and holding a ramp/soak recipe. The function of this input is selected using the C-dI (contact/digital input) menu (see 14.8). For the 16C the contact/digital input card is available with one dedicated alarm relay. The alarm action is configured using the AIr (alarm) menu

- An auxiliary analog output can be used to transmit the setpoint or the process value. The function of this output is selected using the Aout (auxiliary output) menu (see 14.7).

- A remote analog setpoint input can be used to provide the controller with a setpoint from an external device.[41] This input is scaled using the parameters in the rAS (remote analog setpoint) menu (see 14.9).

- A transducer excitation option is available to provide power to remote transducers. There are no configuration parameters associated with use of the transducer excitation output.

To see what options the controller in hand supports, compare the model number on the controller's label with the model number breakdown in the installation manual supplied with the controller.

---

[41] Use of the Remote Analog Setpoint is turned on and off by means of a contact on the RAS option card.

14.3 Summary of Option Parameters

Item	Parameter Name	When Displayed
`Optn` **(option) menu; see 14.4**		
`Card`	Installed Option Card	always; the choice made here determines the other option menus that are displayed. The choices available in the option menu depend on the controller model.
		`none` none
		`d.In` digital input
		`dI.AL` digital input with alarm
		`ALr` alarm
		`A.Out` auxiliary analog output
		`rAS` remote analog setpoint
		`Sc.dI` serial communications with contact/digital input
		`SerL` serial communications
`SerL` **(serial) menu for RS-232 or RS-485 Athena Plus protocol; see 14.6**		
`Idno`	Controller ID Number	This menu is displayed if you chose `SerL` as the card type and the communication firmware supports the Athena Plus protocol. If the menu is displayed, then all the parameters shown here are included.
`bAUd`	Baud Rate	
`dAtF`	Data Format	
`trdL`	Transmission Delay	
`SerL` **(serial) menu for MODBUS protocol; see 14.5**		
`Idno`	Controller ID Number	This menu is displayed if you chose `SerL` as the card type and the communication firmware supports the MODBUS protocol. If the menu is displayed, then all the parameters shown here are included.
`bAUd`	Baud Rate	
`Par`	Parity	
`nn0d`	MODBUS IEEE Register Ordering	

Item	Parameter Name	When Displayed
a.out (auxiliary output) menu; see 14.7		
Out.U	Auxiliary Output Variable	This menu is displayed if you chose Aout as the card type. If the menu is displayed, then all the parameters shown here are included.
SCL.L	Auxiliary Output Scale Low	
SCL.H	Auxiliary Output Scale High	
C-dI (contact/digital input) menu; see 14.8		
Func	Contact/Digital Input Function	This menu is displayed if you chose dIAL or Sc.dI or dIn as the card type.
rAS (remote analog setpoint) menu; see 14.9		
SCL.L	Remote Analog Setpoint Scale Low	This menu is displayed if you chose rAS as the card type. If the menu is displayed, then both the parameters shown here are included.
SCL.H	Remote Analog Setpoint Scale High	
ALr (alarm) menu; see Section 9		
A1.AA	Alarm 1 Action	This menu is always displayed for configuration of the action of the A1 and A2 front panel LEDs. Two alarm outputs are available as an option. The action of the optional alarm outputs follows the action of the A1 and A2 front panel LEDs and is configured using the ALr menu (see Section 9).
A1.A0	Alarm 1 Operation	
A1.dI	Alarm 1 Delay	
A1.IH	Alarm 1 Inhibit	
A1.SP	Alarm 1 Setpoint	
A2.AA	Alarm 2 Action	
A2.A0	Alarm 2 Operation	
A2.dI	Alarm 2 Delay	
A2.IH	Alarm 2 Inhibit	
A2.SP	Alarm 2 Setpoint	

14.4 Specifying the Option Card

Parameter Name:	**Installed Option Card** (E8)
Name as Displayed:	Card
Used By:	all except 1ZC
When Displayed:	always

Choices:

none	none
dI.AL	contact/digital input with alarm
ALr	alarm
A.Out	auxiliary output
rAS	remote analog setpoint
Sc.dI	serial communications with digital input
SErL	serial communications

Default:	*1ZC, 18C, 25C:* none
	16C: serial communications
Description:	Used to choose the option menus to be displayed.
Effect on Other Parameters:	Determines the individual option menus that are displayed.

What's next after specifying the option card?

If you chose "none" for the option card, and you are using PID control, go to Section 16 for tuning.

If you chose "none" for the option card, and you are using on/off control, go to Section 17 for restricting access.

If you chose "serial" for the option card, and the controller supports MODBUS, go to 14.5.

If you chose "serial" for the option card, and the controller supports Athena Plus Protocol, go to 14.6.

If you chose "serial with digital input" for the option card, go to 14.6 and 14.8.

If you chose "auxiliary analog output" for the option card, go to 14.7.

If you chose "contact/digital input with alarm for the option card, go to 14.8 and Section 9.

If you chose "alarm" and have not configured the alarms, go to Section 9.

If you chose "remote analog setpoint", go to 14.9.

14.5 Configuring Serial Communications Parameters for MODBUS

14.5.1 Introduction

The items that appear on the Serᴸ (serial) menu in controllers that support MODBUS are different from the Serᴸ menu items displayed if the controller supports Athena Plus Protocol. The MODBUS communication parameters presented briefly below are described in more detail in *Using the MODBUS Protocol with Athena Series C (1ZC, 16C, 18C, and 25C) Controllers.* We recommend that you consult that manual before setting up your MODBUS network and configuring these communication parameters.

14.5.2 Assigning a Unique Controller Address When MODBUS is Used

Parameter Name:	**Controller ID Number** (D5)
Name as Displayed:	Id.no
Used By:	all except 1ZC (See Note 1 below.)
When Displayed:	if the card type is serial
Range:	1 to 247
Default:	1
Description:	Used to assign a unique address to each controller on the MODBUS network.

Note 1: The address for a 1ZC controller is set using DIP switches as described in the manual provided with the controller.

14.5.3 Selecting the Baud Rate Applicable to MODBUS Communications

Parameter Name:	**Baud Rate** (D6)
Name as Displayed:	baUd
Used By:	all
When Displayed:	if the card type is serial
Choices:	300 600 1200 2400 4800 9600
Default:	9600 (MODBUS only)
Description:	Used to select the baud rate.

14.5.4 Selecting the Parity When MODBUS is Used

Parameter Name:	**Parity** (see Note 1 below)
Name as Displayed:	Par
Used By:	all
When Displayed:	if the card type is serial and the communication firmware supports the MODBUS protocol
Choices:	none none
	0dd odd
	euen even
	(see Note 2 below)
Default:	none
Description:	Used to select the type of parity to be used, if any.

Note 1: Because parity for Athena Plus protocol is included in the data format parameter (D7), this parity parameter has no Athena Plus identification code.

Note 2: Regardless of the parity selected, a Series C controller that supports MODBUS protocol always uses 1 start bit, 8 data bits, and 1 stop bit.

14.5.5 Selecting the Sequence for 32-bit IEEE Registers When MODBUS Is Used

Parameter Name:	**MODBUS IEEE Register Ordering**
Name as Displayed:	nn0d
Used By:	all
When Displayed:	if the card type is serial and the communication firmware supports the MODBUS protocol
Choices:	YES MODBUS standard ordering: low register before high
	no non-standard ordering: high register before low
Default:	yes
Description:	Used to choose whether the two registers that make up a single 32-bit IEEE floating point value are transmitted in standard MODBUS sequence (low before high), or not in standard sequence (high before low)

> **STOP**
>
> **If you are configuring MODBUS serial communications, you have finished configuring the communication parameters. The remainder of this section does not apply to your application**
>
> **If you are using PID control, go to Section 16 for tuning.**
>
> **If you are using on/off control, go to Section 17 for restricting access.**

14.6 Configuring Serial Communication Parameters for Athena Plus Protocol

14.6.1 Introduction

The items that appear on the $SerL$ (serial) menu in controllers that support Athena Plus protocol are different from the $SerL$ menu items displayed if the controller supports the MODBUS protocol. The *Multi-Comm User's Guide* contains more information about configuring a controller to communicate with the Multi-Comm host over an RS-232 or RS-485 network. <u>We recommend that you consult that manual before setting up your Multi-Comm network and configuring these communication parameters</u>.

