Using the Watlow® Series 93 Temperature Controller in a Thermo Scientific SOLA II System

Key Words
* Temperature controller programming and configuration

Purpose

The Thermo Scientific SOLA II sulfur online analyzer uses a temperature controller to control the temperatures of the pyrolyzer heater and analyzer oven. Originally, the analyzer used the Watlow® Series 93 temperature controller. The Series 93 has since been replaced by the Watlow EZ-ZONE® PM6 series controller. Since many SOLA II systems still use the original controller, this technical bulletin can be used as a reference for configuration and programming

Note: For instructions on using the EZ-ZONE PM6 series controller, refer to the SOLA II analyzer user guide.

Description

The Series 93 controller (Figure 1) is used to control the temperatures of the SOLA II pyrolyzer heater and the analyzer oven. This controller provides a signal output if the zone temperature is outside a specific range.

Figure 1. Watlow Series 93 temperature controller

Temperature Controller Interface

The displays and keys on the temperature controller are called out in Figure 2. Descriptions of these items are provided below the figure.
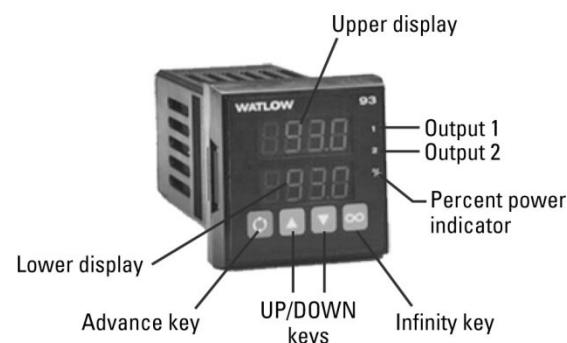

Figure 2. Displays and keys

* Upper display: Normally displays the process value, actual temperature, operating parameter values, or an open sensor.
* Lower display: Normally displays the set point, output value, and parameters for data in the upper display. Error and alarm codes may also be shown as applicable.
* Output 1: When the light is on, output 1 is energized.
* Output 2: When the light is on, output 2 is energized. Can also be configured as a control or alarm output.
* Percent power indicator: (1) Steady light indicates the controller is in Manual operation. (2) Pressing the Infinity key twice causes the controller to enter Automatic mode. (3) If light is blinking, press the Infinity key to toggle between Automatic and Manual mode. If the Infinity key is not pressed within five seconds, the controller returns to its previous state and stops blinking.

- Infinity key: (1) Pressing once clears an alarm and disables the deviation alarm output if silencing is enabled. (2) Pressing a second time within five seconds causes the controller to switch from Automatic to Manual mode.
- Advance key: Steps through the Operations, Setup, and Calibration menus.
- UP/DOWN keys: (1) Increases/decreases value of the displayed parameter. Pressing the key lightly increases/decreases the value by one. Holding the key down increases/ decreases the value rapidly. (2) Press both keys simultaneously for three seconds to enter the Setup menu. (3) Continuing to press and hold both keys simultaneously will take you to the Calibration menu.

Modifying Setup Parameters

Enter the Setup menu by pressing the UP and DOWN keys simultaneously for three seconds. Press the Advance key until *LOC* appears in the lower display. Set the LOC parameter to 0 to unlock access to the Setup menu.

Press the Advance key until you reach the desired parameter. Use the UP and DOWN keys to adjust the setting. Once the setting is correct, press the Advance key to step to the next parameter.

⚠️ Parameters for the temperature controller were set to the optimum values for your application prior to shipment. Changing the parameters may adversely affect system performance.

Lockout Functions

Table 1 shows typical settings for the Series 93 temperature controller. Your particular application may be different.

Table 1. Menus with various lockout settings

Lockout	Visible	Adjustable	Permitted
0	Permits all parameters to be changed or viewed.		
1	Set point, process value, alarm settings	Set point	Manual operation, auto-tune
2	Set point, process value, alarm settings	Set point	Manual operation
3	Set point, process value	Set point	
4	Set point, process value		

Notes:

Lockout levels 0, 1, and 2: Bumpless transfer to Manual operation will occur on sensor break. Percent power adjustable when in Manual operation.

Lockout levels 3 and 4: Bumpless transfer defeated and outputs disabled on sensor break.

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Configuration

The tables in this section list typical temperature controller settings for pyrolyzer and oven temperature control. Consult the application notes shipped with the system or the system logbook for specific settings if different than the ones listed in the tables.

Table 2. Pyrolyzer settings

Parameter	Definition	Setting	Comments
LOC	User Lock Out	4	Set to 0 for access to setup menu.
LN	Input Type	S	For Type S thermocouple.
DEC	Decimal Place	0	0
C_F	Celsius_Fahrenheit	C	Degrees Celsius.
RL	Range Low	0	Lowest obtainable temperature set point.
RH	Range High	1150	Highest obtainable temperature set point.
OT1	Output 1	HT	
HSC	Control Hysteresis	2	
OT2	Output 2	DEA	
HSA	Output 2 Hysteresis	2	
LAT	Latching for Alarm	NLA	
SIL	Silence Alarm	OFF	
RTD	RTD Calibration Curve	None	
RP	Ramp Function	OFF	
RT	Ramp Rate	Use Default	
PL	Power Limiting	30	
DSP	Display	NOR	
PB1	Proportional Band 1		Establish during auto-tune.
RE1	Reset 1		Establish during auto-tune.
IT1	Integral 1		Establish during auto-tune.
RA1	Rate 1		Establish during auto-tune.
DE1	Derivative 1		Establish during auto-tune.
CT1	Cycle Time 1	0.5	
PB2	Proportional Band 2		Establish during auto-tune.
RE2	Reset 2		Establish during auto-tune.
IT2	Integral 2		Establish during auto-tune.
RA2	Rate 2		Establish during auto-tune.
DE2	Derivative 2		Establish during auto-tune.
CT2	Cycle Time 2	Use Default	
ALO	Alarm Low	-5	Injections stop if temperature more than 5°C below temperature set point.
AHI	Alarm High	5	Injections stop if temperature more than 5°C above temperature set point.
CAL	Calibration Offset	0	
AUT*	Auto-Tune	0	0 = off, 1 = slow, 2 = medium, 3 = fast.

