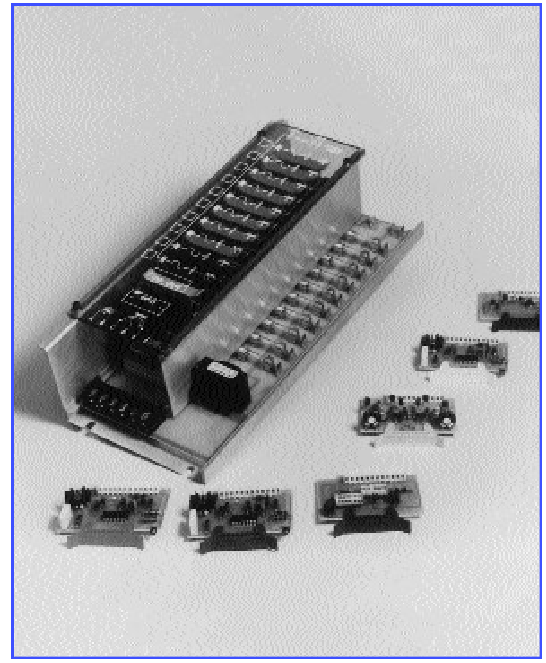
The Temperature Control Company

# Series "S" Solid-State Staging Controller



*Operating Instructions*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# Warranty

Two-Year Limited Warranty

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# Contents

# Section 1 General Introduction

## 1.1 GENERAL DESCRIPTION

The Athena Series “S” Solid State Staging Controls Provide pilot duty sequencing of multiple loads up to 18 stages.

**SU - Up-Down Mode:**
Adds stages in progression. Removes stages in reverse order., the last stage ‘on’ being the first stage ‘off’ on load reductions. Blue Handle Cooling stages provide automatic transfer to cooling. Starts with all stages ‘off.’

Output capacity: 1 AMP per step (10 Amps inrush).

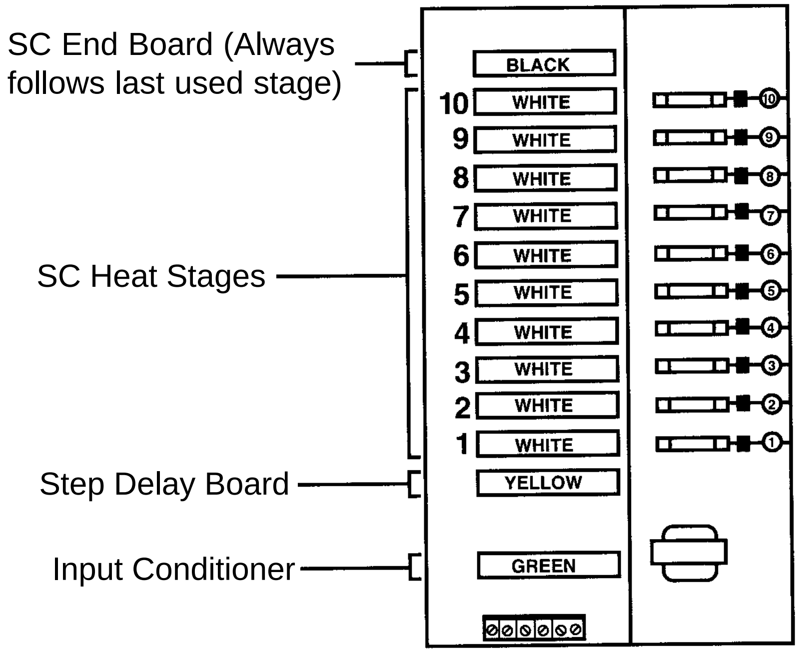
**SC - Circular Mode:**
Operates all heaters and contractors evenly. First stage ‘on’ is first stage ‘off.’ Starts with all stages ‘off.’

Output capacity: 1 Amp per step (10 Amps inrush).

