Series 935B

Now with Remote Timer Start and Fully DIN-a-mite® Compatible

Temperature Controller with Countdown Timer

User Levels:

- New User ..... Go to page 2
- Experienced User / Set-Up ..... Go to page 11
- Expert User ..... Go to page 51

Installers:

- Mounting ..... Go to page 40
- Wiring Information .....Go to page 44

CE

TOTAL CUSTOMER SATISFACTION
3 Year Warranty

ISO 9001
Registered Company
Winona, Minnesota USA

WATLOW

1241 Bundy Boulevard, P.O. Box 5580, Winona, Minnesota USA 55987-5580
Phone: +1 (507) 454-5300, Fax: +1 (507) 452-4507, http://www.watlow.com

U.S. English

0600-0015-0001 Rev C
July 2000
Supersedes: 0600-0015-0001 Rev B

$15.00

Safety Alert
CAUTION or
WARNING

Safety Information in this Manual

Note, caution and warning symbols appear throughout this book to draw your attention to important operational and safety information.

A “NOTE” marks a short message to alert you to an important detail.

A “CAUTION” safety alert appears with information that is important for protecting your equipment and performance.

A “WARNING” safety alert appears with information that is important for protecting you, others and equipment from damage. Pay very close attention to all warnings that apply to your application.

Electrical Shock Hazard

CAUTION or
WARNING

The ⚠ symbol (an exclamation point in a triangle) precedes a general CAUTION or WARNING statement.

The ⚠ symbol (a lightning bolt in a lightning bolt in a triangle) precedes an electric shock hazard CAUTION or WARNING safety statement.

Technical Assistance

If you encounter a problem with your Watlow controller, review all configuration information to verify that your selections are consistent with your application: inputs; outputs; alarms; limits; etc. If the problem persists after checking the above, you can get technical assistance by calling your local Watlow representative (see back cover of this manual), or in the U.S., dial +1 (507) 494-5656. For technical support, ask for an Applications Engineer.

Please have the following information available when you call:

- Complete model number
- All configuration information
- User’s Manual
- Diagnostic menu readings

Warranty and return information is on the inside back cover of this manual.

Your Comments

Your comments or suggestions on this manual are welcome. Please send them to the Technical Literature Team, Watlow, 1241 Bundy Boulevard, P.O. Box 5580, Winona, Minnesota, 55987-5580 U.S.; Telephone: +1 (507) 454-5300; fax: +1 (507) 452-4507.

Copyright July 2000 by Watlow, Inc., with all rights reserved. (1950)

Where to find it...

Table of Contents

Item ..... Page

Introduction 4
How Keys Work 6
Begin Controlling 8
Set Point Change 9
Simple Error / Response 10
Software Map; Learn 11
Operations Menu; Learn 12
PID Menu; Learn 14
Configuration Menu; Learn 18
Lockout Functions 20
Setting Up Inputs and Outputs 22
Using Remote Timer Start Input 24
Front Panel Lockout 25
Alarms; Learn 26
Alarms; Setting and Clearing 28
Timer; Learn 30
Timer; Setting 32
Timer Example 33
Auto-tuning 34
PID Fine tuning 35
Calibrating 36
Errors and Troubleshooting 38
Mounting 40
Dimensions 41
Installing 42
Terminal Block Removal 43
Wiring 44
Wiring Examples 45
Glossary 46
Index 47
Specifications 48
Ordering Information 49
Declaration of Conformity 50
Advanced Software Map 51
Warranty/Returns ..... Inside Back Cover
How to Reach Us ..... Back Cover

Table # ..... Page

1 Output Functions 5
2 Error Messages & Action 10
3 Software Organization 11
4 Operations Menu Overview 13
5 PID Menu Overview 16
6 Configuration Overview 18
7 Lockout Options 21
8 Setting Inputs & Outputs 23
9 Using Front Panel Lock 25
10 Alarm Functions 27
11 More Alarm Functions 29
12 Timer Functions/Settings 31
13 Possible Error Codes 39
14 Troubleshoot Outputs 39
15 Input Range Information 49

Figure # ..... Page

1 Input & Output Overview 5
2 Front Panel Functions 7
3 Begin Controlling 8
4 Changing the Set Point 9
5 Front Panel Lock Wiring 25
6 Auto-tuning 34
7 Calibrating 36
8 Panel Cut-out Dimensions 40
9 Knockout Template 40
10 Dimensions 41
11 Case Top View & Collar 42
12 NEMA 4X/IP65 Seal 42
13 Terminal Block Removal 43
14 Wiring 44
15 System Wiring Example 45
16 Ladder Diagram Example 45

Introduction

Welcome to the Watlow Series 935B!

General Description

The Series 935B is a temperature controller with countdown timer for industrial, commercial, or scientific applications. It offers 1/32 DIN panel-mounting, digital indication, single temperature sensor input from a thermocouple or RTD, and dual control outputs. Both outputs are fully *DIN-a-mite*® compatible, and may operate in combinations of heat or cool, and alarm or timer.

Special Features

- Easy to use operator interface and user's manual
- Compact panel footprint; 1/32 DIN size
- Water and corrosion proof; NEMA 4X / IP65 rated
- Reliable; built to UL, CUL approved safety standards with a three year warranty
- Accuracy with economy
- Universal power supply for worldwide application

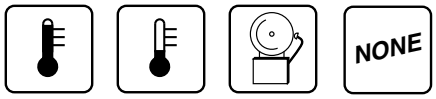
Unique Features

The Series 935B is configured with dual dc *DIN-a-mite*® compatible control outputs and a separate logic input for remote timer start or front panel lock. The Series 935B timer functions include heat/timer or cool/timer countdown modes in hours:minutes or minutes:seconds.

Figure 1 - Series 935B Input and Output Overview

Single Input
Type J, K, T, N, S, E Thermocouple, 1° RTD, or 0.1° RTD

Output 1
Switched dc



Heat Cool Alarm None

Output 2
Electromechanical Relay, Switched dc or Solid-state Relay

Heat Cool Alarm Timer (Hr:Min or Min:Sec) None

- The function of Output 1 determines the options available for Output 2.
- First select the function of Output 1. Refer to the table (right), then select the function of Output 2.

Table 1 - Valid Output Functions

First select **Output 1:**	Then select **Output 2:**
Heat	None, Cool, Alarm, Timer
Cool	None, Heat, Alarm, Timer
Alarm	None, Heat, Cool
None	Heat, Cool, Alarm

Press & read or press & change

Reading or Changing Information is Easy

You can simply:

• Read the normally displayed actual temperature,

or…

• Press and hold SET to read the set point,

or…

1. Press and hold ∧ and ∨ simultaneously for three seconds to move to a software menu.

2. Press and hold SET to display a choice or value.

3. While continuing to press SET, press ∧ or ∨ to choose new data or select a new value.

4. Release SET and the arrow key to complete the change.

NOTE: The normally displayed actual temperature and set point can be altered to show different combinations of actual temperature, set point temperature, or time in hours:minutes or minutes: seconds. See dISP p. 18.

Figure 2 - Series 935B Front Panel Functions

Seven-segment alphanumeric display:

- Shows process value, set point information, time, or
- Shows prompt name or value, depending on the key combination pressed.

Set Key: SET

- Configurable to shift between normally-displayed value and set values. See disP, p.18.
- Clears a latched alarm.

