ATHENA®
The Temperature Control Company

SERIES C

1ZC · 16C · 18C · 19C · 25C

TEMPERATURE / PROCESS CONTROLLER

Controller Operator 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 3.3 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.**

Table of Contents

1.Introduction

1.1 About This Manual

This manual contains the information needed to operate the 1ZC, 16C, 18C, and 25C controllers after they have been configured as described in the *Athena Series C (1ZC, 16C, 18C, and 25C) Controller Configuration and Operation Manual*. (The 19C is functionally identical to the 18C.)

1.2 About the Controllers

Each controller can have one or two standard outputs. One or both is used for control. Each 1ZC, 16C, 18C, and 25C controller can be configured for PID (proportional-integral-derivative) control or on/off control. When PID control is used, you can take advantage of the controllers' Autotune feature for easy tuning of the proportional, integral, and derivative components of the control algorithm. Instructions for Autotuning are in Section 10 of this manual.

The controllers can operate in normal (auto) mode, in which the controller calculates the output based on the setpoint. The controllers can also be operated in manual mode, in which you set the output percentage. Transfer from PID to manual is "bumpless".

- Instructions for viewing and changing the mode are in 3.3.
- Instructions for changing the setpoint are in 6.3.
- Instructions for changing the manual mode output percentage are in 6.4.

The controllers can be configured to alert you to process alarm conditions; see 7.

The controllers can be configured to execute recipes using the control outputs. Instructions for executing recipes are in 9.2.

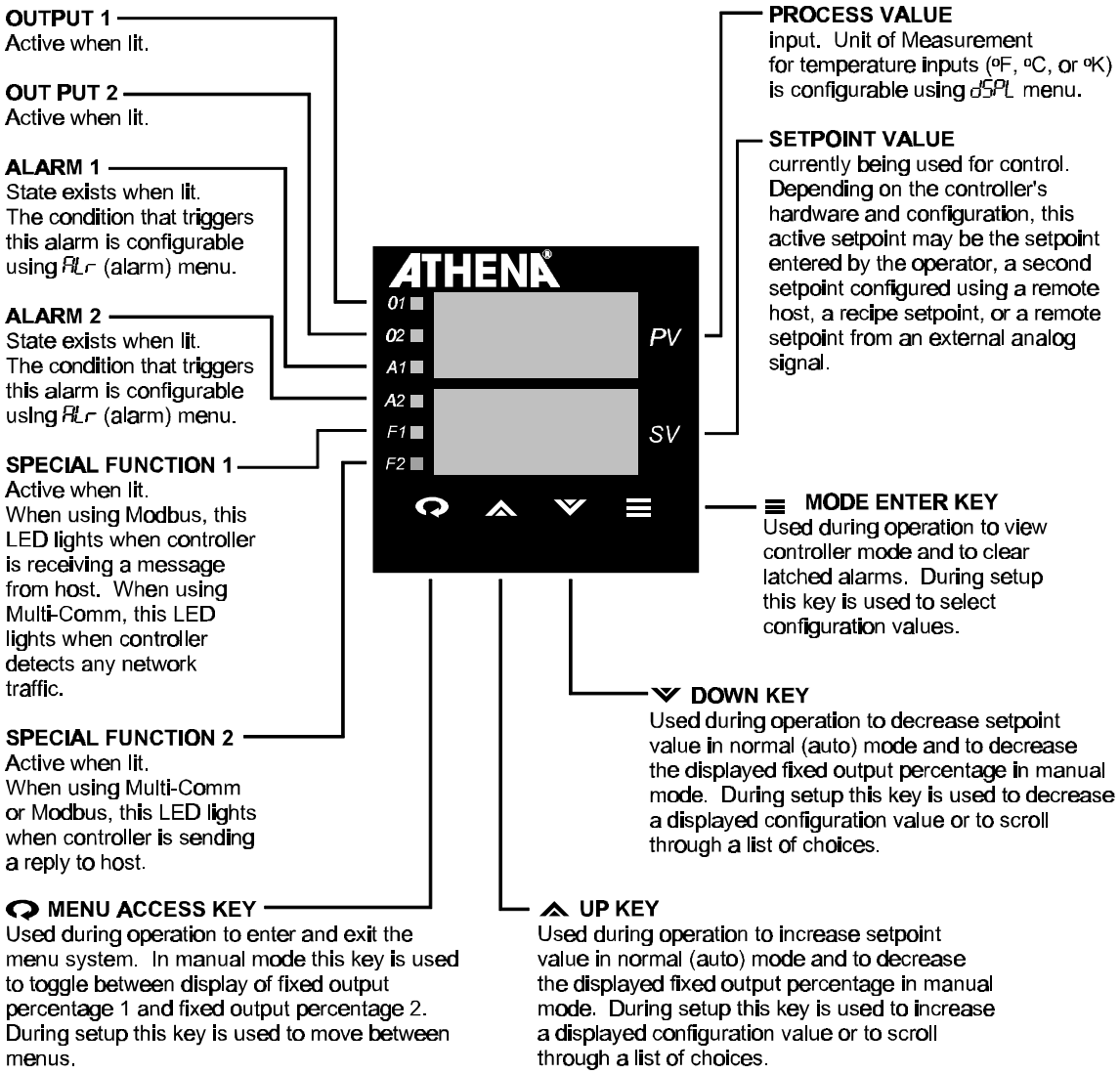
If you cannot use the keypad at all, the process engineer has set up the 16C, 18C, or 25C controller hardware to totally disable the keypad.