## 1.2 TYPICAL CONFIGURATIONS

### Circular - SC Type Controller

10 Heating Steps
Code: SCA - 10 or SCB-10
Any number SC Heat Stages up to ten. End board follows last used stage.



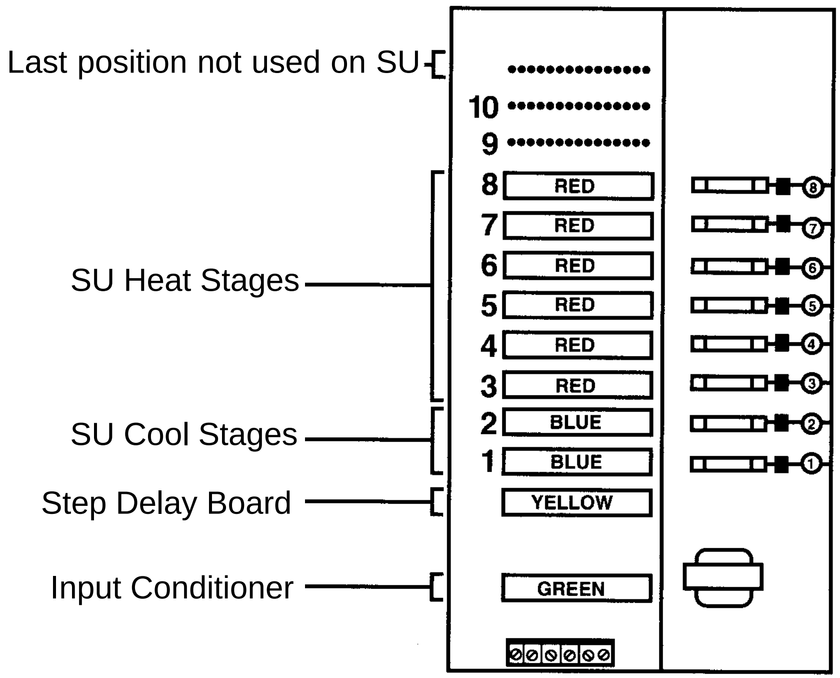
# 1.2 TYPICAL CONFIGURATIONS

## Up-Down Operation – SU type Controller

6 Heating & 2 Cooling Steps
Code: SUA-06-02 or SUB-06-02

Any combination of heat and/or cool steps up to ten.

Cooling and heating modules may be intermixed if reheat is desired. A heat module below a cool module will provide automatic reheat.




# 1.3 SPECIFICATIONS

| | |
|---|---|
| Input 'A': | 4-20 mA dc. 60 mA max, or 5 V dc, 9 V max. 135 ohms slidewire, 100-1000 ohms acceptable |
| Input 'B': | Thermistor probe to match range |
| Output: | One amp per step max (ten amps inrush) |
| Signal Isolation: | 1500 volts from power circuits and ground |
| Time Delay: | Adjustable, from 2.5 to 12 seconds; automatic slow down near balance |
| Adjustments: | Time Proportioning – Adjustable from differential to time proportioning. Span – Adjusts to input range |
| Indication: | L.E.D. logic status light on each output stage. |
| Supply voltage: | 120 V + 10%, - 15%, 50/60 Hz, 4 VA plus total contactor VA |
| Ambient Temp: | 30º to 130º F. (-1.1º to 54.4º C) |
| Dimensions: | 13 1/2" Long, 6" Wide, and 3-1/2 " High. (34.3 cm L x 15.2 cm W x 8.9 cm H) |