LED 1:

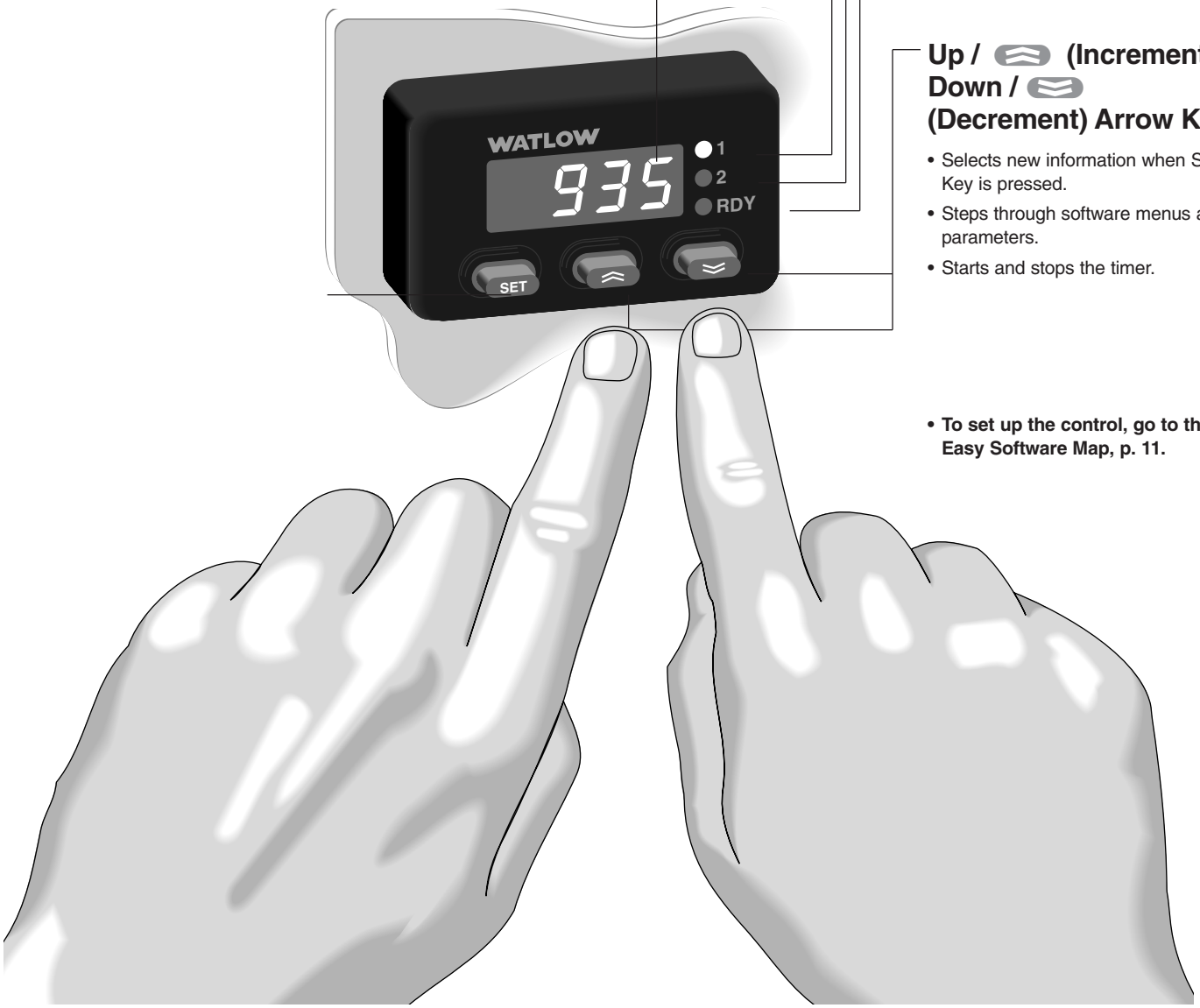
Lit when Output 1 is active.

LED 2:

Lit when Output 2 is active.

RDY:

Lit when the process temperature is inside the timer ready band.



Up / (Increment) Down / (Decrement) Arrow Key:

- Selects new information when Set Key is pressed.
- Steps through software menus and parameters.
- Starts and stops the timer.

- **To set up the control, go to the Easy Software Map, p. 11.**

Begin Controlling

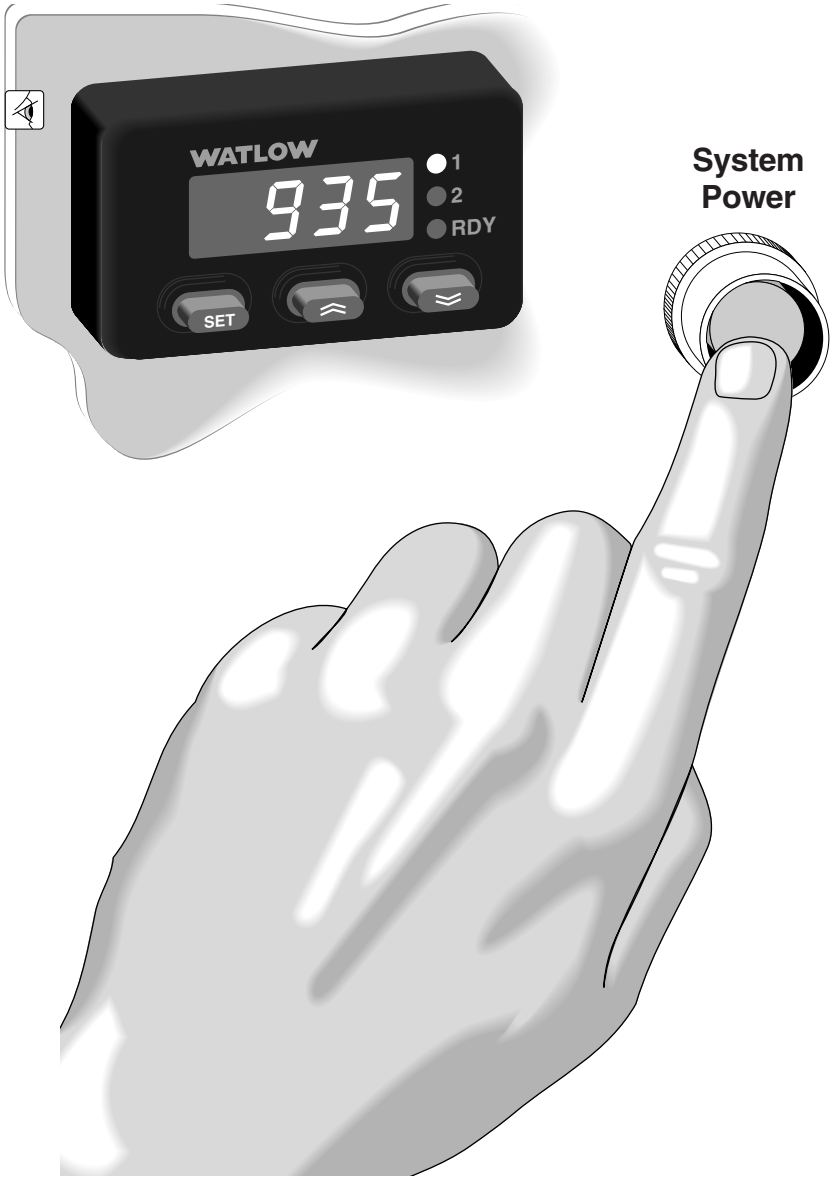
To Begin Controlling:

1. Apply power to the system.
A properly-wired Series 935B will begin controlling the thermal system as soon as you apply power to it.

2. Look at the Series 935B's display. It is reading actual temperature, set point temperature, or time.

- To change set point, go to p. 9.
- The Series 935B will auto-tune when you tell it to, go to p. 34.
- If you see an error, go to p. 10.

