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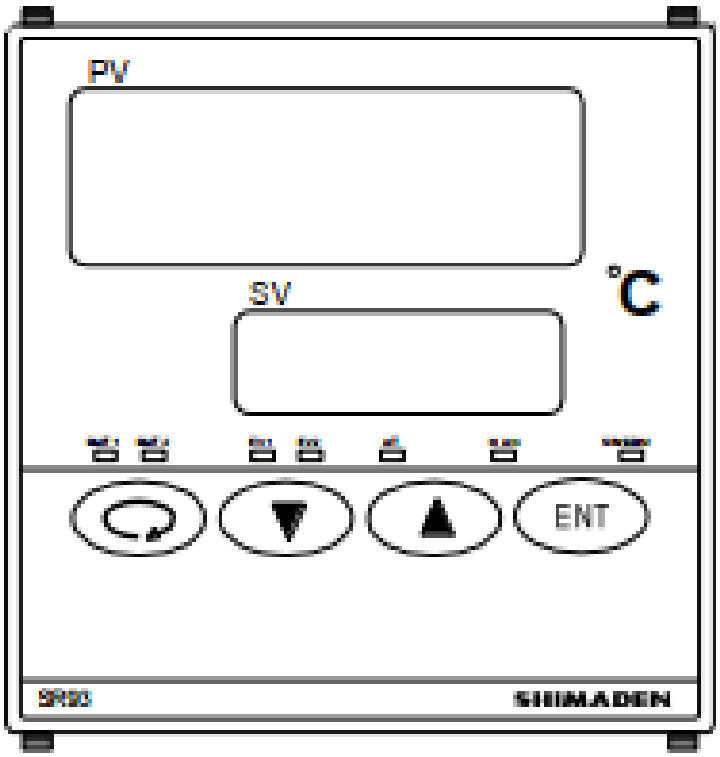
TR893 CONTROLLER
USER GUIDE

WARNING: Make sure to disconnect the controller from any power source during the wiring operation to prevent an electric shock. Be certain that the protective conductor terminal (GND) is properly grounded, otherwise, an electric shock may occur. Do not touch wired terminals and other charged elements while they are being energized to prevent an electric shock. Consult a Watson McDaniel representative if questions arise.



CONTROLLER INTERFACING

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TR893 Interface

Measured Value (PV)

Present measured valued (PV) is displayed on the screen group 0, basic screen and output display screens (OUT1 and OUT2) in red. Type of parameter is shown on each parameter screen. This will be the RTD measured temperature value in the case of the Heat Miser.

NOTE: Pressing parameter key simultaneously with the enter key in screen group 1 calls preceding screen onto display.

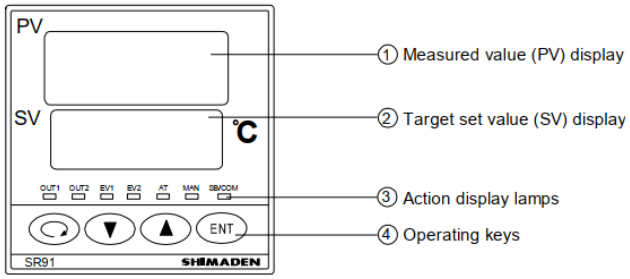

Figure 3: TR893 Controller Display

Target Set Value (SV)

Target set value (SV) is displayed on the basic screen of the screen group 0 in green. Present output value is displayed in % on control output monitor screens (OUT1 and OUT2) of the screen group 0. Selected item and set value are displayed on each parameter screen. This is how the user sets a temperature value for the Heat Miser system, SV should be just below or above desired temperature to ensure overheat does not occur.

Action Display Lamps

Control Output Indicators: (option) OUT1 and OUT2 (green) OUT1 lights when output turns on and goes out when off during contact or SSR drive voltage. Brightness changes in proportion to output increase/decrease during current or voltage output. OUT2 functions only if this option is added.

Event Output Indicators: EV1/EV2 (option) (orange) light when assigned events including heater break or loop alarm turn on if equipped.

Auto Tuning Action Indicators: AT (green) flashes when on is selected by up key on the AT action selection screen and AT is executed by enter key and goes out when AT terminates automatically or is released.