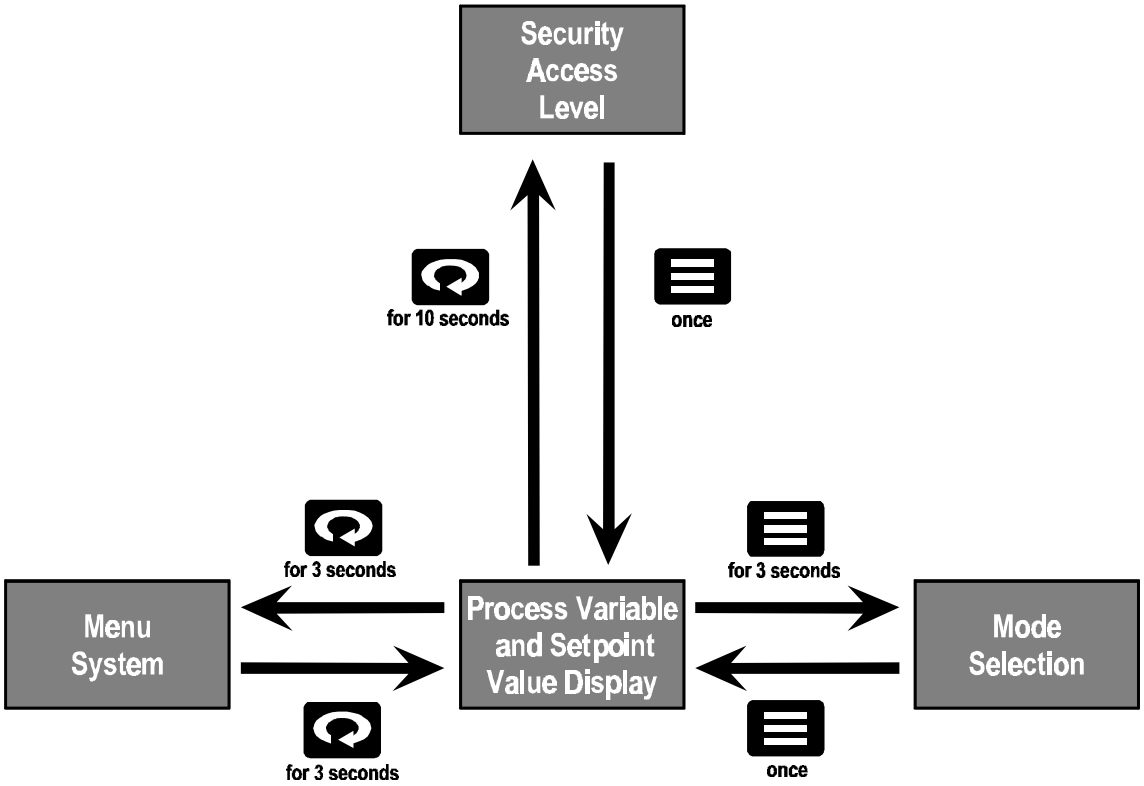
If you can do some functions with the keypad, but not all, the process engineer has used the controller's firmware to limit functions that can be accessed using the keypad.