# Section 2 Installation Instructions

## 2.1 INSTALLATION

1. Carefully unpack instrument. Handle with care. Inspect for shipping damage. Report any damage to carrier immediately.

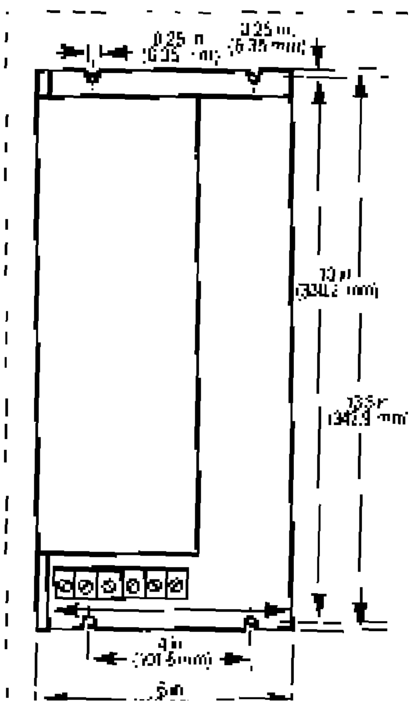
2. Pick a location for the controller where it will not be subjected to excessive shock, vibration, dirt, moisture or oil. The ambient temperature of the area should be between 30º and 130ºF (-1.1º to 54.4º C).

3. Mount the controller with four 8-32 x 1/2” screws. The controllers are not position sensitive and can be mounted in any plane.

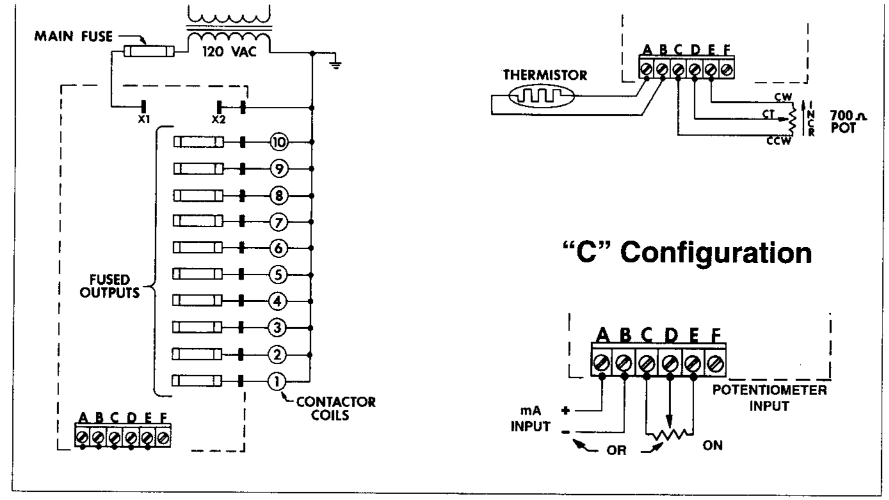
4. Consult the wiring diagram on the next page. Standard units require 120 V 50/60 Hz.

5. Be certain that power is off. Then connect power wires to .250 push-on terminals marked X1 and X2. If used on a grounded system, the X2 terminal should be grounded.