Manual Control Output Action Indicator: MAN (green) flashes when manual control output is selected on control output display screens (OUT1/OUT2); remains unlit during automatic control output.

Set Value Bias/Communication Indicator: SB/COM (green) Lights when optional set value bias function is added and at the time of shorting across SB terminal. Also, lights when optional communication function is added and COM mode is selected, goes out when Local is selected for communication mode.

Operating Keys

Parameter Key: When this key is pressed on any screen of the screen group 0 or 1 calls the next screen onto display. When pressed continuously for 3 seconds, this key functions to move between the basic screen of group 0 and the initial screen of group 1.

Down Key: When pressed on a parameter screen, the decimal of the rightmost digit flashes and the set data decreases or moves backward.

Up Key: When pressed on a parameter screen, the decimal of the rightmost digit flashes and the set data increases or moves forward.

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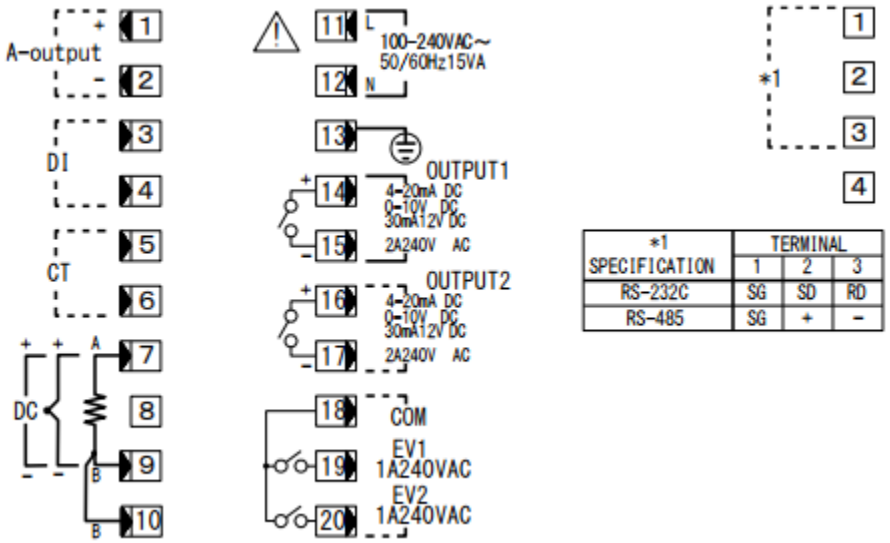
Entry/registration Key: This is used to register a set data changed by means of the up/down key on a parameter screen. When pressed continuously for 3 seconds, this key functions to switch between automatic and manual output.

PID CONTROLLER WIRING



*1 SPECIFICATION	TERMINAL 1	2	3
RS-232C	SG	SD	RD
RS-485	SG	+	−

Name of terminal	Description/Code	Terminal No. SR91	SR92	SR93·94
Power supply	100-240V AC:L	6	8	11
	100-240V AC:N	7	9	12
	24V AC:L / 24V DC: +	6		
	24V AC:N / 24V DC: −	7		
Protective conductor	⏚	8	10	13
Input	R.T.D.: A, thermocouple/voltage/current: +	2	4	7
	R.T.D.: B, thermocouple/voltage/current: −	4	6	9
	R.T.D.: B	5	7	10
Control output 1	Contact: NO, SSR drive voltage/Voltage/Current: +	9	11	14
	Contact: NO, SSR drive voltage/Voltage/Current: −	10	12	15
Control output 2 (option)	Contact: NO, SSR drive voltage/Voltage/Current: +	11	13	16
	Contact: NO, SSR drive voltage/Voltage/Current: −	12	14	17
Event output (option)	COM	13	19	18
	EV1	14	20	19
	EV2	15	21	20
Heater break (option)	CT input	11-12	17-18	5-6
Analog output (option)	+	11	15	1
	−	12	16	2
Communication (option)	RS-232C: SD, RS-485: +		2	2
	RS-232C: RD, RS-485: −		3	3
	SG	1	1	1
	RS-485: +	11		
	RS-485: −	12		
DI (option)		11-12	1-2	3-4

NOTE:
With thermocouple/voltage/current input, shorting across B and B terminal will cause an error.