Figure 3 - Begin Controlling



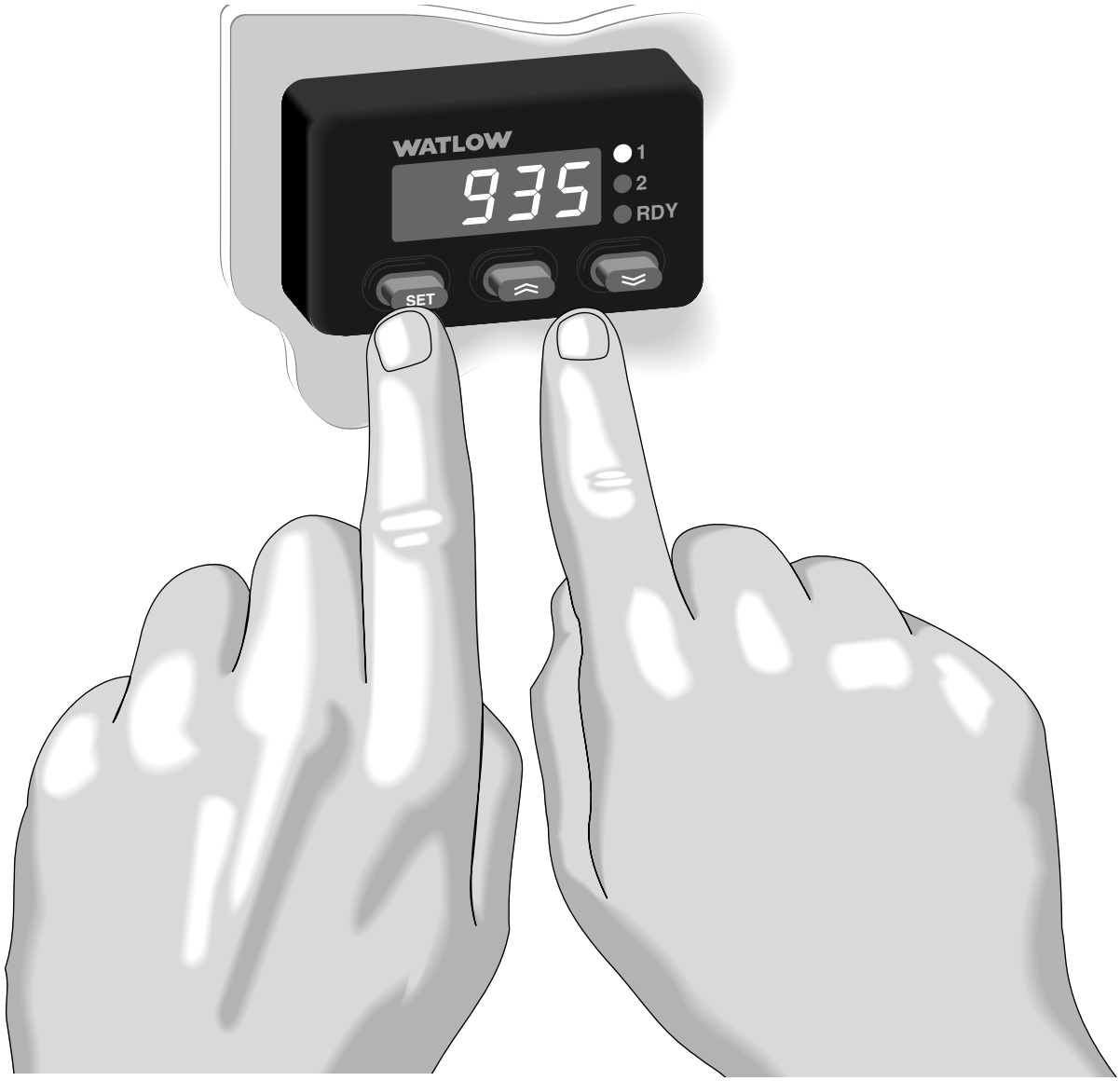
Change Set Point

To Change the Set Point:

Your Series 935B displays the actual process temperature when it comes from the factory. You can change it to normally display the set point or time. Go to p. 18, see dISP.

1. Press and hold SET.
2. Press one of the arrow keys to alter the set point either upward or downward.
3. Release SET to complete the change.

Figure 4 - Changing the Set Point



Respond to a simple error

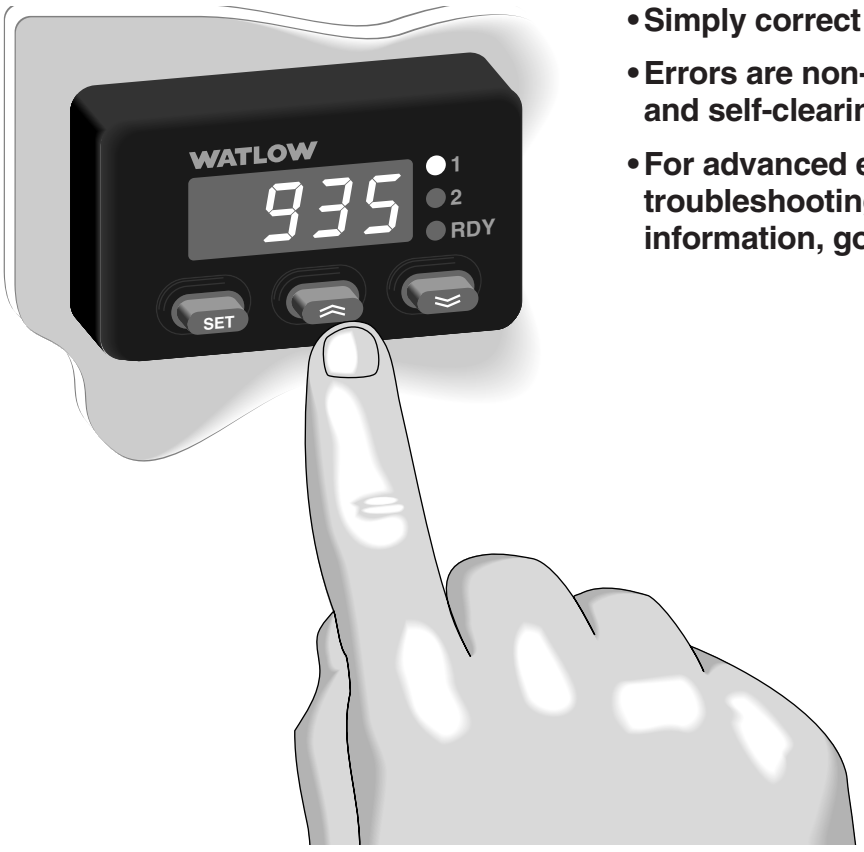
If You See An Error Code:

1. Be aware that most errors are input (sensor) related.

2. Read the table below and follow its recommendations.

Table 2 - Error messages and recommended action

Display	Probable Cause	Recommended Action
Er 1	Reversed thermo-couple connection + to –.	Change the sensor leads on Terminals 1 and 2.
Er 2	Sensor type mismatch or open RTD.	Go to In prompt, check selection (see p. 22), or check RTD, replace as necessary.
Er 3	Sensor type mismatch.	Go to In prompt, check selection (see p. 22).
Er 4	Open Thermocouple, bad connection, or broken wire.	Check the sensor, replace as necessary.
Er 5	Electrical noise.	Cycle power to system. See if error clears. Check system for electrical interference.
	Control is inoperable.	Check for line voltage at terminals 7 and 8.