14.6.2 Assigning a Unique Controller Address When Athena Plus is Used

Parameter Name:	Controller ID Number (D5)
Name as Displayed:	Id.no
Used By:	all except 1ZC (See Note 1 below.)
When Displayed:	if the card type is serial
Range:	1 to 255
Default:	1
Description:	Used to assign a unique address to each controller on the RS-485 network. (RS-232 communication is one-to-one, so the default address 1 is always OK for RS-232 controllers.)

Note 1: The address for a 1ZC controller is set using DIP switches as described in the manual provided with the controller.

14.6.3 Selecting the Baud Rate Applicable to Athena Plus Communications

Parameter Name:	**Baud Rate** (D6)
Name as Displayed:	baUd
Used By:	all
When Displayed:	if the card type is serial
Choices:	300 600 1200 2400 4800 9600
Default:	*16C, 18C, 25C:* 9600 *1ZC:* 2400
Description:	Used to select the baud rate.

14.6.4 Selecting the Number of Data Bits and Stop Bits, and the Parity Applicable to Athena Plus Communications

Parameter Name:	**Data Format** (D7)
Name as Displayed:	dat.F
Used By:	all
When Displayed:	if the card type is serial and the communication firmware supports the Athena Plus protocol
Choices:	8.n.1 8 data bits, no parity, 1 stop bit
	7.E.2 7 data bits, even parity, 2 stop bits
	7.o.2 7 data bits, odd parity, 2 stop bits
	7.n.2 7 data bits, no parity, 2 stop bits
	7.E.1 7 data bits, even parity, 1 stop bit
	7.o.1 7 data bits, odd parity, 1 stop bit
	8.n.2 8 data bits, no parity, 2 stop bits
	8.E.1 8 data bits, even parity, 1 stop bit
	8.o.1 8 data bits, odd parity, 1 stop bit
	(See Note 1 below.)
Default:	8 data bits, no parity, 1 stop bit
Description:	Used to select the serial data format.

Note 1: Regardless of the selection made here, a Series C controller with communication firmware that supports Athena Plus protocol always uses 1 start bit.

14.6.5 Transmission Delay When Athena Plus is Used

Parameter Name:	**Transmission Delay** (D8)
Name as Displayed:	tr.dL
Used By:	all
When Displayed:	if the card type is serial and the communication firmware supports the Athena Plus protocol
Range:	*not used*
Default:	*n/a*
Description:	*not used*

STOP

If you are configuring Athena Plus Protocol serial communications, you have finished configuring the communication parameters.

If you chose "serial with digital input" for the option card, go to 14.8.

If you are using PID control, go to Section 16 for tuning.

If you are using on/off control, go to Section 17 for restricting access.

14.7 Configuring Auxiliary Output Parameters

14.7.1 Introduction

If the card type is A.Out, then the A.Out menu is displayed.

14.7.2 Selecting the Value to be Transmitted

Parameter Name:	**Auxiliary Output Variable** (G1)
Name as Displayed:	Out.U
Used By:	all except 1ZC
When Displayed:	if the card type is auxiliary analog output
Choices:	St.Pt setpoint
	Proc process value
Default:	process value
Description:	Used to choose the value to be transmitted by the auxiliary analog output.

14.7.3 Scaling the Auxiliary Analog Output

Parameter Name:	**Auxiliary Output Scale Low** (G2) and **Auxiliary Output Scale High** (G3)
Name as Displayed:	SCL.L and SCL.H
Used By:	all except 1ZC
When Displayed:	if the card type is auxiliary analog output
Range:	*RTD and thermocouple input types:* sensor low limit to sensor high limit
	linear input types: limited by the scaling defined for the input using the SCL.L and SCL.H parameters in the InP (input) menu (See Note 1 below.)
Default:	*scale low:* –328
	scale high: 1400
Description:	Used to specify the PV or SV represented by the lowest (SCL.L) and highest (SCL.H) possible auxiliary analog output signal.

Note 1: The range is reduced when a linear input is used and the value of the dSPL (display) menu dEC.P (decimal position) parameter is not 0 (zero). See 4.3.2 for more information about the effect of a linear input on numerical ranges.

14.8 Configuring the Contact/Digital Input Parameter

14.8.1 Introduction

If the card type is SC.dI or di.aL, then the C-dL (contact/digital input) menu is displayed. It contains a single parameter, which is described below.

14.8.2 Selecting Contact/Digital Input Function

Parameter Name:	**Contact/Digital Input Function** (G7)
Name as Displayed:	Func
Used By:	all except 1ZC
When Displayed:	if the card type is contact/digital with alarm, or serial communications with contact/digital switch
Choices:	dIS disabled rS.rH toggle between ramp/soak recipe run and hold StbY toggle between standby and normal (automatic mode) S.SP.S enable use of second setpoint
Default:	disabled
Description:	Used to select the action that will result from activating/deactivating the contact/digital input switch.

You have finished configuration of the contact/digital input option parameter.

If you are using PID control, go to Section 16 for tuning.

If you are using on/off control, go to Section 17 for restricting access.

14.9 Configuring the Remote Analog Setpoint Parameters

14.9.1 Introduction

If the card type is rAS, then the rAS (remote analog setpoint) menu is displayed. It contains two parameters, which are described below.

14.9.2 Scaling the Input for the Remote Analog Setpoint

Parameter Name:	**Remote Analog Setpoint Scale Low** (G5) and **Remote Analog Setpoint Scale High** (G6)
Name as Displayed:	SCL.L and SCL.H
Used By:	all except 1ZC
When Displayed:	if the card type is remote analog setpoint
Range:	−1999 to 9999 (See Note 1 below.)
Default:	*scale low:* −1999 *scale high:* 9999
Description:	Used to specify the SV represented by the lowest (SCL.L) and highest (SCL.H) possible remote analog input signal.

Note 1: The range is reduced when a linear input is used and the value of the dSPL (display) menu dEC.P (decimal position) parameter is not 0 (zero). See 4.3.2 for more information about the effect of a linear input on numerical ranges.

15. Numbers Used to Identify Parameters in Multi-Comm Messages and Athena Plus Protocol

STOP **Skip this section if you are configuring a 16C, 18C, or 25C controller using its front panel (or using a MODBUS host). The information in this section does not apply to your situation. The table below is provided for users of Multi-Comm software and other custom applications that take advantage of the Athena Plus communication protocol.**

The table below lists all the configuration parameters and the Athena Plus protocol identification code for each. It also contains setpoint and status values that can be read by applications that are compatible with the Athena Plus protocol, such as the Athena Multi-Comm application.

The "used by" column shows which of the Series C controllers can use the parameter. "All" means 1ZC, 16C, 18C, and 25C. However, even if a parameter can be used by a controller model, the parameter may not apply to every control strategy. See the descriptions of the parameters in Sections 5 through 14 for information about applicability.