NOTE:
The optional functions of the SR90 are subject to the following conditions:

SR91:
Only one of control output 2, heater break alarm, analog output, communication and DI is selectable.

SR92:
Communication and DI are not selectable simultaneously.

SR93/SR94:
Communication and analog output, or communication and DI are not selectable simultaneously.
Simultaneous selection of analog output and DI is possible, though.

PID CONTROLLER TUNING GUIDE

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This section will assist with autotuning the PID controller equipped on your Watson McDaniel Heat Miser. Verify the controller model installed and reference the applicable section associated with the equipped model. Manual tuning should be performed only after it has been determined that the Auto Tune process has not provided adequate control for the process. When changing PID settings, allow some time for the changes to take effect by observing the process and tracking the oscillation time between dwells if applicable.

Note: Menu pathways differ between TR893 and Nanodac controllers, refer to applicable section for steps. However, the PID manual tuning logical process remains the same. Refer to the Manual Tuning Guide section below for more information.

TR893 Autotune

1. Turn on the controller and/or verify it is at the main screen.
2. Apply a typical hot water demand on the system.
3. Press the Parameter button, the first button on the left side, to scroll through the menu screens.
4. The top display will read “At” for the Auto Tune screen.
5. Press the “Up” button to change the “off” value on the bottom display to “On”.
6. Press “Enter”, far right side button, to lock in the value.
7. The AT led will illuminate to confirm operation.
8. The Auto Tune sequence will begin by stroking the control valve open and closed twice which typically takes 1-5 minutes.
9. When complete the Auto Tune light will turn off.

TR893 Manual Tune Menu Path

1. Turn on the controller and/or verify it is at the main screen.
2. Press and hold the Parameter button, the first button on the left side for 3 seconds.
3. After 3 seconds the top display will show “PArA” to let you know that you are in the Parameters Menu.
4. Press the “Parameter” button to scroll through the Parameter menus.
5. The P, proportional, value will be the 3rd screen, the I, integral, will be next, and the D, derivative, will be the next screen.
6. To edit the PID values, press the “Up” or “Down” Buttons.
7. Press “Enter”, far right side button, to lock in the value.
8. Hold the Parameter button down to scroll through the Screens until it returns to the main “PArA” screen.
9. Hole the parameter button for 3 seconds to exit back to the main menu.
10. Proceed to the Manual Tuning Guide section for full manual tune logic.

Nanodac Autotune

1. Turn on the controller and/or verify main screen selected.
2. Press the page button, the first button on the left side.
3. Highlight ‘Login’ by using the arrow buttons and press the Scroll Button, second button in from the left. See Figure 4 in the manual.
4. Select ‘Engineer’ access and press Scroll button.
5. Press the down arrow 3 times to select ‘Numeric’ and press Scroll.
6. Enter 100 or eewwqq12 as the password using the Arrow & Scroll buttons. Note the password will depend upon the version of Nanodac equipped. Then Press Page when complete.
7. The confirmation box will appear. Highlight ‘Yes’ to confirm. Now the Auto tune can be initiated through the controller’s configuration.
8. On the main screen, press the page button to access the top level menu.

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9. Highlight ‘Loop’ in the Configuration Menu and press the Scroll Button.
10. Select Loop 1 and press the Scroll Button.
11. Highlight ‘Tune’ in the Loop Menu and press the Scroll Button.
12. Highlight ‘Tune Enable’. ‘On’ initiates the Auto Tune. You must log out of Engineer to start Auto Tune. Legend changes to ‘Off’ when Auto Tune is Complete. Set to ‘Off’ manually, to stop the tuning process.
13. ‘State’ will display the progress of the Auto Tune. Verify that it is ‘Running’. **Log out of the Engineer level after Setting Tuning Enable.**
14. On the main screen, press the page button to access the top level menu.
15. Highlight ‘Logout’ by using the arrow buttons and press the Scroll.