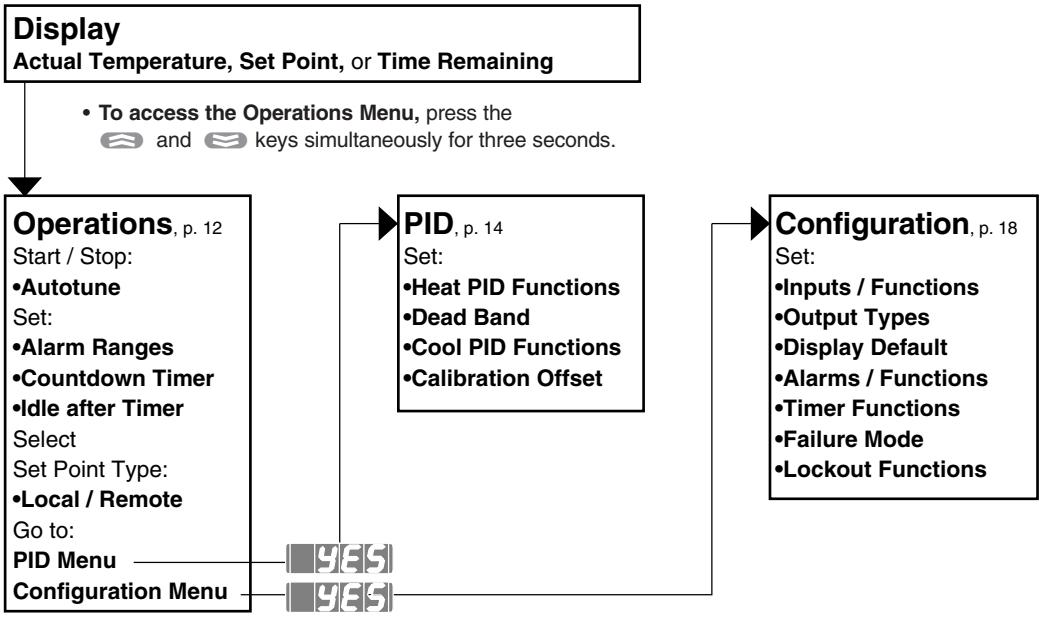
- **Simply correct the cause.**
- **Errors are non-latching and self-clearing.**
- **For advanced error and troubleshooting information, go to p. 39.**

Learn Easy Software Map

Software Organization

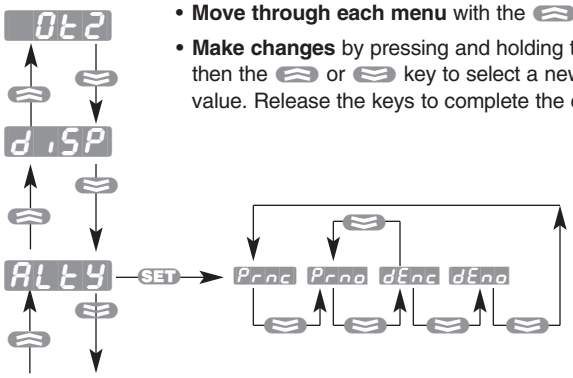
- The Series 935B has three primary menus in addition to a normal display.
- The software reverts to the normal display after 60 ± 5 sec. with no key action.

Table 3 - Software Organization



• **At the** Pid **or** CnFG **prompt,** press and hold the SET key, and the or key to select YES. Release the keys to move to the new menu.

Navigation Example



- **Move through each menu** with the or key.
- **Make changes** by pressing and holding the SET key, and then the or key to select a new choice or value. Release the keys to complete the change.

• **To exit any menu:** Press and hold the and keys for three seconds, or
the display will revert to normal display after 60± 5 seconds.

Learn the Operations Menu

The Series 935B Operations Menu is the first menu you encounter when you press the and keys simultaneously for three seconds. The Operations Menu provides a location to initiate the following actions or complete the following tasks:

- **Auto-tune** **:** Start or stop the auto-tuning process. Auto-tuning selects a set of viable proportional, integral, and derivative values for heat and/or cool output.
- **Alarm Points,** **and** **:** Select the values for the high alarm point and the low alarm point. Alarm points, dependent on sensor type high and low ranges, reside in the Operations Menu for easy access.
- **Timer Countdown Time** **:** Select a countdown time value between 00:00 and 99:59 hours:minutes or minutes:seconds. Time interval choices and reside in the Configuration Menu for Output 2.
- **Idle Set Point** **:** or an adjustable value between and . Choose to have the Idle Set Point track , or equal, the Primary Set Point; or select an Idle Set Point value in °F or °C between the range low and range high values. The Idle Set Point is active both before and after the timing sequence. The normal or Primary Set Point controls during the timing sequence.
- **Go to the PID Menu** **:** Choose to proceed to the PID Menu.
- **Go to the Configuration Menu** **:** Choose to proceed to the Configuration Menu.

The table on the next page presents this information in graphic form.

NOTE: Not every prompt listed here or on p. 13 in the Operations Menu will appear in your unit. Prompts vary with lockout function and output set-up. Whether or not prompts appear in the Operations Menu depends on two features of the Series 935B:

- Lockout function; the Lockout Tag function masks prompts from view in the various menus. (If you cannot see a prompt, you can make no change.) See Using Lockout Functions, p. 20, for more information.
- Output 1 and 2 Configuration; some outputs are mutually exclusive. For example, if Output 1 is Alarm, then Output 2 cannot be Timer. Therefore, the Operations menu will have no timer-related prompts. See the Valid Output Functions Table, p. 5, or Setting Up Inputs and Outputs, p. 22.

Table 4 - Operations Menu Overview

To enter the **Operations Menu**, press the ∧ and ∨ keys simultaneously for three seconds.

Auto-tune - Start the auto-tune action to automatically select a set of viable PID values; tunE will flash during auto-tuning.

NO YES

Alarm Low - Select a low alarm point, adjustable between Off, Range Low and Alarm High.

Alarm High

Alarm High - Select a high alarm point, adjustable between Alarm Low and Range High, or OFF.

Alarm Low

Countdown Timer - Select a countdown time duration.

00:00 to 99:59 Hrs:Min or Min:Sec

Idle Set Point Type - Choose to track set point, or select a separate idle set point adjustable between Range Low and Range High. When Ot1 = tHrM or trMS, view the idle set point from the set point display with a three second SET press.

Track Set Point | Range Low | Range High

PID Menu - Go to the PID Menu.

NO YES

Configuration Menu - Go to the Configuration Menu.

NO YES

Learn the PID Menu

Choosing a PID Setting Strategy

You may rely solely on the Auto-tune AUt function (p. 34) and factory defaults to determine PID values for your system, or you may use auto-tuning and additional manual adjustments. You must select dead band db and calibration offset CAL values manually.

The Series 935B PID Menu is the first sub-menu you encounter after moving to the Operations Menu. The PID Menu provides a software location to select the individual heat or cool proportional band, hysteresis, and cycle time values; and the dead band, integral, derivative, and calibration offset values.

To go to the PID Menu:

1. Go first to the Operations Menu by pressing ⌃ and ⌄ simultaneously for three seconds.

2. Scroll through the Operations Menu with ⌄ until you see the PId prompt.

3. While pressing SET to display no, choose YES with ⌃ or ⌄.

4. Release SET to see the first PID prompt.

NOTE: Access to the PID Menu and the prompts there varies with lockout function and output set-up. The PID Menu is locked out when the 935B leaves the factory.

- Lockout function; the Lockout Tag tAG function masks menus from view (if you cannot see a prompt, you can make no change).
  See Using Lockout Functions, p. 20.
- Output set-up; you must choose HEAt or COOL in either Output 1 or Output 2 to have access to the PID Menu. With a HEAt only choice, COOL prompts are not visible, and vice versa.

See the Valid Output Functions Table, p. 5, or Setting Up Inputs and Outputs, p. 22.

NOTE: Proportional Band, Integral, Derivative, Dead Band, and Calibration Offset values are adjustable in whole or tenth °F or °C, depending on input type In and C_F Celsius/Fahrenheit Configuration Menu choices.