Code	Parameter Name	Used By	Read/Write	Where Described
1	Controller Type	all	R	*See Note 1.*
2	Software Version	all	R	*See Note 1.*
3	Communications Firmware Version	all	R	*See Note 1.*
4	Status Byte	all	R	*See Note 1.*
5	Process Value	all	R	*See Note 1.*
6	Operating Mode	all	R/W	2.4
7	Access Level	all except 1ZC	R/W	17
8	Contact/Digital Input State	all except 1ZC	R	*See Note 1.*
9	Setpoint – RAM and EEPROM	all	R/W	1.6
10	Setpoint – RAM only	all	R/W	1.6

Code	Parameter Name	Used By	Read/Write	Where Described
11	Second Setpoint – RAM and EEPROM	all except 1ZC	R/W	1.6
12	Second Setpoint – RAM only	all except 1ZC	R/W	1.6
13	Remote Analog Setpoint	all except 1ZC	R	1.6
14	Recipe Setpoint	all	R	1.6.
16	Output 1 Percentage	all	R	*See Note 1.*
17	Output 2 Percentage	all	R	*See Note 1.*
18	Output 1 Manual Mode Fixed Output Percentage	all	R/W	2.4.5
19	Output 2 Manual Mode Fixed Output Percentage	all	R/W	2.4.5
20	Output 1 Deadband	all	R/W	8.2.2
21	Output 1 Hysteresis	all	R/W	8.2.3
22	Output 1 Proportional Band	all	R/W	8.3.2
23	Output 2 Proportional Band	all	R/W	8.3.2
30	Rate/Derivative Action	all	R/W	8.3.3
32	Automatic Reset Integral Action	all	R/W	8.3.5
34	Manual Reset Integral Action	all	R/W	8.3.4
37	Output 2 Deadband	all	R/W	8.2.2
38	Output 2 Hysteresis	all	R/W	8.2.3
39	Autotune Damping	all	R/W	10.2
40	Recipe Option	all	R/W	11.2
41	Single-Setpoint Ramp Time	all	R/W	11.3.1
42	Ramp Time 1	all	R/W	11.4.3.1
43	Ramp Time 2	all	R/W	11.4.3.1
44	Ramp Time 3	all	R/W	11.4.3.1
45	Ramp Time 4	all	R/W	11.4.3.1
46	Ramp Time 5	all	R/W	11.4.3.1
47	Ramp Time 6	all	R/W	11.4.3.1
48	Ramp Time 7	all	R/W	11.4.3.1
49	Ramp Time 8	all	R/W	11.4.3.1
50	Ramp Event 1	all except 1ZC	R/W	11.4.3.2
51	Ramp Event 2	all except 1ZC	R/W	11.4.3.2
52	Ramp Event 3	all except 1ZC	R/W	11.4.3.2

Code	Parameter Name	Used By	Read/Write	Where Described
53	Ramp Event 4	all except 1ZC	R/W	11.4.3.2
54	Ramp Event 5	all except 1ZC	R/W	11.4.3.2
55	Ramp Event 6	all except 1ZC	R/W	11.4.3.2
56	Ramp Event 7	all except 1ZC	R/W	11.4.3.2
57	Ramp Event 8	all except 1ZC	R/W	11.4.3.2
58	Soak Level 1	all	R/W	11.4.3.3
59	Soak Level 2	all	R/W	11.4.3.3
60	Soak Level 3	all	R/W	11.4.3.3
61	Soak Level 4	all	R/W	11.4.3.3
62	Soak Level 5	all	R/W	11.4.3.3
63	Soak Level 6	all	R/W	11.4.3.3
64	Soak Level 7	all	R/W	11.4.3.3
65	Soak Level 8	all	R/W	11.4.3.3
66	Soak Time 1	all	R/W	11.4.3.4
67	Soak Time 2	all	R/W	11.4.3.4
68	Soak Time 3	all	R/W	11.4.3.4
69	Soak Time 4	all	R/W	11.4.3.4
70	Soak Time 5	all	R/W	11.4.3.4
71	Soak Time 6	all	R/W	11.4.3.4
72	Soak Time 7	all	R/W	11.4.3.4
73	Soak Time 8	all	R/W	11.4.3.4
74	Soak Event 1	all except 1ZC	R/W	11.4.3.5
75	Soak Event 2	all except 1ZC	R/W	11.4.3.5
76	Soak Event 3	all except 1ZC	R/W	11.4.3.5
77	Soak Event 4	all except 1ZC	R/W	11.4.3.5
78	Soak Event 5	all except 1ZC	R/W	11.4.3.5
79	Soak Event 6	all except 1ZC	R/W	11.4.3.5
80	Soak Event 7	all except 1ZC	R/W	11.4.3.5

Code	Parameter Name	Used By	Read/Write	Where Described
81	Soak Event 8	all except 1ZC	R/W	11.4.3.5
82	Recipe Recycle Number	all	R/W	11.4.2.3
83	Recipe Holdback Band	all	R/W	11.3.2
84	Recipe Termination State	all	R/W	11.4.2.2
85	Recipe Resume After Power Failure	all	R/W	11.4.2.4
86	Input Bias	all	R/W	5.6.1 and 5.7.1
87	Input Low Scale	all	R/W	5.7.2
88	Input High Scale	all	R/W	5.7.2
89	Setpoint Low Limit	all	R/W	5.6.2 and 0
90	Setpoint High Limit	all	R/W	5.6.2 and 0
91	Input Filter	all	R/W	5.6.3 and 5.7.4
92	Input Type	all	R/W	5.5
94	Output 1 Type	all	R/W	7.2
95	Output 1 Control Action	all	R/W	7.3 and 7.4.1
96	Output 1 Alarm Action	1ZC, 16C	R/W	7.5.1
97	Output 1 Alarm Operation	1ZC, 16C	R/W	7.5.2
98	Output 1 Alarm Delay	1ZC, 16C	R/W	7.5.3
99	Output 1 Alarm Inhibit	1ZC, 16C	R/W	7.5.4
A0	Output 1 Process Alarm Setpoint	1ZC, 16C	R/W	7.5.5
A1	Output 1 Deviation, Normal Band, Inverse Band Alarm Setpoint	1ZC, 16C	R/W	7.5.5
A2	Output 1 Cycle Time	all	R/W	7.4.2
A3	Output 1 Low Limit	all	R/W	7.4.3
A4	Output 1 High Limit	all	R/W	7.4.3
A5	Output 2 Type	all	R/W	7.2
A6	Output 2 Control Action	all	R/W	7.3 and 7.4.1
A7	Output 2 Alarm Action	1ZC, 16C	R/W	7.5.1
A8	Output 2 Alarm Operation	1ZC, 16C	R/W	7.5.2
A9	Output 2 Alarm Delay	1ZC, 16C	R/W	7.5.3
B0	Output 2 Alarm Inhibit	1ZC, 16C	R/W	7.5.4
B1	Output 2 Process Alarm Setpoint	1ZC, 16C	R/W	7.5.5
B2	Output 2 Deviation, Normal Band, Inverse Band Alarm Setpoint	1ZC, 16C	R/W	7.5.5