2. LEDs and Keypad on 16C, 18C, and 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.

The keypad functions are also described below. The displays available are described in Section 3.





3. Modes of Operation and Controller Displays

3.1 Control Modes

Unless both standard outputs are turned off during configuration or configured to annunciate alarms, 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.[1]

The table below summarizes the control modes and shows the display used to select each mode[2]. Instructions for using the keypad to display and change the mode are in 3.3. The operational display for each mode is in 3.4.

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. 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 or the input received, the outputs used are the fixed percentages specified by the operator using the percent 1 and percent 2 values. See 6.4 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 Section 10.

[1] 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 ☰ (mode) key.

[2] The compact 1ZC does not include a display. The 1ZC is designed to be mounted on a DIN rail in a cabinet. Its mode, normal mode setpoint, and manual mode output percentage are 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. The 1ZC does have status LEDs; see Section 4 for the function of each.

Control Mode	Selection Display	Description
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 9.
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.

3.2 Configuration

In addition to the operating displays associated with the control modes described above 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 the *Athena Series C (1ZC, 16C, 18C, and 25C) Controller Configuration and Operation Manual*.

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 3.3 (or in the manual supplied with the host software).**

3.3 Viewing and Changing the Mode

To view and change the controller's 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 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 the desired mode is displayed on the lower line. For example, to put the controller in standby, press one of the arrow keys until the display shows:

   CtrL
   StbY

3. Press the ☰ key again (briefly). The display will show the current mode (StbY for example) 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

If the controller is in standby, then to return the 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

3.4 Display on 16C, 18C, and 25C Contollers

What is displayed when the controller is in one of the control modes described above 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.

Circumstance	What's Displayed Top Line Lower Line	Example Top 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)	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 Top Line Lower Line	Example Top Line Lower Line
controller detects a problem with its own operation	Err displayed	Err
	numeric code displayed; see 11.3.2 for the codes	0100

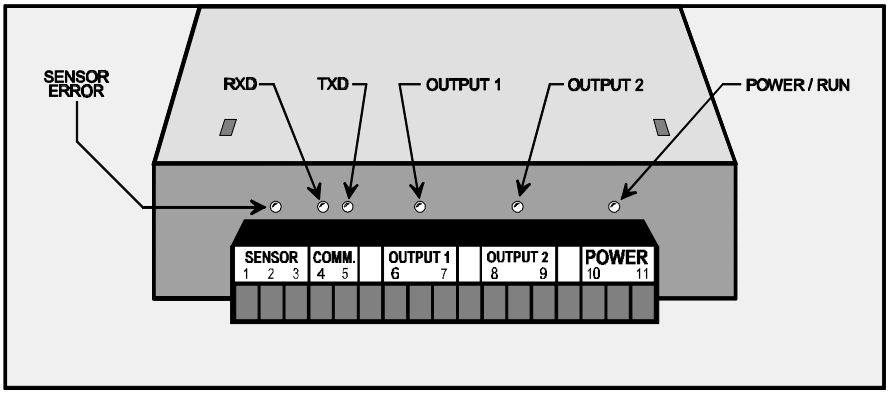
Note 1: The controller can be configured to limit the length of time the setpoint is displayed. If the setpoint display blanking parameter is set to a value other than OFF, the setpoint will be displayed for only the configured number of seconds. At the end of that time period, the setpoint display will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

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. See Section 9 for instructions for starting and stopping recipes based on the ramp/soak parameter values stored in the controller's database.