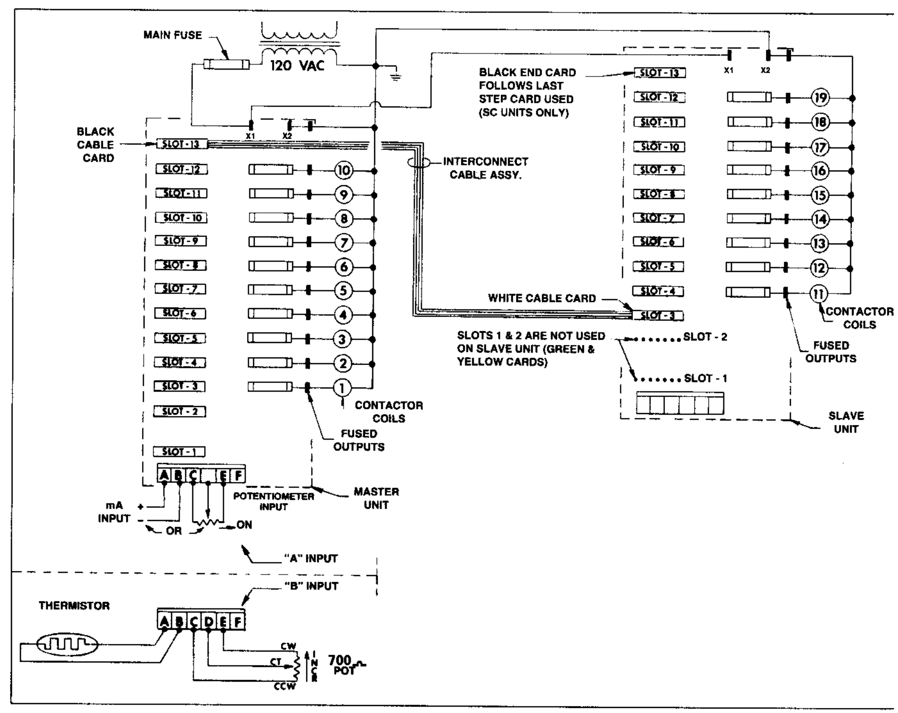
**Mounting Dimensions**



**Standard Wiring (up to 10 steps)**




**Standard Wiring (11 to 18 steps)**



6. Contactors are connected to the .250 push-on terminals marked on through ten. Connect one lead from each contactor coil to the terminals starting from number one up to a maximum of ten. Connect the returnwire from the contactors to X2, outside terminal.

***Note:*** ***Power lines should be free of high power radio frequency signals or other damaging voltage spikes. If R.F. induction heating equipment or high powered electric welders are nearby, filter all power lines leading to the staging controller.***

7. If a fuse blows, check wiring and/or contactors for shorts or overcurrent.

8. Units with standard inputs (4-20 mA, or 135 ohms slidewire) can be quickly checked by jumpering terminals D and E. All heating stages should turn on, as indicated by the red L.E.D. on each stage. Remove jumper from D and E and connect to C and D. All heat stages should turn off and cool stages (if any) should turn on., see red L.E.D. on cool stages. Remove jumper from C and D.

9. Connect input signal to appropriate lettered terminals – A through F. Standard Units: Terminals A & B – 4-20 mA source (Temperature Controller).
   (A Input) Terminals C, D & E – 135 ohms slidewire (Thermostat).

10. Turn Power on and check total system for proper operation.

***Warning:*** ***Since solid state devices do not turn off in the same sense as relay contacts, a potential shock hazard exists. For your protection, be certain all line and control power has been disconnected before working on the unit or the auxiliary contactors.***

## 2.2 MODULE EXPLANATION

The Series S Staging Controller consists of a main frame and a large printed circuit board into which are inserted a variety of input, timing and output stage boards. For ease of identification and maintenance, the individual boards are supplied with color coded handles.

| BOARD# | CODE | DESIGNATION | FUNCTION |
|---|---|---|---|
| 785A072U01 | Green | Input Signal Conditioner | 4-20 mA; 135 Slidewire (A) |
| 785A074U02 | Green | Input Signal Conditioner | Thermistor Temp. Control (B) |
| 785A074U01 | Yellow | Step Delay Driver | Adj Delay 2-5 to 12 Sec. |
| 785A078U01 | White | Circular Mode Output Stge | Heating SC Units |
| 785A076U01 | Black | Circular End Board | Completes Circular Loop |
| 785A078U02 | Red | Up-Down, Heat | SU Units |
| 785A077U02 | Blue | Up-Down, Cool | SU Units |

There are labels on each green and yellow handle describing the exact input and time delay of the signal conditioner and step delay modules. The label supplies quick identification of the unit’s operating modes. On the white, red, and blue stages, a logic status light (light emitting diode – L.E.D.) can be seen through the over in the appropriate box as each stage is energized.

The status light indicates the operation of the stage, but is not an indication of the fuse nor the output triac condition.

***Note:*** ***Modules should never be placed in the unit in arbitrary positions or while the controller is energized.***

## 2.3 OPERATION

The operation of a typical staging controller on a heating process is as follows:

When power is applied, all steps at first will be off. Then each step will turn on at the set time interval until all steps are turned-on. When the process reaches operating temperature (or as the process is approaching setpoint depending on the proportional band setting of the temperature controller), the staging controller will cut back the number of steps on, until the process requirements are satisfied.