Setting PID Menu Values

- **Proportional Band, Heat and Cool Pb h and Pb c:** Select a value (degrees) to set up band on either side (±) of the Primary Set Point in which the heat and/or cool proportioning function(s) will be active.
  For on/off control, set Pb h or Pb c = 0.
  Range: 0 to 999°F/555°C, or 0.0 to 999.0°F/555.0°C
  Default: 25°F/17°C, or 25.0°F/17.0°C
- **Hysteresis, Heat and Cool hysh and hysc:** For use with on/off control only. Select the value (degrees) for the process variable change required to re-energize the control heat and/or cool output.
  For ON/off control, set Pb h or Pb c = 0.
  Range: 1 to 999°F/555°C, or 0.1 to 999.0°F/555.0°C
  Default: 3°F/2°C, or 3.0°F/2.0°C
- **Cycle Time, Ct h and Ct c:** Select the value (seconds) required for the heat and/or cool output(s) to complete a full ON through off cycle.
  Range: Switched dc/Solid State Relay: 0.1 to 60.0 seconds
  Default: 5.0 seconds
  Range: Electromechanical Relay: 5.0 to 60.0 seconds
  Default: 30.0 seconds
- **Dead Band db:** Dead Band adjusts the effective cool set point above the primary set point by the Dead Band value in degrees. This creates a band between the heating and cooling proportional bands where only integral and derivative activity will occur. For more information on Dead Band fine tuning, go to p. 35.
  Range: 0 to 999°F/555°C, or 0.0 to 999.0°F/555.0°C
  Default: 0°
- **Integral It:** Select a value (minutes/repeat) for the integral function. Integral is the inverse of Reset; It(value) = 1/Reset(value).
  Range: 0.00 to 99.99 minutes/repeat
  Default: 5.00 minutes/repeat
- **Derivative dE:** Select a value (minutes) for the derivative function.
  Range: 0.00 to 9.99 minutes
  Default: 0.00 minutes
- **Calibration Offset CAL:** Eliminates the difference between the displayed process temperature and the actual process temperature value.
  Range: -999 to 9999°F/C, or -99.9 to 999.9F/C
  Default: 0°

Learn the PID Menu - Details

Table 5 - PID Menu Overview

Set-Up Heat

Proportional Band Heat - Select a heat proportional band value.

0 to 999	0 to 555	0.0 to 999.0	0.0 to 555.0
0°F to 999°F, or	0°C to 555°C, or	0.0°F to 999.0°F, or	0.0°C to 555.0°C

Hysteresis Heat - Select a heat ON/off control switching hysteresis.

1 to 999	1 to 555	0.1 to 999.0	0.1 to 555.0
1°F to 999°F, or	1°C to 555°C, or	0.1°F to 999.0°F, or	0.1°C to 555.0°C

Cycle Time Heat - Select a heat output cycle time.

0.1 to 60.0	5.0 to 60.0
0.1 to 60.0 seconds (SSR or Switched dc)	5.0 to 60.0 seconds (Electromechanical Relay)

Dead Band - Select a dead band value.

0 to 999	0 to 555	0.0 to 999.0	0.0 to 555.0
0°F to 999°F, or	0°C to 555°C, or	0.0°F to 999.0°F, or	0.0°C to 555.0°C

Set-Up Cool

Proportional Band Cool - Select a cool proportional band value.

0 to 999	0 to 555	0.0 to 999.0	0.0 to 555.0
0°F to 999°F, or	0°C to 555°C, or	0.0°F to 999.0°F, or	0.0°C to 555.0°C

Hysteresis Cool - Select a cool ON/off control switching hysteresis.

1 to 999	1 to 555	0.1 to 999.0	0.1 to 555.0
1°F to 999°F, or	1°C to 555°C, or	0.1°F to 999.0°, or	0.1°C to 555.0°C

Cycle Time Cool - Select a cool output cycle time.

0.1 to 60.0	5.0 to 60.0
0.1 to 60.0 seconds (SSR or Switched dc)	5.0 to 60.0 seconds (Electromechanical Relay)

Set-Up General

Integral Function - Select an integral value.

0.00 to 99.99 minutes/repeat

Derivative Function - Select a derivative value.

0.00 to 9.99 minutes

Calibration Offset - Select a calibration offset value.

-999° to 9999°F or C or -99.9° to 999.9°F or C

NOTE: Access to the PID Menu and the prompts there varies with lockout function and output set-up. The PID Menu is locked out when the 935B leaves the factory.

- Lockout function; the Lockout Tag tAG function masks menus from view (if you cannot see a prompt, you can make no change). See Using Lockout Functions, p. 20.
- Output set-up; you must choose HEAt or COOL in either Output 1 or Output 2 to have access to the PID Menu. With a HEAt only choice, COOL prompts are not visible, and vice versa. See the Valid Output Functions Table, p. 5, or Setting Up Inputs and Outputs, p. 22.

Learn the Configuration Menu

The Configuration Menu is the second sub-menu in the Operations Menu. Use it to set Inputs, Ranges, Output Types, Alarms, Timer, Failure Mode, and Lockouts.

To go to the Configuration Menu:

1. Go first to the Operations Menu by pressing ⩓ and ⩔ simultaneously for three seconds.
2. Scroll through the Operations Menu with ⩔ until you see the CnFG prompt.
3. While holding SET to display no, choose YES with ⩓ or ⩔.
4. Release SET to see the first CnFG prompt, In.
5. To leave the Configuration Menu, press ⩓ and ⩔ for 3 seconds.

Table 6 - Configuration Menu Overview

Input Type - Choose sensor type. See p. 23 for sensor ranges.

In	J	K	t	n	E	S	rtd	rtd
	J t/c	K t/c	T t/c	N t/c	E t/c	S t/c	1.0° RTD	0.1° RTD

Celsius/Fahrenheit - Choose displayed unit of measure.

C_F	°F	°C
	°F	°C

Input Range Low - Select lowest displayable set point. Ranges, p. 23.

rL	In	rh
		Select a value (lowest displayable set point) between Input Type Range Low and Input Range High.

Input Range High - Select highest displayable set point. Ranges, p. 23.

rh	rL	In
		Select a value (highest displayable set point) between Input Type Range High and Input Range Low.

Output 1 Function - Choose Output 1 type; see Valid Outputs Table, p. 23

Ot1	HEAt	COOL	ALM1	nonE
	Heat	Cool	Alarm	None

Output 2 Function - Choose Output 2 type (dependent on Output 1 choice).

Ot2	HEAt	COOL	ALM1	thM1	tM1S	nonE
	Heat	Cool	Alarm	Timer Hr./Min.	Timer Min./Sec	None

Remote Timer Start - Choose remote timer start operation.

rtS	oFF	FPL	tM1r
	Off	Front Panel Lock	Countdown Timer

Display Default - Choose the primary (last 2 characters) and secondary (first 2 characters) default displays. Press SET to toggle to the secondary display for 15 seconds.

diSP	Ac	AcSP	Act1	t1Ac	t1SP
	No secondary Actual temp.	Actual temp. Set pnt temp.	Actual temp. Time remaining	Time remaining Actual temp.	Time remaining Set point temperature

Alarm Type - Choose alarm type with output action.

ALty	PrnC	PrnO	dEnC	dEnO
	Process normally closed	Process normally open	Deviation normally closed	Deviation normally open

NOTE: Access to Configuration Menu varies with lockout function. See p. 21.

Alarm Hysteresis - Choose alarm switching band.

AHYS | 1 | 999 | 1 | 555 | 0.1 | 999.0 | 0.1 | 555.0

1°F to 999°F, or 1°C to 555°C, or 0.1°F to 999.0°F, or 0.1°C to 555.0°C

Alarm Latch - Choose latching or non-latching alarms.
A latching alarm requires a SET press to clear it after the alarm condition clears.

LAt | no | YES

NO YES

Alarm Silencing - Choose to silence alarms on startup, or not.
SIL = YES silence an alarm with a SET press.

SIL | no | YES

NO YES

Failure Mode - Choose output action after a sensor failure.
Bumpless transfer provides a smooth transition to percent power control without output state change.