4. LEDs on the 1ZC Controller

The compact 1ZC does not include a display. The 1ZC is designed to be mounted on a DIN rail in a cabinet. The 1ZC controller's mode, normal mode setpoint, and manual mode output percentage are 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.

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 configured using the supervisor menu failsafe output parameters as described in Section 12 of the *Athena Series C (1ZC, 16C, 18C, and 25C) Controller Configuration and Operation Manual*.
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 with the Athena Plus protocol, 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).

5. What Happens When You Power Up the Controller

5.1.1 Outputs

When the controller is powered up, under some circumstances the outputs may be activated. If the controller has been configured, this is expected. 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 3.3.

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

5.1.2 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.[3] 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 3.4 for more information about the controller displays.

5.1.3 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, then the controller's control algorithm will use the outputs to achieve the configured setpoint using the configured control strategy.

Information about the various setpoints that can be used by a Series C controller are in the next section.

[3] 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.

6. Normal Mode Setpoint and Manual Mode Output Percentage

6.1 Introduction

The controllers can operate in normal (auto) mode, in which the controller calculates the output based on the setpoint; see 6.2 for the sources of setpoints and 6.3 for instructions for changing the setpoint using the front panel of a 16C, 18C, or 25C controller.

The controllers can also be operated in manual mode, in which you set the output percentage. Transfer from PID to manual is "bumpless". See 6.4 for instructions for putting the controller into manual mode and changing the output percentage.

6.2 Where Setpoints Come From

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 (automatic) mode.

The setpoint used (and displayed) is not always the one you enter using the front panel as described in 6.3.

- The active setpoint can come from a recipe; see 6.2.1.
- The active setpoint can be written to the controller from a host computer; see 6.2.2.
- A second stored setpoint can be used when an external device triggers an optional switch in the controller; see 6.2.3.
- The setpoint can come from an external device by means of an optional analog input; see 6.2.4.

For the algorithm used by the controller to determine which setpoint is the "active" setpoint, that is, the setpoint being used now, see 6.2.5.

6.2.1 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 Section 9.

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, you 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*.

6.2.2 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.

6.2.3 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.

You 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, you 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.

6.2.4 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. You cannot change the setpoint using the front panel while use of the remote analog setpoint is enabled.

6.2.5 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).

6.3 Displaying and Changing the Setpoint Using the Front Panel

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 displayed setpoint:

Use the ▲ and ▼ keys to change the displayed value. (The range of values you can enter is limited during configuration of the controller.)

6.4 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 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.

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.

7. Alarms

7.1 How You Are Alerted to Alarm Conditions

All the controllers can be configured to monitor for process alarms. The 16C, 18C, and 25C all have LEDs on the front panel that are used to signal that an alarm condition exists. The 16C, 18C, and 25C can be ordered with optional alarm outputs. These alarm outputs go on and off with the alarm LEDs on the front panel.

If one of the standard outputs on a 1ZC or 16C is not used for control, it can also be used to trigger an external alarm. (This alarm output is configured separately from the 16C front panel alarm.)

7.2 Types of Alarms

During configuration, the 1ZC, 16C, 18C, and 25C controllers are set up to use one or more of the following types of alarms.

- **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.
- **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.
- **inverse band alarm** – Activated when the process value is within a specified band centered around the setpoint.
- **normal band alarm** – Activated when the process value is outside a specified band centered around the setpoint.
- **event** – This special use of an alarm indicates that the controller has reached a particular point in a ramp/soak recipe.

7.3 Clearing Latched Alarms

Depending on how the alarm is configured, the alarm may be deactivated as soon as the alarm condition goes away, or the alarm may remain "latched" after the alarm condition clears until you press the ☰ key once (briefly).

8. Access Levels

8.1 Introduction

The 16C, 18C, and 25C controller hardware can be used to totally disable the keypad. Usually, however, customers leave the keypad enabled, and use the controller's firmware to limit functions that can be accessed using the keypad.