Nanodac Manual Tune Menu Path

1. On the main screen, press the page button to access the top level menu.
2. Highlight ‘Configuration’ by using the arrow buttons and press the Scroll Button.
3. Highlight ‘Loop’ in the Configuration Menu and press the Scroll Button.
4. Highlight ‘PID’ in the Loop Menu and press the Scroll Button.
5. The Proportional Band ‘PB’, Integral Time ‘Ti’, and the Derivative Time ‘Td’ will be in this menu.
6. Proceed to the Manual Tuning Guide for full manual tune logic.

Manual Tuning Guide

Proportional Band Setting (P)

1. Adjust the set point to the desired temperature.
2. Set the Proportional Band (P) to 75% of the set point temperature to start. a. Ex: 120°F Desired Temperature would be P = 90
3. Set the Integral and Derivative (I and D) to ‘off’.
4. Apply a normal heating load or demand on the system. a. Ex: Open several hot water faucets or wash down hoses.
5. Watch the Process Variable (PV – actual measured outlet temperature) and verify that there is a stable temperature. The Process Temperature will most likely be sluggish in response and offset, high or low, from the set temperature. See Figure 5.1 for a visual example. If the PV does not have these characteristics, then multiply P by 2 and observe until it does.

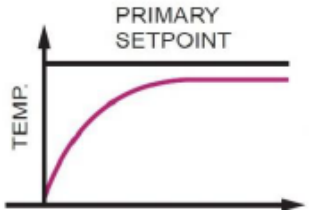

Figure 5.1: High P Value (Stable but Offset)

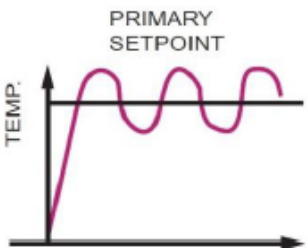

Figure 5.2: Low P Value (Large Oscillations)

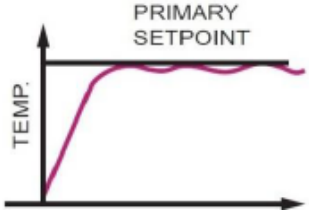

Figure 5.3 Ideal P Value (Minimal Oscillations)

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6. Once a stable High P value has been observed, divide the P value by 2 and observe the PV, Process Temp.
   Ex: Stable @ P = 90 (Figure 5.1) Divide P by 2 so P = 45
7. Repeat step 6 until oscillations are noticeable and then multiply P by 1.5.
   Ex: Stable @ P = 45 (Figure 5.1) Divide P by 2 so P = 22. PV now resembles Figure 5.2
8. Observe the Process Temp, PV, to see if it matches Figure 5.3
   Ex: Multiply P by 1.5 to get PV value to resemble Figure 5.3
9. Adjust the P value between the two images Figure 5.1 and Figure 5.2 values until an ideal P value is achieved as shown in Figure 5.3. Note: There should be a minimal PV deviation and the dwell time between oscillations should be several minutes.
10. Observe the process at startup to ensure that the Temperature rises to the set point with minimal overshoot.

Integral Time Setting (I)

1. Track the length of time in between oscillations in seconds and multiply that by 5/8. This will be the starting Integral value.
   Ex: 1-minute oscillations = 60 seconds; I = 60 seconds x 5/8 = 38
2. Track the performance of the Integral by changing the heating load conditions.
3. To increase the response time of the offset, reduce I value by 0.5x, and to reduce the response time, increase by 0.5x.
   Ex: Sluggish recovery after heating load change, 38 x 0.5 = 19; I = 38 – 19 = 19
4. From a cold start, test and verify that the Integral Time allows maximum elimination of offset with minimum overshoot. If not completely satisfied, fine-tune the value, up or down, as needed and test until correct.

Derivative Time Setting (D)

1. Use the oscillation time from before and divide it by 10 to enter the Derivative value.
   Ex: 1-minute oscillations = 60 seconds; D = 60 seconds / 10 = 6
2. If the system is very dynamic the D value may remain at zero.
3. Make 25% changes with D to adjust. Increase if the response is still sluggish and decrease if oscillations are at a quick rate.