FAIL | bPLS | -100 | 100

Bumpless Percent Power

Timer Output Function - Choose output function for the end of the timer.
Delay ON = Turn ON, Delay Off = Turn off, Signal ON = Toggle ON, Signal off = Toggle off

tIM7 | dLon | dLoF | SGon | SGoF

Delay on | Delay Off | Signal On | Signal Off

Start Timer Function - Choose the start timer conditions:
IM7d = Immediate start on a ≈ press; rdy = ≈ press and Actual temp. is inside the Ready Band; rdyA = ≈ press, plus Actual temp. is inside the Ready Band, then acknowledge with a SET press;
PWUr = immediate start on power-up without waiting for Ready Band temp. or a ≈ press.

Strt | IM7d | rdy | rdyA | PWUr

Immediate | Ready | Ready Acknowledge | Power

Timer Ready Band - If Strt = rdy or rdyA, select ready band high/low values.

rdy | 0 | 999 | 0 | 555 | 0.0 | 999.0 | 0.0 | 555.0

0°F to 999°F, or 0°C to 555°C, or 0.0°F to 999.0°F, or 0.0°C to 555.0°C

Signal Time - If tIM7 = SGon or SGoF, select a Signal ON or Signal off time duration to trigger an annunciator or other action at completion of countdown time.

St | 1 | 9959

1 sec. to 99:59 min:sec.

Set Point Lock - Choose to lock the Primary Set Point from change, not view.

SLOC | no | YES

NO YES

Lockout Tag - Choose undisplayable/unchangeable menus; PCOA = all locked.

tAG | PCOA / COA | PCO / CO | PC A / C A | PC / C | P OA / OA | P O / O | P A / A | P

Choose the menus / function that will not be displayed, and therefore cannot be changed. P = PID Menu, C = Configuration Menu (except tAG), O = Operations Menu (except CnFG), A = Auto-tune.

Using Lockout Functions

Configuration Menu

- In — Input Type
- C_F — Celsius/Fahrenheit
- rL — Input Range Low
- rh — Input Range High
- Ot1 ✓ — Output 1 Function
- Ot2 — Output 2 Function
- rtS — Remote Timer Start
- diSP — Display Default
- ALtY — Alarm Type
- AhyS — Alarm Hysteresis
- LAt — Alarm Latch
- SIL — Alarm Silencing
- FAIL — Failure Mode
- tIM — Timer Function
- Strt — Start Timer
- rdy — Timer Ready Band
- St — Signal Time
- SLOC ✓ — Set Point Lockout
- tAG ✓ — Lockout Tag

Key Lockout Information

The Series 935B offers three different security, or "lockout," options. Set up one or all three lockout options in the Configuration Menu.

- **Front Panel Lock** FPL uses an input for an external hardware switch; it requires wiring, see p. 25. Choose Front Panel Lock FPL from the rtS choices.
- **Choose Set Point Lock** SLOC as the simplest lockout option. It locks the Primary Set Point from change, but not from view.
- **Choose the Security Tag** tAG as a means of masking the Series 935B software menus from view. By selecting all or part of the four-digit binary acronym, PCOA (Proportional / Configuration / Operation / Autotune), you can choose to mask those items from view, and therefore from change. For example: In the Configuration Menu tAG set-up, if you can see the P, the operator cannot see the PID menu.
  - Exceptions to PCOA tAG are:
    "C" does not lock out tAG .
    "O" does not lock out CnFG .

Table 7 - Series 935B Lockout Options

Three Lockout Options Detailed

	Front Panel Lockout rtS	Set Point Lockout SLOC		Security Tag tAG			A
	FPL	no	YES	P	C	O	
View Process	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
View Set Point	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Change Set Point	**No**	**Yes**	**No**	**Yes**	**Yes**	**Yes**	**Yes**
Auto-tune	**No**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**No**
View, Change Operation Menu	**No**	**Yes**	**Yes**	**Yes**	**Yes**	**No**	**Yes**
View, Change Configuration Menu (except tag)	**No**	**Yes**	**Yes**	**Yes**	**No**	**Yes**	**Yes**
View, Change PID	**No**	**Yes**	**Yes**	**No**	**Yes**	**Yes**	**Yes**

Note: Front Panel Lockout requires an external hardware switch. For FPL set-up and wiring information, see p. 25. For more wiring information, see p. 45.

P = PID Menu,
C = Configuration Menu (except tAG),
O = Operations Menu (except CnFG),
A = Auto-tune

Setting Inputs and Outputs

Configuration Menu

- In ✓ Input Type
- C_F ✓ Celsius/Fahrenheit
- rL ✓ Input Range Low
- rh ✓ Input Range High
- Ot1 ✓ Output 1 Function
- Ot2 ✓ Output 2 Function
- rtS ✓ Remote Timer Start
- diSP ✓ Display Default
- ALtY Alarm Type
- AhyS Alarm Hysteresis
- LAt Alarm Latch
- SIL Alarm Silencing
- FAIL Failure Mode
- tIMr Timer Function
- Strt Start Timer
- rdy Timer Ready Band
- St Signal Time
- SLOC Set Point Lockout
- tAG Lockout Tag

Key Input/Output Set-up Information

- All initial input and output set-up occurs in the Configuration Menu.
- Indication of °C or °F units of measure occurs only in the C_F prompt.
- Sensor input type minimum and maximum range (see p. 53) is further defined with Range Low rL and Range High rh to set the working span of set points and remote set point scaling.
- Output 1 and Output 2 configure the prime functions of the Series 935B, they are the “golden” prompts.
- Output 1 must be heat or cool to use Output 2 as a timer.
- Front Panel Lock FPL requires a customer-supplied external switch wired on Terminals 3 and 4. Switch open = unlocked; closed = locked. Select this feature with rtS = FPL.
- Remote Timer Start requires a customer-supplied switch on Terminals 3 and 4. Switch closed=start. Select this feature with rtS = tMr.
- Output 2 sets timer interval in hours:minutes tHrM or minutes:seconds tMrS.
- Display Default diSP lets you choose the primary (last 2 characters) and secondary (first 2 characters) default displays. Press SET to toggle to the secondary display for 15 seconds.
  - Ac = Normal Display: Actual Temperature
    Secondary: None
  - AcSP = Normal Display: Set Point Temperature
    Secondary: Actual Temperature
  - Act.t = Normal Display: Time Remaining
    Secondary: Actual Temperature
  - t.Ac = Normal Display: Actual Temperature
    Secondary: Time Remaining
  - t.SP = Normal Display: Set Point Temperature
    Secondary: Time Remaining

NOTE: Access to Configuration Menu varies with lockout function. See p. 21.

Configuration Menu

Table 8 - Setting Inputs and Outputs

Input Type - Choose sensor type.

J t/c | K t/c | T t/c | N t/c | E t/c | S t/c | 1.0° RTD | 0.1° RTD

Input Range Information

J t/c:	32	to	1382°F	or	0	to	750°C
K t/c:	-328	to	2282°F	or	-200	to	1250°C
T t/c:	-328	to	662°F	or	-200	to	350°C
N t/c:	32	to	2282°F	or	0	to	1250°C
S t/c:	32	to	2642°F	or	0	to	1450°C
E t/c:	-328	to	1470°F	or	-200	to	799°C
1° RTD (DIN):	-328	to	1292°F	or	-200	to	700°C
0.1° RTD:	-99.9	to	999.9°F	or	-99.9	to	700.0°C

Celsius/Fahrenheit - Choose displayed unit of measure.

°F | °C

Input Range Low - Select lowest displayable Set Point, dependent on In.

Select a value (lowest displayable set point) between Input Type Range Low and Input Range High.

Input Range High - Select highest displayable Set Point, dependent on In.

Select a value (highest displayable set point) between Input Type Range High and Input Range Low.

Output 1 Function - Choose Output 1 type.

Heat | Cool | Alarm | None

- The function of Output 1 determines the options available for Output 2.
- First select the function of Output 1. Refer to the table (right), then select the function of Output 2.