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.

Instructions for viewing the access level are in 8.2.

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.
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 as described in Section 6. However, you cannot 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", you can use the keypad 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 3.1 for a description of all control modes, and 3.3 for instructions for changing the mode.
USEr	user	**All the "setpoint plus mode" functions, and limited access to menus.** When the access level is "user", you can use the keypad 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. Instructions for these activities are in *Athena Series C (1ZC, 16C, 18C, and 25C) Controller Configuration and Operation Manual*.

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. Configuration instructions are in *Athena Series C (1ZC, 16C, 18C, and 25C) Controller Configuration and Operation Manual*.
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.

8.2 Viewing the Access Level

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

Press the key once to go back to the PV and SV display.

9. Ramp/Soak Recipes

9.1 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 can have 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), the recipe "holdback" parameter can be configured 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 of the 16C, 18C, and 25C, as described below, or
- an optional contact/digital input on the 16C, 18C, or 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 of the *Athena Series C (1ZC, 16C, 18C, and 25C) Controller Configuration and Operation Manual* for more information about ramp/soak capabilities.

9.2 Starting, Pausing, and Terminating Recipe Execution

To start execution of the single-setpoint ramp[4] 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 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 r.S (ramp/soak) will be one of the mode choices on the lower line. The display will show:

   CtrL
   r.S

[4] If single-setpoint ramp is enabled, then the ramp will be executed automatically at startup.

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.[5]

- 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 during recipe configuration 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.[6]
- 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.

[5] Whether the process value actually matches the setpoint when the ramp time has elapsed depends on how the recipe was configured. If the holdback feature was not used and the ramp time was not configured realistically for your process, the PV may not match the SV when the ramp time has elapsed. The recipe should be reconfigured.

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

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 Section 11 of the *Athena Series C (1ZC, 16C, 18C, and 25C) Controller Configuration and Operation Manual*.
   - 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.

10. Autotuning for PID Control

10.1 Introduction

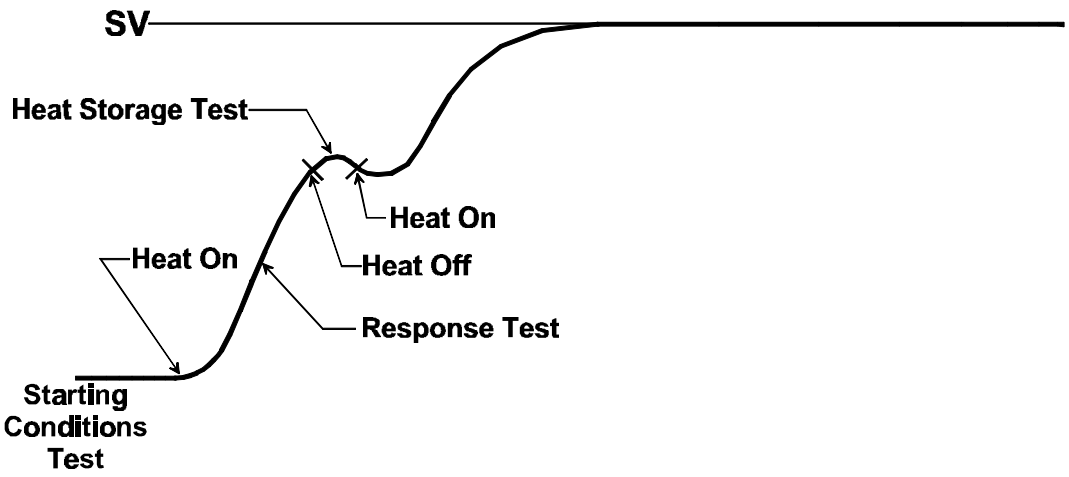
When Proportional-Integral-Derivative (PID) control is used, the controller modulates output power by adjusting the output power percentage within a proportional band. Power is proportionally reduced as the process temperature gets closer to the setpoint temperature. The integral action affects the output 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 10.2.