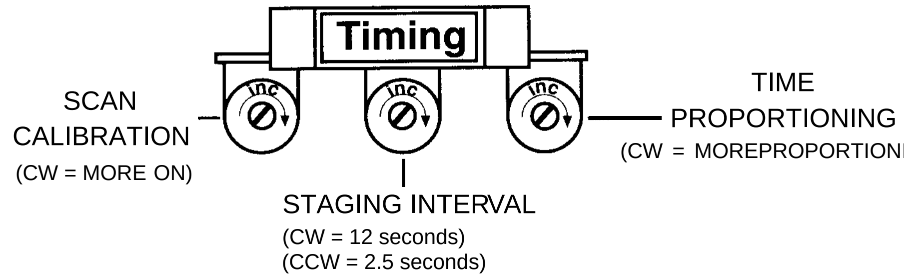
After stabilization and if the time proportioning adjustment is set at minimum, no steps will turn on and off unless the process temperature changes enough to require more or less steps if the time proportioning adjustment is turned clockwise on an ‘Up-Down’ stepper, the last step ‘on’ will cycle on and off to provide closer temperature control. On the circular stepper, the next ‘off’ step willbe turned on, the first ‘on’ step will be turned off, and this action will continue around as in a circle. The fastest rate occurs with the adjustment full clockwise.

Note: The step interval is set by the timing module. Time proportioning is only on the last step – and the fastest rate is 5 seconds.

## 2.4 ADJUSTMENTS

The following adjustments are found under the cover plate on the yellow (step delay) module. If a touch-up is desired, turn gently and wait at least 1 minute to observe results.

Timing Trim Pot




## 2.5 TIME PROPORTIONING (CYCLING) ADJUSTMENT – RIGHT SIDE

This adjustment is used to provide vernier control of power between steps by time proportioning a step of power. Up-down steppers will proportion the last ‘on’ step, and the circular stepper will add the next ‘off’ step and subtract the last ‘on’ step at the required percentage time. Turning the adjustment fully clockwise wil provide the fastest rate.

Minimum setting (ccw) provides an ‘on-off’ differential on each stage (no time proportioning). Maximum cycling will give high resolution control, but will also cause maximum wear on contractors. Forced hot air heating systems will generally require some time proportioning for best control. Water heating will usually not require any time proportioning for excellent results, and the adjustment can be set to zero (ccw).

## 2.6 STAGING INTERVAL ADJUSTMENT

This adjustment is used to set the time delay between steps. Counterclockwise is the minimum delay of 2.5 seconds, adjustable fully clockwise to a maximum of 12 seconds.

## 2.7 SPAN ADJUSTMENT – LEFT SIDE

This adjustment scales the input signal to the number of output steps on. On standard units, it is factory present to turn all heat stages 'on'with 20 mAinput and all heat stages 'off'with less than 4 mA. If signal levels are low or if span is miscalibrated, with full input signal applied, very slowly turn the adjustment clockwise until all heat stages come on. Also, if it is desired to limit the number of steps on, apply full input signal to the controller and turn the span adjustment counterclockwise to turn off steps.

## 2.8 SYSTEM ADJUSTMENTS

Dynamic stability of the whole system should be optimized using the proportional band adjustment on the controller that drives the staging controller.

Anarrow proportional band will produce tight control with minimal droop on load changes. If there are multiple time lags between heater and sensor, or it thermal coupling is loose, the system will continuously overshoot and undershoot (oscillate). Abetter sensor location or wider proportional band setting should stabilize the process.

## 2.9 FUSING

The controller is supplied wit 1Asmall glass fuses. Littelfuse type 3AG or Bussman type AGC. These fuses protect the triacs in the output boards from shorts in the contactor or in the contactor wiring. for slow acting or larger contactors, the fuses should be replaced with littelfuse type 3AG 'Slo-Blo'or Bussman type MDL(1A). Small contactors up to NEMAsize 2 will operate with standard fuses. NEMA 3 and 4 contactors may require slow blow fuses, depending on the manufacturer. NEMA6, 7, and 8 are similar to the small contactors because they have internal pilot contactors.