Code	Parameter Name	Used By	Read/Write	Where Described
B3	Output 2 Cycle Time	all	R/W	7.4.2
B4	Output 2 Low Limit	all	R/W	7.4.3
B5	Output 2 High Limit	all	R/W	7.4.3
B6	RTD and T/C Decimal Position	all	R/W	6.2.1
B7	Linear Decimal Position	all	R/W	6.3.1
B8	Display Filter	all except 1ZC	R/W	6.2.2 and 6.3.2
B9	Display Units	all	R/W	6.2.3
C1	Display Blanking	all except 1ZC	R/W	6.2.4 and 6.3.3
C2	Alarm 1 Action	all except 1ZC	R/W	9.2.1
C3	Alarm 1 Operation	all except 1ZC	R/W	9.2.2
C4	Alarm 1 Delay	all except 1ZC	R/W	9.2.3
C5	Alarm 1 Inhibit	all except 1ZC	R/W	9.2.4
C6	Alarm 1 Process Alarm Setpoint	all except 1ZC	R/W	9.2.5
C7	Alarm 1 Deviation, Normal Band, Inverse Band Setpoint	all except 1ZC	R/W	9.2.5
C8	Alarm 2 Action	all except 1ZC	R/W	9.2.1
C9	Alarm 2 Operation	all except 1ZC	R/W	9.2.2
D0	Alarm 2 Delay	all except 1ZC	R/W	9.2.3
D1	Alarm 2 Inhibit	all except 1ZC	R/W	9.2.4
D2	Alarm 2 Process Alarm Setpoint	all except 1ZC	R/W	9.2.5
D3	Alarm 2 Deviation, Normal Band, Inverse Band Setpoint	all except 1ZC	R/W	9.2.5
D4	Communication Protocol	all	R	*See Note 1*
D5	Controller ID (Address)	all	R/W	14.5.2 and 14.6.2
D6	Communication Baud Rate	all	R/W	14.5.3 and 14.6.3
D7	Communication Data Format	all	R/W	14.6.4
D8	Communication Transmit Delay	all	R/W	14.6.5

Code	Parameter Name	Used By	Read/Write	Where Described
E1	Output 1 Failsafe %	all	R/W	12.2
E2	Output 2 Failsafe %	all	R/W	12.2
E3	Loop Break Time	all	R/W	12.3
E4	Highest Reading	all	R/W	12.4
E5	Lowest Reading	all	R/W	12.4
E8	Option Selection	all except 1ZC	R	*See Note 1*
E9	Thermocouple Zero Offset	all	R/W	*See Note 2*
F0	Thermocouple Span Adjustment	all	R/W	*See Note 2*
F1	RTD Zero Offset	all	R/W	*See Note 2*
F2	RTD Span Adjustment	all	R/W	*See Note 2*
F3	Low-Voltage Zero Offset	all	R/W	*See Note 2*
F4	Low-Voltage Span Adjustment	all	R/W	*See Note 2*
F5	High-Voltage Zero Offset	all	R/W	*See Note 2*
F6	High-Voltage Span Adjustment	all	R/W	*See Note 2*
F7	Current (mA) Zero Offset	all	R/W	*See Note 2*
F8	Current (mA) Span Adjustment	all	R/W	*See Note 2*
G1	Auxiliary Output Variable Selection	all except 1ZC	R/W	14.7.2
G2	Auxiliary Output Scale Low	all except 1ZC	R/W	14.7.3
G3	Auxiliary Output Scale High	all except 1ZC	R/W	14.7.3
G5	Remote Analog Setpoint Scale Low	all except 1ZC	R/W	14.9.2
G6	Remote Analog Setpoint Scale High	all except 1ZC	R/W	14.9.2
G7	Contact/Digital Switch Function	all except 1ZC	R/W	14.8.2
H2	Autotune State	all	R	*See Note 1*
H3	Recipe State	all	R	*See Note 1*
H5	Currently Active Recipe Segment	all	R	2.2.1
H6	Active Setpoint	all	R/W	1.6
H7	Resume Exhaustion Flag	all	R	*See Note 4*
H8	LED Status Indicator	all	R	*See Note 1*
H9	RTD with Decimal Support Zero Offset	all	R/W	*See Note 2*

Code	Parameter Name	Used By	Read/Write	Where Described
I0	RTD with Decimal Support Span Cal	all	R/W	*See Note 2*
I1	0 to 5 V, 0 to 10 V Zero Offset	all	R/W	*See Note 2*
I2	0 to 5 V, 0 to 10 V Span Adjustment	all	R/W	*See Note 2*
I3	10 to 50 mV, 0 to 100 mV Zero Offset	all	R/W	*See Note 2*
I4	10 to 50 mV, 0 to 100 mV Span Adjustment	all	R/W	*See Note 2*
I5	Watchdog Disable	1ZC	R/W	*See Note 3*
I6	Controller Ambient Temperature	1ZC	R	*See Note 1*

Note 1: This read-only value is not described in this manual.

Note 2: This value cannot be configured using the front panel. The appropriate value is calculated by the controller during calibration. The value is writeable only for the purpose of restoring the value from a backup file if the controller's zero offset or span adjustment is accidentally lost.

Note 3: This value is writeable only for the purpose of troubleshooting by a member of the Athena technical support team.

Note 4: The Resume Exhaustion Flag signals the same situation as error code 3865 described in 19.3.2.

16. Tuning the Controller for PID Control

16.1 Introduction

When Proportional-Integral-Derivative (PID) control is used, the controller modulates output power by adjusting the output power percentage within a proportional band. Power is proportionally reduced as the process temperature gets closer to the setpoint temperature. The integral action affects the output based on the duration of the process value's variation from the setpoint, and the derivative action affects the output based on the rate of change of the process value. If both standard outputs are used for PID control, then the same integral and derivative parameters apply to both outputs. Proportional band is specified for each output individually, unless both outputs use the same action (direct or reverse).

The proportional band, derivative action (rate), and integral action (auto reset) parameters are automatically adjusted by the Autotune operation described in 16.2.

Autotune is best suited to temperature control applications. Some other applications may respond well to Autotune. However, some non-temperature control applications may require manual tuning, in which the proportional band, derivative action (rate), and integral term or manual reset are entered using the control menu as described in 16.3.

Typical Autotune PV Profile
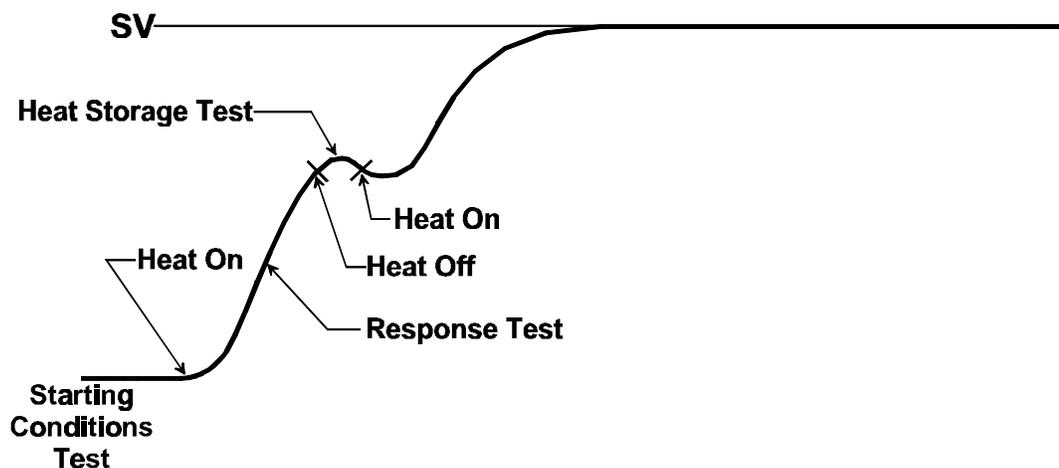
16.2 Autotuning

16.2.1 Introduction

The procedure below is used to start Autotune using the front panel of a 16C, 18C, or 25C controller. You can also use a Multi-Comm host or a MODBUS master to change the mode, view and change parameter values, and to start Autotune for the 1ZC, 16C, 18C, and 25C models.

The Autotune operation overwrites any existing proportional band, integral, and derivative parameter values that were previously configured. (When PID control is used, the manual reset value is ignored.)

16.2.2 Procedure

To use the Autotune feature for temperature applications:

1. Put the controller in standby mode by pressing the ▤ key until $CtrL$ is displayed on the top line (after approximately three seconds) and the current mode on the lower line. Press the ▲ or ▼ key to cycle through the modes until $StbY$ is on the lower line. Press the ▤ key again (briefly). The display will show $StbY$ alternating with the process value on the top line, and the setpoint displayed steadily on the lower line.