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 Section 16 of the *Athena Series C (1ZC, 16C, 18C, and 25C) Controller Configuration and Operation Manual*.

Note: Change of state applications and electrically heated processes with soft start power control cannot be Autotuned.

Typical Autotune PV Profile



10.2 Autotuning

10.2.1 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.)

The controller must be configured before Autotune is used.

- For the Autotune feature to be available, at least one output type parameter must be set to PID (see Section 7 of of the *Athena Series C (1ZC, 16C, 18C, and 25C) Controller Configuration and Operation Manual*).
- For Autotune to work, the controller cannot be configured to ramp to the setpoint at startup as described in Section 11 of the *Athena Series C (1ZC, 16C, 18C, and 25C) Controller Configuration and Operation Manual*. (The single step ramp feature does not have to be disabled, but if it is enabled, the SSrt (single step ramp time) parameter must be set to 0 (zero).)

10.2.2 Procedure

To use the Autotune feature for temperature applications:

1. 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.
2. Enter the process setpoint using the ▲ and ▼ keys.
3. 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 sensor span above or below the initial process value, the Autotune will terminate with an 05 error code (see 10.2.3).
4. 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.
5. 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. 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 2.)

6. 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 10.2.3 for the Autotune error codes. Fix the problem and try tuning again.

7. 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, the Autotune damping setting should be changed from the default normal to high, and Autotune repeated. If the process response is sluggish, the damping setting should be changed to low and Autotune repeated. (See Section 10 of the *Athena Series C (1ZC, 16C, 18C, and 25C) Controller Configuration and Operation Manual*.)

10.2.3 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 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 Section 16 of the *Athena Series C (1ZC, 16C, 18C, and 25C) Controller Configuration and Operation Manual*.
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 Section 16 of the *Athena Series C (1ZC, 16C, 18C, and 25C) Controller Configuration and Operation Manual*, or configure the controller for on/off control.

11. Error Messages and Codes

11.1 Introduction

As described in 3.4, 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.

11.2 Problem with Input Signal

11.2.1 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:

ErHi
250

11.2.2 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 Section 12 of the *Athena Series C (1ZC, 16C, 18C, and 25C) Controller Configuration and Operation Manual.)*

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.*

11.3 Problem with Controller

11.3.1 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 instead of the setpoint. For example, if the controller detects a checksum error, the display will show:

Err
0100

11.3.2 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. Do not write the setpoint to the EEPROM when you are writing a temporary setpoint to the controller, such as when you are ramping to a final setpoint under the direction of a MODBUS master.

12. Index

Athena Series C Controllers

Parameter List

Please note the numbers or selections used in your controller for these key parameters. (Not all parameters apply to every controller or to every control strategy.)

Write down the values after the controller has been Autotuned and is working well. Save this sheet for future reference. If someone accidentally changes the configuration or you must replace the controller (with the same model controller), you can re-enter these values and minimize downtime.

Model Number (on controller label) _____

Firmware Version Number (displayed when the controller is powered up after all segments on both lines of the display have been tested) _____

InP (input)	OutP (output)		CtrL (control)	Alr (alarm)
tYPE _____	01.tY _____	02.tY _____	db.1 _____	A1.AA _____
bIAS_____	01.Ac _____	02.Ac _____	HYS.1 _____	A1.A0 _____
SCL.L_____	01.cY _____	02.cY _____	db.2 _____	A1.d1 _____
SCL.H_____	01.LL _____	02.LL _____	HYS.2 _____	A1.IH _____
SP.LL_____	01.HL _____	02.HL _____	Pb1 _____	A1.SP _____
SP.HL_____	01.AA _____	02.AA _____	Pb2 _____	A2.AA _____
I.FIL_____	01.A0 _____	02.A0 _____	dEr _____	A2.A0 _____
	01.dL _____	02.dL _____	OFFS _____	A2.d1 _____
	01.IH _____	02.IH _____	Int _____	A2.IH _____
	01.SP _____	02.SP _____		A2.SP _____

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