Valid Output Functions

First select **Output 1:**	Then select **Output 2:**
Heat	None, Cool, Alarm, Timer
Cool	None, Heat, Alarm, Timer
Alarm	None, Heat, Cool
None	Heat, Cool, Alarm

Output 2 Function - Choose Output 2 type (dependent on Output 1 choice).

Heat | Cool | Alarm | Timer Hr./Min. | Timer Min./Sec | None

Remote Timer Start - Choose Off, Front Panel Lock, or Timer (Hrs:Min).

Off | Front Panel Lock | Timer

Display Default - Choose the primary (last 2 characters) and secondary (first 2 characters) default displays. Press SET to toggle to the secondary display for 15 seconds.

No secondary Actual temp. | Actual temp. Set pnt temp. | Actual temp. Time remaining | Time remaining Actual temp. | Time remaining Set point temperature

Using Remote Timer Start Input

Configuration Menu

In ✓
Input Type

C-F ✓
Celsius/Fahrenheit

rL
Input Range Low

rh
Input Range High

Ot1 ✓
Output 1 Function

Ot2
Output 2 Function

rtS ✓
Remote Timer Start

diSP
Display Default

FAIL
Failure Mode

SLOC
Set Point Lockout

tAG
Lockout Tag

Operations Menu

Aut
Auto-tune

L-r
Local / Remote

Pid
PID

CnFG
Configuration

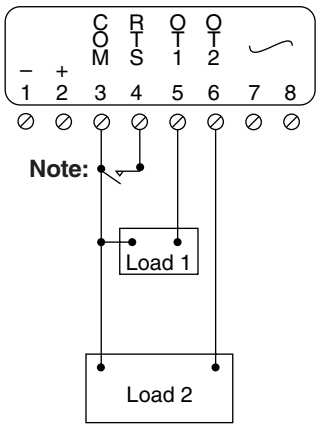
To Set Up Remote Timer Start…

1. Wire the control per the example below and the information on p. 44-45.
2. Make In and C_F choices, then
3. Select trmr at the rtS prompt.
4. Close switch to remotely start the timer.

Figure 5 - Remote Timer Start Wiring

See p. 45 for more wiring information.

(Closed switch = Starts Timer)



Note: Customer -supplied N.O. momentary switch.

WARNING: All wiring and fusing must conform to local and national electric codes. Contact local authorities for further information. Failure to comply with electric codes could result in injury or death, or damage to property.

Using Front Panel Lockout

Configuration Menu

- In — Input Type
- C_F — Celsius/Fahrenheit
- rL — Input Range Low
- rh — Input Range High
- Ot1 — Output 1 Function
- Ot2 — Output 2 Function
- rtS ✓ — Remote Timer Start
- diSP — Display Default
- FAIL — Failure Mode
- tIM — Timer Function
- Strt — Start Timer
- rdy — Timer Ready Band
- St — Signal Time
- SLOC — Set Point Lockout
- tAG — Lockout Tag

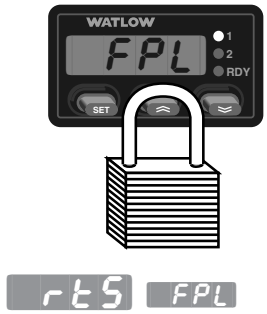
To Set Up Front Panel Lock…

1. Install an external switch.

2. Wire the control per the example below and the information on p. 44-45.

3. Go to CnFG menu, then rtS prompt, and choose FPL.

Table 9 - Using Front Panel Lock



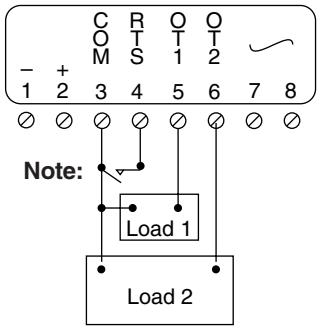
rtS FPL

rtS = FPL	
View Process	Yes
View Set Point	Yes
Change Set Point	No
Auto-tune	No
Reset Alarm	Yes
View or Change Operation Menu (Except Config. Menu)	No
View or Change Configuration Menu (Except Tag)	No
View or Change PID Menu	No

Figure 6 - Front Panel Lock Wiring

See p. 44 and 45 for more wiring information.

(Closed switch = locked panel)



Note: Customer-supplied two-position switch.

Learning Alarms

Configuration Menu

- In — Input Type
- C_F — Celsius/Fahrenheit
- rL — Input Range Low
- rh — Input Range High
- Ot1 — Output 1 Function
- Ot2 — Output 2 Function
- rtS — Remote Timer Start
- diSP — Display Default
- ALty ✓ — Alarm Type
- AhyS ✓ — Alarm Hysteresis
- LAt ✓ — Alarm Latch
- SIL ✓ — Alarm Silencing
- FAIL — Failure Mode

Operations Menu

- Aut — Auto-tune
- AL0 ✓ — Alarm Range Low
- Ah1 ✓ — Alarm Range High
- Pid — PID
- CnFg — Configuration

Key Alarm Information

Alarms signal an excursion from normal operating conditions. In general, audible alarms or lights connected to alarm outputs will signal a problem. In the 935B the front panel LED "1" or "2" indicates an alarm with h1 or LO flashing on the main display.

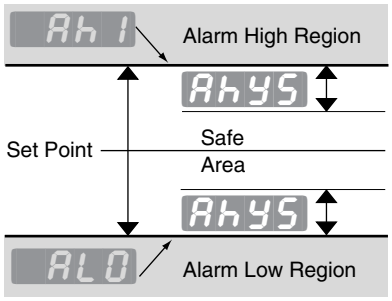
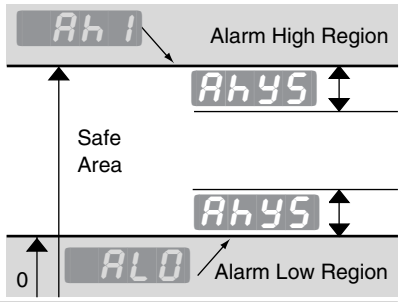
- **Process alarms** use absolute high and low values to trigger an alarm. Use this alarm type if your process may be subject to temperatures that it must not exceed. Use Ah1 and AL0 to set alarm points at or near these values. See Table 10: ALty, next page.
- **Deviation alarms** are triggered by a deviation from the set point. The alarm high value Ah1 is the deviation above set point, and the low value AL0 is the deviation below set point. Whenever the set point is adjusted, the alarm settings are relative to that value. Deviation alarms use the currently controlling set point, whether primary, remote, idle, or 90% of primary, during auto-tuning. See Table 10: ALty, next page.
- **Normally Open, dEno or Prno, Alarms** energize the alarm output when an alarm condition occurs, and de-energize it when cleared. Use this type to activate external devices such as audible alarms or lights. See Table 10: ALty, next page.
- **Normally Closed, dEnc or Prnc, Alarms** de-energize the alarm output when an alarm condition occurs, and energize it when the alarm is cleared. Use this type as a "deadman" switch where system continuity is required for operation. See Table 10: ALty, next page.

  For example, by running the control output through the alarm output, you can set a normally closed process alarm to disable the process when the process exceeds the alarm set point. The alarm output will be off when power is off.
- **Alarm Hysteresis** sets a point the process must pass on a return (from an alarm condition excursion) to the AL0 and Ah1 points before the alarm can clear. This prevents the alarm output from "chattering" if the process is hovering around the alarm set point. See Table 10: AhyS, next page.
- **Latching Alarms** require the operator to clear them with a SET press after the process returns to a safe, or non-alarm condition. Non-latching alarms self-clear. See Table 11: LAt, p. 29.
- **Silenced Alarms** provide a means to clear the alarm output with a SET press even if the alarm condition still exists. The flashing h1 or LO message will persist until the alarm condition ceases. See Table 11: SIL, p. 29. If SIL = YES, alarms are disabled (no message or output) on startup until the safe area is reached.
- **Alarm High and Low** Points, Ah1 and AL0, in the Operations menu determine where alarms will trigger. Alarm hysteresis AhyS determines where an alarm condition clears. See Table 11, page 29.