2. Configure the controller. Quick instructions for setting up a controller to use PID control and many of the configuration default values are in Section 3.

    *   For the Autotune feature to be available, at least one output type parameter must be set to PID (see 7.2).

    *   For Autotune to work, the controller cannot be configured to ramp to the setpoint at startup as described in 11.2. You do not have to disable the single step ramp feature, but if it is enabled, set the $SSrt$ (single step ramp time) parameter to 0 (zero).

3. Select the appropriate Autotune damping setting (see 10.2), or leave it set to the default normal.

4. Enter the process setpoint using the ▲ and ▼ keys.

5. If possible, wait for the process to become stable (no latent energy remaining). For heating or cooling applications, wait for the process to reach ambient temperature. Unless the setpoint is at least 1% of supported sensor span above or below the initial process value, the Autotune will terminate with an 05 error code (see 16.2.3).

6. Start the Autotune operation. To initiate autotuning in a 16C, 18C, or 25C controller, press the ▤ key until $CtrL$ is displayed on the top line and $StbY$ on the lower line. Use the ▲ or ▼ key to display $Atun$ on the lower line. Press the ▤ key again to start the Autotune operation.

7. <u>Unless you want to terminate the Autotune by putting the controller in standby or manual mode, do not press any keys during the Autotune operation</u>. While the controller does the Autotune, $tunE$ will alternate with the process value on the top line. (The lower line will continue to display the setpoint your entered in Step 4.)

8. When the controller has completed autotuning successfully, the flashing $tune$ will disappear. The display will revert to the normal mode operating display, with the process value on the top line and the setpoint on the lower line. The controller will save the tuning parameter values in the proportional band, rate, and auto reset parameters. (The new tuning values can be viewed in the $CtrL$ menu.)

   If the Autotune was unsuccessful, the top line will briefly display Er plus a two-digit error code, then go back to flashing $StbY$. Refer to 16.2.3 for the Autotune error codes. Fix the problem and try tuning again.

9. Once Autotune has been completed successfully, and the PV and SV are on display, the controller is controlling the process.

   Monitor the process. If unacceptable overshoot occurs, change the Autotune damping setting to high and repeat the Autotune. If the process response is sluggish, change the damping setting to low and repeat the Autotune.

Once setup is complete, we recommend changing the security access level to the most restrictive level suitable for your application. See Section 17 for details.

16.2.3 Autotune Error Codes

If an Autotune error occurs, the top line of the display will alternately show $tune$ and an error code for three seconds before the autotuning terminates and the controller goes back into standby mode. The error codes are in the table below.

Error Code	Description
02	Neither output is configured for PID using the $01.tY$ or $02.tY$ (output type) parameter in the $OutP$ (output menu).
03	The process changes in the wrong direction. The cause is usually reversed thermocouple leads or an incorrectly configured $01.Ac$ or $02.Ac$ (output action) parameter.
05	There is not enough difference between initial PV and the setpoint. For Autotune to work, the difference must be at least 1% of supported sensor span.
08	The startup curve (change in PV) was not acceptable to the Autotune algorithm. This could be caused by a process upset that occurred during tuning. Try Autotuning again when the process is stable. If the error recurs, your process is not suitable for Autotuning. Use manual tuning as described in 16.3.
09	The Autotuning timed out, because the process was unresponsive (or extremely slow). Your process is not suitable for Autotuning. Use manual tuning as described in 16.3, or configure the controller for on/off control (see 1.5.3 and 8.2).

16.3 Manual Tuning (Zeigler-Nichols PID Method)

16.3.1 Introduction

This tuning method may be used for non-temperature control processes or if the spread between initial process temperature and process operating temperature is small. This manual tuning process requires that the PV be tracked over time. If the controller is equipped with an auxiliary analog output card, connect a chart recorder to its terminals, and use the A.out (auxiliary output) menu to specify that the PV will be retransmitted. If the controller is not equipped with an auxiliary analog output, you can graph the displayed PV against time manually.

The procedure below is used to do manual tuning using the front panel of a 16C, 18C, or 25C controller. You can use a Multi-Comm host or a MODBUS master to change the mode, and to view and change tuning parameter values for the 1ZC, 16C, 18C, and 25C controllers.

16.3.2 Procedure

To perform manual tuning:

1. For heat/cool control processes, disable any cooling device used or set the output type parameter (in the OutP (output) menu) for this direct-acting output to off. (Usually, output 2 is used for cooling, so you would set O2.tY = OFF.)

2. **With the power off** and the controller NOT in the Key Lockout security level, apply power and immediately put the controller in standby mode by pressing the ☰ key until CtrL is displayed on the top line (after approximately three seconds) and the current mode on the lower line. Press the ▲ or ▼ key to cycle through the modes until StbY is on the lower line. Press the ☰ key again (briefly). The display will show StbY alternating with the process value on the top line, and the setpoint displayed steadily on the lower line.

3. Enter the process setpoint using the ▲ and ▼ keys.

4. Make sure the Pb (proportional band) is set to its maximum value, and that der (derivative / rate action), OFFS (manual reset), and Int (integral offset / auto reset) are all set to zero. To access the menu system, press and hold the ↻ key until a menu name abbreviation is displayed on the top line. Press the ↻ key repeatedly until the CtrL menu is reached. Step through the tuning parameters using the ☰ key. To change values, use the ▲ and ▼ keys, then press ☰ to write the new value to the controller's database.

5. Put the controller in normal (automatic) mode by pressing the ☰ key until CtrL is displayed on the top line (after approximately three seconds) and the current mode on the lower line. Press the ▲ or ▼ key to cycle through the modes until nor is on the lower line. Press the ☰ key again (briefly). The display will show the process value on the top line and the setpoint on the lower line.

6. While monitoring the recording device or plotting the displayed PV against time manually, decrease the proportional band value by repeatedly halving the value until a small, sustained temperature oscillation is observed. Measure the period in seconds of one cycle of oscillation ("T" on the diagram below).
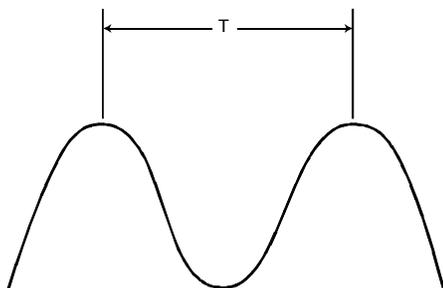
7. Divide the period of oscillation (T) by 8. The resulting number (quotient) is the correct der (derivative) time in seconds.

8. Divide T by 2. The resulting number (quotient) is the correct integral time in seconds.

9. Multiply the proportional band value used in Step 6 (to obtain T) by 1.66 and enter this as the new proportional band value.

Manual tuning of the heating output is complete. If the second output will be used for PID cooling, set the cooling output type to PID. (It was disabled in Step 1 of the manual tuning process.) Enter the proportional band value calculated in Step 9 for the cooling output also. If overcooling results, increase the cooling proportional bandwidth. If too little cooling action results, decrease the cooling proportional band.

17. Changing the Security Access Level

17.1 Introduction

The 16C, 18C, and 25C controllers can be configured to limit the functions and configuration menus that can be accessed using the keypad. For example, the access level can be set to allow operators to change only the setpoint or the manual mode output percentage.

A controller can be set to any of the access levels in the table below. The sequence of levels in the table is from most restrictive to least restrictive. New 16C, 18C, and 25C controllers are shipped with the access level set to cnF9 (configuration).

<u>After you have configured the controller for your application, set the access level to the most restrictive level appropriate for your site</u>.

Instructions for changing the access level are in 17.2.

Instructions for disabling the keypad entirely are in 17.3.