Table 3. Oven settings

Parameter	Definition	Setting	Comments
LOC	User Lock Out	4	Set to 0 for access to setup menu.
LN	Input Type	rt.d	For RTD.
DEC	Decimal Place	0	0
C_F	Celsius_Fahrenheit	C	Degrees Celsius.
RL	Range Low	0	Lowest obtainable temperature set point.
RH	Range High	200	Highest obtainable temperature set point.
OT1	Output 1	HT	
HSC	Control Hysteresis	0.2	
OT2	Output 2	DEA	
HSA	Output 2 Hysteresis	0.2	
LAT	Latching for Alarm	NLA	
SIL	Silence Alarm	OFF	
RTD	RTD Calibration Curve	JIS	
RP	Ramp Function	OFF	
RT	Ramp Rate	Use Default	
PL	Power Limiting	70	
DSP	Display	NOR	
PB1	Proportional Band 1		Establish during auto-tune.
RE1	Reset 1		Establish during auto-tune.
IT1	Integral 1		Establish during auto-tune.
RA1	Rate 1		Establish during auto-tune.
DE1	Derivative 1		Establish during auto-tune.
CT1	Cycle Time 1	0.5	
PB2	Proportional Band 2		Establish during auto-tune.
RE2	Reset 2		Establish during auto-tune.
IT2	Integral 2		Establish during auto-tune.
RA2	Rate 2		Establish during auto-tune.
DE2	Derivative 2		Establish during auto-tune.
CT2	Cycle Time 2	Use Default	
ALO	Alarm Low	-5	Injections stop if temperature more than 5°C below temperature set point.
AHI	Alarm High	5	Injections stop if temperature more than 5°C above temperature set point.
CAL	Calibration Offset	0	
AUT*	Auto-Tune	0	0 = off, 1 = slow, 2 = medium, 3 = fast.

DIP Switch Settings

The temperature controllers used for the pyrolyzer heater and analyzer oven use different temperature input devices. The DIP switches located on the bottom of the controller must be set based on what it will be controlling. See Table 4.

Table 4. Series 93 temperature controller DIP switch settings

Controlled Zone	Input Type	DIP SW 1	DIP SW 2
Pyrolyzer temperature	Type S thermocouple	OFF	ON
Oven temperature	RTD	OFF	OFF

Auto-Tuning

⚠️ Auto-tune the pyrolyzer after the control set point has been reached. Auto-tuning from ambient temperature applies 100% power and will cause damage to the heater.

⚠️ Each temperature controller must be properly configured before auto-tuning.

Auto-tuning automatically selects a set of viable PID values. To auto-tune the pyrolyzer, follow the steps below.

1. Enter the Setup menu by pressing the UP and DOWN keys simultaneously for three seconds.

2. Press the Advance key until *LOC* appears in the lower display. Set the LOC parameter to 0 to unlock access to the Setup menu.

3. Press the Advance key until you reach the auto-tune function (AUT). Use the UP and DOWN keys to select a thermal response value of 2 (1 = slow response, 2 = average response, 3 = fast response).

4. Press the Advance key. While the controller is in tuning mode, the lower display will alternately display the normal information and the prompt *AUe* in one second intervals.

5. When tuning is complete, the display will return to the previous state and *AUe* will revert to 0. If no keys are pressed for approximately 60 seconds, the controller will return to the default display.

Error Codes

If an error code is displayed on the controller, consult Table 5 to determine the possible cause. For assistance, contact Thermo Fisher Scientific Technical Support.

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Table 5. Series 93 temperature controller error codes

Code	Indication	Possible Cause/Action
0	--- in upper display with a zero in the lower display.	Typically indicates an open thermocouple.
Er 4	Configuration error; defective microprocessor.	Repair or replace the unit.
Er 5	Nonvolatile checksum error.	May be caused by momentary power interruption or by defective nonvolatile memory. Cycle power to the controller. If error persists, repair or replace the unit.
Er 6	A/D under flow error; A/D under range voltage too low to convert A/D signal.	Check for an open or reversed polarity sensor. Ensure input parameters and DIP switches are set properly.
Er 7	A/D over flow error; A/D over range voltage too high to convert A/D signal.	Check for an open or reversed polarity sensor. Ensure input parameters and DIP switches are set properly.

Notes:

Errors may be caused by electrical noise, vibration, excessive humidity, or high ambient temperatures. Check these in addition to the items noted above.

After correcting an Er 4 or Er 5 condition, cycle the controller power to clear the error message.

Table 6. Series 93 temperature controller error conditions

Code	Resulting Conditions
Er 4, Er 5	- Controller stays in automatic mode. - Both outputs go to OFF. - All keys become inactive. - All setup parameters return to defaults.
Er 6, Er 7	If LOC is set to 3 or 4: - Controller stays in automatic mode. - Both outputs go to OFF. - The Infinity and Advance keys become inactive. - Setup mode is accessible.

Notes:

Error conditions mask alarm displays. Alarm displays are also masked when the controller is in Setup or Calibration mode.

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