Recommendations

1. Make slow methodical changes and track the PID settings w/ any high/low cyclic temps as well as oscillation times.
2. Track temperature changes and recovery times during heat load changes as well to ensure minimal overshoot.
3. Decrease the Integral if overshooting occurs. Decrease the Derivative accordingly as well if on.
4. Systems with quick PV changes may benefit from a low P (0.2) & higher I (1.5-10) or high P (1.5 x set point) & low I (2-10).

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HIGH LIMIT SETUP

The high limit package is an optional adder that improves the safety of the Heat Miser in case of system failure. This includes an integrated high limit safety in the control valve which can shut off when temperature limitations are reached. The FDC-L91 high limit valve is usually paired with a butterfly valve that can shut off the steam supply to the heat exchanger to prevent overheating and damage of equipment.

High Limit Display

Enter/Scroll Key

When acting as an enter key, press the scroll key for 4 seconds and the display will enter the setup menu. Pressing the key for 8 seconds will enter calibration mode. When used as a scroll key, one can press to select a setpoint to be displayed. As well as selecting a parameter to be viewed or adjusted. It can also advance the display from a parameter code to the next parameter code.

Up/Down Key

When the lock indicator is off, these keys can increase or decrease the selecting parameter.

Reset/Unlock Key

When used as the reset key, it can reset the limit condition after the process is within the limit. It can also revert the display to normal display, reset the latching alarm, and reset the annunciator. When used as an unlock key, pressing the key for 4 seconds will enable the up/down functions and the lock indicator LED will turn off. This function is disabled if remote lock is selected for EIFN (event input function).

Note: If the enter/reset key is left pressed only one reset operation will occur. If the unit goes into a state where reset is required again, release the key and press in again.

Indicators

OP1/OP2: Output status one and two

C/F: Temperature reading in Celsius or Fahrenheit

PV: Process Value

HSP1: High limit set point 1

LSP1: Low limit set point 1

SP2: Set point 2 for output 2

LOCK: Lock status on/off

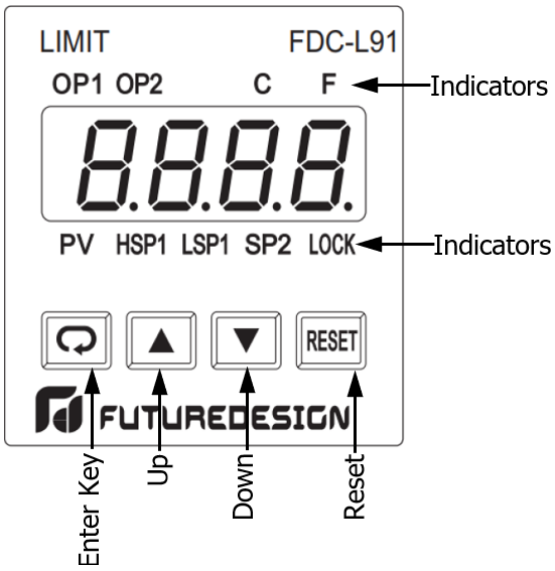

Figure 6: High Limit Controller Display

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High Limit Setup

1. Press and hold the enter/scroll key for 4 seconds to open parameters.

2. Hold the reset/unlock key to unlock controller.

3. Use Table 4 to update controller settings, reference the display settings on how to maneuver through the menu items.

Setting	InPt	Unit	rESo	SHiF	FiLt	Out1	01.HY	HSP.L	HSP.H	Out2	EiFn	diSP
User Input	Pt.dn	°F	no.dP	0	0	H1.	2	32	200	EiFn	rEST	SP1

Table 4: High Limit Controller User Defined Parameters

ELECTRICAL PANEL CONFIGURATIONS

Electrical Schematics

The Watson McDaniel Heat Miser runs off standard United States power grid electric, 120 VAC 50-60Hz. Several variations of electrical schematic exist for the Watson McDaniel Heat Miser. Alternate configuration selections will change the schematics shown below. Alternate configurations may include additional RTDs, NO high limit package w/ high limit valve, split range control valves (electronic or pneumatic), or selecting no PID controller and instead using an Aquastat high limit switch and/or HD valve with temperature pilot.

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