Displayed Abbreviation	Access Level	Description
Loc.0	keypad lockout	**Highest security level; no access.** While the access level is "keypad lockout", no controller values can be changed, not even the setpoint. To escape, press the ↻ key for approximately ten seconds, until Loc.0 is displayed, then press ⬆.
SP	setpoint only	**Setpoint or manual outputs can be adjusted; no access to mode or menus.** When the access level is "setpoint only", the keypad can be used to change the setpoint or the manual mode output percentage. However, the operator will not be able to change the controller from normal (automatic) mode to manual, and vice versa.
SP.PL	setpoint plus mode	**Setpoint or manual outputs can be adjusted; mode can be changed; no access to menus.** When the access level is "setpoint plus mode", the keypad can be used to change the setpoint, manual mode output percentage, and control mode, including executing recipes, and switching from normal (automatic) to manual, and vice versa. (See 1.3.1 for a description of all control modes.)
USEr	user	**All the "setpoint plus mode" functions, and limited access to menus.** When the access level is "user", the keypad can be used to do all the functions available in "setpoint plus mode". At the "user" level, the keypad can also be used to view and change the values on the control menu (tuning parameters), adjust the Autotune damping parameter, and view and change all the ramp/soak parameters.

Displayed Abbreviation	Access Level	Description
CnF9	configuration	**All the "user" functions, and access to all menus except calibration.** When the access level is "configuration", the keypad can be used to perform all controller functions and access all menus, except the calibration menu.
FACt	factory	**Access to everything.** When the access level is "factory", the keypad can be used to do all controller functions, including re-calibrating the controller. The controllers are calibrated at the factory. Usually the controllers will never need re-calibration. See 5.2 for the circumstance that dictates re-calibration. **Do not leave the controller set to this access level after you have re-calibrated the controller.**

17.2 Procedures

17.2.1 To View the Access Level

To view the access level when the PV and SV are displayed:

1. Press and hold the ⟳ key for approximately ten seconds. (After the first three seconds a menu name will be displayed on the top line. Ignore it and continue to press the ⟳ key.) The display will show the access level label AcLu and the access level now in effect. For example, if the controller is set to "user" level, the display will show:

    AcLu
    USEr

2. What you do next depends on whether the present access level is OK.

    If you <u>do not</u> want to change the access level, press the ☰ key once to go back to the PV and SV display.

    If you <u>do</u> want to change the access level, follow the instructions in 17.2.2.

17.2.2 To Change the Access Level

To change the access level when the current access level is on display:

1. Use the ▲ or ▼ key to step through the list of access level choices.

2. When the desired access level is on display, press the ☰ key to write the new access level to the controller's database and return to the PV and SV display.

17.3 Disabling the Keypad

To disable the keypad entirely, remove the JMP03 jumper from the processor board. The processor board is the board on the left when facing the controller. Refer to the illustration below for the location of JMP03. (This illustration shows the bezel and circuit board assembly as viewed from below.)

JUMPER AS SHOWN ENABLES KEYPAD ACCESS.
TO DISABLE KEYPAD ACCESS, REMOVE JUMPER.
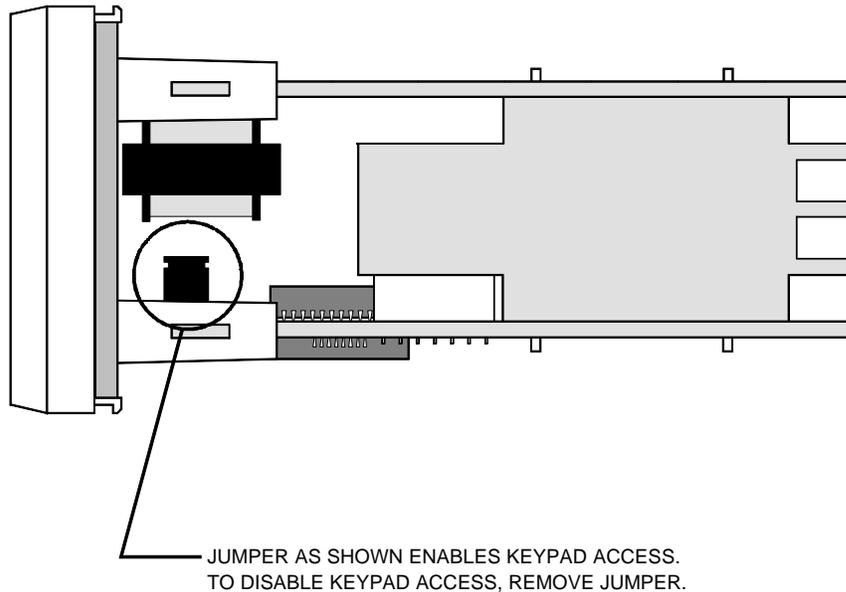
18. Calibrating the Controller

18.1 Introduction

You do not have to calibrate every new controller. When a controller was ordered, you specified an input type for which the unit was calibrated at the factory. This is not the specific type chosen with the input menu tYPE (type) parameter, such as J thermocouple, or 0 to 20 mA linear. In the context of ordering the controller, "type" refers to these choices:

- RTD

- compressed RTD (RTD with decimal support)

- thermocouple

- millivolt linear

- volt linear

- current linear input

The controller was calibrated at the factory for the type of input specified. If you use the controller with a different type of input, you must recalibrate as described in this section unless you ordered the "Calibrate All" input option.[42]

For example, if you specified when you ordered the controller that you planned to use a thermocouple as the sensor, then you can use the input menu tYPE (type) parameter to choose any thermocouple type: B, C, E, J, K, N, NNM, R, S, T, or Platinel II. The controller will be calibrated appropriately at the factory. However, if you ordered thermocouple calibration, but decide to use the controller with an RTD sensor, then you must recalibrate before using the controller. The "low calibration" procedure will offset zero if necessary, and the "high calibration" will perform the span adjustment.

If you change the input type (including changing linear input type) for a 16C, 18C, or 25C controller, you might also have to change input jumper settings. See 5.3 for details.

⚠ WARNING	All wiring should be done by an experienced technician and be installed in accordance with national and local electrical codes. To avoid serious personal injury and damage to equipment, follow all warnings and cautions provided in the controller installation manuals.

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[42] To determine whether the controller in hand was calibrated at the factory for all input types, check the model number on the label on the controller. The meaning of each character in the model number is in the installation manual supplied with the controller.

18.2 Determining the Simulated Input to be Used During Low and High Calibration

18.2.1 Introduction

When calibrating the controller, you will remove the output wiring. You will remove the input wiring and substitute an appropriate simulated input to the controller's input terminals.

- When calibrating for an RTD input, you will apply an appropriate resistance value across the input terminals using a "decade box" or precision resistors as described in 18.2.2.

- When calibrating for an thermocouple input, you will use a thermocouple simulator to provide input during calibration as described in 18.2.3.

- When calibrating for a linear input, you will use a milliamp, millivolt, or voltage input device as described in 18.2.4.

18.2.2 Simulating RTD Input for Calibration

When calibrating the controller for use with an RTD input, you will remove the output wiring. You will remove the input wiring and substitute an appropriate resistance across the controller's input terminals. For this purpose, good results can be achieved using a "decade box" type of calibrator or using precision resistors. Use of an "active resistance" calibrator (that simulates resistance with its circuitry instead of actually providing the resistance) may not produce satisfactory results.

Before calibrating the controller, you must determine the correct resistance to apply. Two resistance values are used, one for low calibration and one for high calibration. For RTD inputs, each of these resistances corresponds to a calibration low and calibration high temperature. The calibration temperatures depend on the specific type of input. The values can be read from the CALo (cal low) and CAHi (cal high) parameters in the CAL (calibration) menu as described in Section 13.