If a fuse blows, check the contactor and contactor wiring for shorts before operating the controller. **The controller cannot cause the fuses to blow.**

# Section 3 Options

## 3.1 THERMISTOR INPUT – 'B' OPTION

When the 'B'put module is added to the staging controller, the controller becomes a simple non-indicating temperature controller. connect the Thermistor probe to points A& B and connect the setpoint pot to points C, D, and E. The leads can be extended using conventional copper wire. Available ranges are 50-180ºF (5006), 100-200ºF (5006), and 140- 250ºF (5008). The controller is failsafe to both open and shorted probes.

To quickly check the controller, connect a test resistor (1000 to 10,000 ohms) across points A& B to simulate the probe. Turn the setpoint fully clockwise (high temperature). All steps should come on. If all steps do not turn on, slowly turn the span adjustment on the yellow board clockwise until all steps turn on (allow 1 minute per step).

Short terminals A& B and all heating stages will turn off (cooling stages will turn on). Connect probe and energize system.

For best control, the Thermistor should be placed in the process so that it can detect any temperature change with little thermal lag.

Refer to Table 1 for typical Initial Temperature settings for a number of different types of heating systems.

| | TYPICAL HEATING MEDIUM TEMPER-ATURE AT DESIGN COND. | TYPICAL INITIAL SETPOINT | RESET RATIO DESIGN TEMPERATURE -20° F | 0° F | 20° F |
|---|---|---|---|---|---|
| **DRONIC** | | | | | |
| **irect** | | | | | |
| Standing | 190° F | 100° F | 1:1 | 1:1.4 | 1:1.6 |
| Convector/baseboard | 200° F | 120° F | 1.1:1 | 1:1.1 | 1:1.6 |
| Fan Coil | | | | | |
| Heating Only | 180° F | 80° F | 1:1.1 | 1:1.4 | 1:2 |
| Heating/Cooling | 140° F | 80° F | 1.5:1 | 1.2:1 | 1:1.2 |
| **ndirect** | | | | | |
| Floor Radiant | 90° F | 70° F | 1.5:1 | 3.5:1 | 2.5:1 |
| Ceiling Radiant | 110° F | 70° F | 2.2:1 | 1.7:1 | 1.2:1 |
| **RCED AIR** | 150° F | 80° F | 1.3:1 | 1:1 | 1:1.4 |
| **KE-UP AIR** | 75° F | 70° F | 18:1 | 14:1 | 10:1 |

**TABLE 1 - RESET SELECTION GUIDE**

## RESET RATIO

The reset ratio expresses the amount of change in the heating medium control point caused by a change in outdoor temperature. It is the ratio of outdoor change to heating medium control point change. Notice that this is an inverse ratio: when outdoor temperature goes down, the control point goes up.

## SELECTING THE RESET RATIO

The reset ratio should be selected to provide a complete range of heating medium temperatures when the outdoor temperature goes from 70ºF to the outdoor design temperature. Typical reset ratios for a number of different types of heating systems are given in TABLE 1. These figures are intended to provide the installer with a starting point on installations where the reset ratio is not specified. Further adjustments may be necessary depending on the requirements of a particular system.

## OPERATION

The 5002 sensor measures the outdoor temperature. A change to in and outdoor air temperature causes a resistance change in the Thermistor element of the sensor. This resistance change unbalances the bridge circuit of the reset controller. The effect of the unbalance is to offset the heating medium control point. The amount of offset in the relation to outdoor change is determined by the setting of the Reset Ratio knob. The action of the controlled equipment compensates for the bridge unbalance by supplying more or less heat to the controlled space.

# Section 4 Unit Repairs

It is recommended that units requiring service be returned to an authorized service center. Before a controller is returned for service, please consult the service center nearest you. In many cases, the problem can be cleared up over the telephone. When the unit needs to be returned, the service center will ask for a detailed explanation of problems encountered and a Purchase Order to cover any charge. This information should also be put in the box with the unit. This should expedite return of the unit to you.