For example, if the InP (input) menu tYPE (type) parameter is set to rtd and the Unit (unit of measure) parameter in the dSPL menu is set to F (Fahrenheit), then the calibration low value displayed will be 32 and the calibration high value displayed will be 1414.

The table below shows the resistance that represents the RTD calibration low and calibration high temperatures. Use this table to determine what resistance to apply across the input terminals when performing the calibration procedure described in this section.

	Low Calibration		High Calibration	
Input	**Resistance Setting in ohms**	**Temperature Equivalent in °F (°C) [°K]**	**Resistance Setting in ohms**	**Temperature Equivalent in °F (°C) [°K]**
RTD	100 ohms	32 °F (0 °C) [273 °K]	365.94 ohms	1414 °F (768 °C) [1041 °K]
RTD with decimal support	100 ohms	32 °F (0 °C) [273 °K]	221.95 ohms	622.4 °F (328 °C) [601.2 °K]

18.2.3 Simulating Thermocouple Input for Calibration

When calibrating the controller for use with a thermocouple input, you will remove the output wiring. You will remove the input wiring and substitute a simultated input provided by a thermocouple simulator.

Before calibrating the controller, you must determine the correct temperature input values to simulate during calibration. Two values are used, one for low calibration and one for high calibration. The temperatures to be simulated depend on the specific type of input. The values can be read from the CALo (cal low) and CAHi (cal high) parameters in the CAL (calibration) menu as described in Section 13.

For example, if the InP (input) menu tYPE (type) parameter is set to J thermocouple and the Unit (unit of measure) parameter in the dSPL menu is set to F (Fahrenheit), then the calibration low value displayed will be 32 and the calibration high value displayed will be 1258.

Set the thermocouple simulator accordingly when performing the calibration procedure described in this section.

18.2.4 Simulating Linear Input for Calibration

When calibrating the controller for use with a linear input, you will remove the output wiring. You will remove the input wiring and substitute a simulated input provided by a milliamp input device, millivolt input device, or voltage input device, depending on the type of input you plan to use for control.

During calibration, you will simulate two process values: one for low calibration and one for high calibration. In the case of linear inputs, these are usually the process values that are configured for the SCL.L (linear input scaling low limit) and SCL.H (linear input scaling high limit) parameters in the InP (input) menu. These scaling values are the values displayed for the CALo (cal low) and CAHi (cal high) parameters in the CAL (calibration) menu as described in Section 13.

Configure the input scaling parameters SCL.L and SCL.H before calibrating the controller. During calibration, use the lowest input value for the calibration low value and the highest input value for the calibration high value. For example, if you plan to use a 0 to 20 mA input for control, then apply 0 (zero) mA to the input terminals during low calibration and 20 mA to the input terminals during high calibration.

18.3 Preparing the Controller

To prepare the controller for calibration:

1. Make sure the access level in a 16C, 18C, or 25C is set to FACt (factory). Instructions for viewing and changing the access level controller are in Section 17.

2. Go to the InP (input menu) and select the new input type as described in 5.5. (For 1ZC controllers, refer to the *Multi-Comm User's Guide* or *Using MODBUS with Series C (1ZC, 16C, 18C, and 25C) Controllers.)* Be sure to press the ≡ key when the new input type is on display, so that the change is written to the controller's database.

3. In the case of linear input types, also use the SCL.L and SCL.H (scaling low and scaling high) parameters (in the input menu) to specify the PV represented by the lowest possible linear input signal and the PV represented by the highest possible linear input signal.

4. **Remove power from the controller** and disconnect all output wiring.

5. Disconnect the input wiring.

6. Attach an appropriate calibrator (or precision resistor representing the calibration low process value) to the input terminals. (Refer to 18.2 to determine the type of device to be used to calibrate for the input type you have selected.)

7. Power up the controller and put it in standby mode. Allow the controller to warm up for fifteen minutes after you have attached the calibrator (or precision resistor for the low calibration).

After the fifteen minute warm-up, you are ready to proceed with the calibration as described in 18.4.

18.4 Initiating the Calibration

To calibrate the controller after it has been prepared as described in 18.3 (including the fifteen minute warm-up period in standby mode):

1. For a 16C, 18C, or 25C controller, go to the CAL (calibration) menu and display CALo (calibration low). It will alternate with the process value for which you must apply a simulated input (see 18.2).

2. To initiate low calibration in a 16C, 18C, or 25C controller, when CALo is on display, press the ▲ or ▼ key.

    To initiate low calibration using a MODBUS write function, follow the instructions in *Using MODBUS Protocol with Athena Series C (1ZC, 16C, 18C, and 25C) Controllers.* (Special values must be written to the correct two MODBUS registers in the same write operation.)

3. While the controller performs the calibration, the display on a 16C, 18C, or 25C will freeze with CALo on the lower line. When the low calibration has been completed, the lower line will display donE.   (If the calibration is not successful, ErCL (error calibration) will be displayed. You probably did not supply the correct simulated input. Fix the problem and try again.)

4. After successfully doing the low cal operation, you are ready to continue with the high calibration procedure.

    If you are using a "decade box" calibrator, thermocouple calibrator, or linear input source, switch to the appropriate input for the calibrate high operation.

    If you are using precision resistors for RTD calibration, **remove power from the controller,** remove the low calibration resistor, and install the high calibration resistor across the input terminals, then power up the controller. After powering up the controller, wait fifteen minutes before proceeding to the next step. (This fifteen minute wait for warm-up is required only if the controller has been powered down to permit you to change a precision resistor at the input terminals.)

5. Display CAHi . (If CALo is on display, press ▤ to display CAHi .) CAHi will alternate with the PV for which you must apply a simulated input (see 18.2).

6. To initiate high calibration in a 16C, 18C, or 25C controller, when CAHi is on display, press the ▲ or ▼ key.

    To initiate high calibration using a MODBUS write function, follow the instructions in *Using MODBUS Protocol with Athena Series C (1ZC, 16C, 18C, and 25C) Controllers.* (Special values must be written to the correct two MODBUS registers in the same write operation.)

7. While the controller performs the calibration, the display on a 16C, 18C, or 25C will freeze with CAHi on the lower line. When the high calibration has been completed, the lower line will display donE. (If the calibration is not successful, ErCL (error calibration) will be displayed. You probably did not supply the correct simulated input. Fix the problem and try again.)

If both the low calibration and the high calibration were successful, you are ready to return the controller to service as described in 18.5.

18.5 Returning the Controller to Service

To return the controller to service:

1. **Remove power from the controller**.

2. Remove the precision resistor or calibrator from the inputs.

3. Replace the input and output wiring.

4. Power up the controller.

19. Error Messages and Codes

19.1 Introduction

As described in Section 2, usually the controller displays the process variable on the top line and the setpoint on the lower line of the display. When the controller is in a mode other than normal (automatic), the mode alternates with the PV. However, when the controller detects a problem with the input signal or with its own operation, messages and codes are displayed to alert you to a condition that requires your immediate attention.

19.2 Problem with Input Signal

19.2.1 Introduction

When the controller detects a problem with the input signal, a message is displayed on the top line in place of the process value. For example, if the controller detects an open sensor when the setpoint is 250, the display would look like this:

<div align="center">

ErHi
250

</div>

19.2.2 Input Error Messages

The table below lists the error messages and codes that the 16C, 18C, and 25C controllers display in place of the process value when a problem with the input is detected by the controller. These error conditions can be read from all controllers (including 1ZC controllers) by a MODBUS master or a Multi-Comm host.

When the controller detects any of these sensor problems, the controller's outputs will go to the percentage specified using the failsafe values (if any) configured using the FS01 and FS02 parameters in the SUPr (supervisor) menu (see 12.2).

Display	Error Condition	Operator Action
ErHi	open sensor	Check the sensor and wiring. *This message will clear when the problem has been corrected.*
ErLo	reversed sensor	Make sure the correct input type has been selected for the input type parameter. Check sensor polarity. *This message will clear when the problem has been corrected.*
LPbr	loop break; the input value has not changed for the time period specified using the supervisor menu's loop break time parameter.	Check sensor and wiring. *This message will not clear automatically when the problem has been corrected. You must cycle the power to the controller to clear the message and to cause the controller to resume normal operation.*

19.3 Problem with Controller

19.3.1 Introduction

If the controller detects a problem with its own operation, it displays Err on the top line instead of the process value and displays a numerical code on the lower line <u>instead of the setpoint</u>. For example, if the controller detects a checksum error, the display will show:

<div align="center">

Err
0100

</div>

19.3.2 Controller Error Codes

The table below lists the error messages and codes that the 16C, 18C, and 25C controllers display in place of the setpoint value when a self-diagnostic is failed by the controller. These error conditions can be read from all controllers (including 1ZC controllers) by a MODBUS master or a Multi-Comm host.

The effect of the error condition on the controller's outputs depends on the error, as described below.

Display	Error Condition	Operator Action
0100	controller processor checksum error *This message is usually displayed only at startup, before any outputs are calculated.*	Press any key to clear the message.
0101	RAM error *This message is usually displayed only at startup, before any outputs are calculated.*	Press any key to clear the message. .
0202	default parameter values were loaded automatically, because the controller found corrupted values stored on the EEPROM *This message is usually displayed only at startup, before any outputs are calculated.*	Press any key to clear the message. Re-configure all configuration parameter values, including input type. .
0303	EEPROM write failure *This message is usually displayed only at startup, before any outputs are calculated.*	Press any key to clear the message. Try the write operation again. If the message recurs and persists, the EEPROM may be worn out. Call for service. *(See Note 1 below.)*

Display	Error Condition	Operator Action
3865	power fail resume feature cannot be used *The EEPROM is worn out; no storage space is available for storage of recipe execution information. Therefore, this message is displayed when power is restored after a power failure that occurred while a recipe was being executed under the direction of the controller. When this message is displayed, execution of the recipe cannot be resumed automatically.*	Press any key to clear the message. Call for service. *(See Note 1 below.)*
3630 through 3543	interrupt-related problem *While one of these messages is on display, the controller outputs are held at the relay state or analog output percentage in use when the problem was detected.*	Cycle the power to the controller. If the message recurs and persists, call for service.

Note 1: A host computer can wear out the EEPROM by writing to it too many times. <u>Do not write the setpoint to the EEPROM when you are writing a temporary setpoint to the controller</u>, such as when you are ramping to a final setpoint under the direction of a MODBUS master.

20. Frequently Asked Questions

20.1 Introduction

You can reach our technical support team by phoning 1-800-782-6776 (from the United States) or 610-828-2490 (from anywhere in the world).

Before you call, please look at this section to see if your question is covered here. If you do call for technical assistance, be ready to supply the following information:

- complete model number of controller

- symptoms of the problem

- unusual events, if any, that preceded the problem

- remedies you have already tried

20.2 How do I change from thermocouple to RTD (or vice versa)?

To change the type of sensor used (or to switch to a linear input), go to the input menu and change the input type specified (see 5.5). If you change to a linear input type, you can use input menu parameters to scale the input.

Unless the controller was ordered with the "calibrate all" choice, you must also re-calibrate the controller for the new sensor type. (see Section 18).[43]

Because all temperature inputs (RTD and thermocouple) require the same input jumper settings, you do not have to change JMP01 or JMP02 on the processor board. However, if you change from a temperature input to a voltage signal above 100 mV or to a current input, you must change the jumper settings (see 5.3).

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[43] To determine whether the controller in hand was calibrated at the factory for all input types, check the model number on the label on the controller. The meaning of each character in the model number is in the installation manual supplied with the controller.

20.3 Why doesn't the PV displayed match the value on a thermometer in the process?

Unless the thermometer and the sensor providing input to the controller are very close to one another, their readings will not match in some applications, because of temperature variations within the process.   However, if you want the controller to maintain the setpoint value at the location of the thermometer, instead of at the location of the sensor, use the input menu's bias parameter for RTD or thermocouple inputs.   Applying bias allows you to compensate for any difference between sensor temperature and the location to be measured. The process variable and setpoint will be offset by the value entered for the bias parameter. (See 5.6.1.)

For example, suppose you want the process to be 150 °F. However, the sensor providing input to the controller is so close to the heater that it reads 50 degrees higher than the process at the location of interest to you. Enter -50 as the bias value. Enter the setpoint of 150. The setpoint 150 will be displayed. However, the controller will use a setpoint of 200. The process value displayed will also be offset, so that when the temperature at the sensor location next to the heater is 206 °F, the controller shows 156, the temperature at the location of interest in the process.

20.4 Why does my compressor cycle so often?

If the controller's output type parameter is set to PID, the controller attempts to moderate the rate of change of the PV. PID control is not appropriate for devices such as compressors that are either on or off. Change the output type to on/off.

- When the on/off output action is configured for reverse action (heating applications), the controller will apply 100% output if the process temperature is <u>below</u> the setpoint and 0% if the PV is at the SV.

- When the on/off output action is configured for direct action (cooling applications), the controller will apply 100% output if the process temperature is <u>above</u> the setpoint and 0% if the PV is at the SV.

The result of switching from PID to on/off will be a reduction in the cycling of the compressor. The trade-off is greater oscillation of the process temperature. (If there is still too much cycling, introduce hysteresis to the on/off control as described in 1.5.3.1.)

20.5 Why doesn't the controller communicate with the host computer?

When a controller has been communicating successfully with a MODBUS master or Multi-Comm host computer, then stops communicating, the cause is most likely damage to the network wiring. However, before going to search for the fault, take a quick look at the communication settings on the serial menu. Make sure that the controller ID has not been changed, and that the other communication settings match those used by the host. (See 14.5.)

20.6 Why isn't the setpoint displayed all the time?

The controller's dSPL (display) menu contains a bLAn (setpoint blanking) parameter that can be used to specify the number of seconds the setpoint is displayed. Once the configured time period has elapsed the setpoint display will go blank and remain blank until any key is pressed. Pressing any key will cause the controller to display the setpoint again. The setpoint will remain on display until the period specified in the setpoint blanking parameter has elapsed.

If you want the setpoint to be displayed all the time while the unit is in a control mode, turn off the blanking function by setting the setpoint blanking parameter to OFF.   (See 6.2.2 or 6.3.2.)

20.7 The last digit of the PV display changes very frequently. How can I slow it down?

If the display is configured to show one or more decimal places, those values might change frequently, sometimes so quickly that the value is hard to read. Go to the dSPL (display) menu and increase the value of the dFIL (display filter) parameter. The display filter parameter is used to specify the minimum time period between changes of the displayed PV value. The display filter value has no effect on control. (See 6.2.2 or 6.3.2.)

In contrast, the input menu's input filter <u>does</u> affect control, because the input filter is used to specify the time period over which the controller will average the input values before using the value in the calculation of control output values. (See 5.6.3 or 5.7.4.)

20.8 Why is the setpoint changing? I haven't touched the controller!

As described in 1.6, the setpoint used (and displayed) when the controller is operating in "normal"mode (automatic) is not always entered by the operator as described in 2.4.2.

- The active setpoint can come from a recipe; see 1.6.2.

- The active setpoint can be written to the controller from a host computer; see 1.6.3.

- A second setpoint can be used when an external device triggers an optional switch in the controller; see 1.6.4.

- The setpoint can come from an external device by means of an optional analog input; see 1.6.5.

For the algorithm used by the controller to determine which setpoint is the "active" setpoint, that is, the setpoint being used now, see 1.6.6.

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