- **To Clear an Alarm** that is latched or “silence-able’ requires the operator to press the SET key after the process returns to a safe, or non-alarm condition. Non-latching alarms self-clear. See Table 11: LAt and SIL, p. 29.

Table 10 (below) and Table 11 (p. 29) illustrate the Series 935B alarm features.

Table 10 - Alarm Functions

ALTY	Deviation Alarm		Process Alarm	
	dEnc	dEno	Prnc	Prno
Alarm Type ➡	**Deviation normally closed**	**Deviation normally open**	**Process normally closed**	**Process normally open**
Non-Alarm State LED off Alarm Output:				
Alarm State LED on Alarm Output Status:				
Silenced-Alarm State LED off Alarm Output Status:				
Power-Off State LED off Alarm Output Status:				
Function A deviation alarm tracks set point. A process alarm is a fixed value, independent of set point.				
AHTY	Alarm Hysteresis is the change in the process variable (actual) required to clear the alarm relay after an alarm occurs.			

Note: With no power connected to the unit, the alarm output will be in an open state.

Setting and Clearing Alarms

Configuration Menu

- In — Input Type
- C_F — Celsius/Fahrenheit
- rL — Input Range Low
- rh — Input Range High
- Ot1 — Output 1 Function
- Ot2 — Output 2 Function
- rtS — Remote Timer Start
- diSP — Display Default
- ALtY ✓ — Alarm Type
- AhyS ✓ — Alarm Hysteresis
- LAt ✓ — Alarm Latch
- SIL ✓ — Alarm Silencing
- FAIL — Failure Mode

Operations Menu

- Aut — Auto-tune
- AL0 ✓ — Alarm Range Low
- Ah1 ✓ — Alarm Range High
- Pid — PID
- CnF9 — Configuration

To Set Up Series 935B Alarms…

1. Plan an alarm strategy. What do you want to happen when an alarm occurs?
2. Wire the appropriate control output, Output 1 or Output 2, and associated switching and annunciators. See p. 44-45 for wiring information.
3. Go to the 935B's Configuration Menu CnF9. See p. 18.
4. Set either Output 1 Ot1 or Output 2 Ot2 as the ALM1 output.
5. Set Alarm Type ALtY.
6. Set alarm hysteresis AhyS.
7. Set alarm latching LAt.
8. Set alarm silencing SIL.
9. Set a failure mode FAIL. See p. 38-39.
10. Go to the 935B's Operation Menu. See p.12.
11. Set the alarm high and low AL0 and Ah1 points.
12. Test and adjust the alarm system.
13. Document the alarm settings and system.

CAUTION: Verify, in Table 10, p. 27, the alarm state / alarm output condition you want before making the Alarm Type ALtY choice. Failure to do so could result in damage to equipment and property.

WARNING: Do not rely on the Series 935B alarms to provide redundant temperature limit control. Use correctly specified, properly installed temperature limit controls instead. Failure to do so could result in injury, death or damage to equipment and property. (See accompanying Watlow Bulletin 89.4.3.)

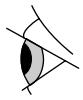
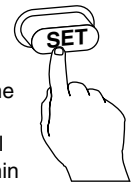
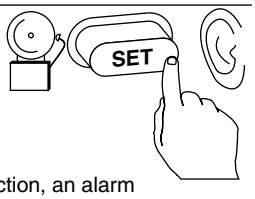
To Clear a Series 935B Alarm…

In general, press the SET key to clear a latched or 'silence-able' (SIL = YES) alarm.

Ultimately, the system process value must return within the safe area for the alarm to remain clear. Non-latching alarms self-clear.

Table 11 (below) and Table 10 (p. 27) illustrate the Series 935B alarm features.

Table 11 - Alarm Functions

LAt **Latching alarm**	**no**  An unlatched alarm self-clears when actual temperature returns to within the safe area.	**YES**  A latched alarm requires the operator to press the SET key to clear after the actual temperature returns to within the safe area.
SIL **Silence alarm**	**no** With this selection, an alarm cannot be silenced at the 935B front panel (unless the alarm is latched [**LAt**=**YES**], and the alarm condition no longer exists).	**YES**  With this selection, an alarm can be silenced by pressing the SET key. **YES** provides automatic alarm silencing on start up.
ALO **Alarm Low**	A value from input Range Low to **Ahi**. At the Range Low value, a press displays **oFF** and **Ahi** disables.	
Ahi **Alarm High**	A value from **ALo** to input Range High At the Range High value, a press displays **oFF** and **Ahi** disables.	

Learn the Countdown Timer

Configuration Menu

- In — Input Type
- C_F — Celsius/Fahrenheit
- rL — Input Range Low
- rH — Input Range High
- Ot1 — Output 1 Function
- Ot2 ✓ — Output 2 Function
- rtS ✓ — Remote Timer Start
- diSP ✓ — Display Default
- ALty — Alarm Type
- AhyS — Alarm Hysteresis
- •
- •
- •
- tIM ✓ — Timer Function
- Strt ✓ — Start Timer
- rdy ✓ — Timer Ready Band
- St ✓ — Signal Time

Operations Menu

- Aut — Auto-tune
- tMr ✓ — Countdown Timer
- IdLE ✓ — Idle

Key Timer Information

- The timer requires Output 1 to work as either a heat or as a cool output.
- The 935B timer is a function of Output 2, a switched dc output.
- Hours: minutes (hh:mm) or minutes:seconds (mm:ss) choices reside in Output 2 Ot2.
- Timer set-up occurs in two locations, in the Configuration Menu and the Operations Menu.
- starts the timer.
- stops the timer.
- diSP choices set up the timer display (see p. 18).
- LED colon flashes when timer runs. LED colon ON steadily when timer is not running.

Configuration Menu set-up includes: (see p. 18)

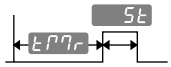
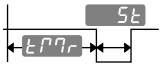
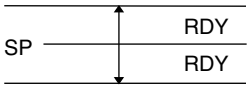
- Output 1 Ot1; heat HEAt or cool COOL
- Output 2 Ot2; timing interval, hours:minutes thrM, or minutes:seconds trMS
- Remote Timer Start rtS choices:
  1. Manual start oFF
  2. Remote Timer Start trMr
  3. Front Panel Lockout FPL
- Timer (Output 2) function tIM hours: minutes or minutes:seconds (thrM or trMS) can perform one of four possible actions after timing:
  1. Turn ON, also called, “delay ON” dLon
  2. Turn off, also called, “delay off” dLoF
  3. Toggle ON, also called, “signal ON” SGon
  4. Toggle off, also called, “signal off” SGoF
- Start timer function Strt choices:
  1. Immediate start IMd
  2. Start once inside a ready band rdy
  3. Start once inside a ready band, acknowledging rdyA with a SET press
  4. Start immediately on control power up PwJr without waiting for Ready Band temp. or press.
- Ready band width rdy above and below set point: degrees
- Signal time St (if applicable) duration: seconds

Operations Menu set-up includes: (see p. 12)

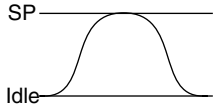
- Countdown Time tMr: hours:minutes or minutes:seconds
- Idle Set Point Type IdLE, two choices:
  1. Track primary set point
  2. Set an idle set point

The next page presents this information in graphic format with additional detail.

Table 12 - Series 935B Timer Functions/Settings

Ot2	**tHM** **tMS** Choose time in hr:min or min:sec.			Timer set-up available only when **rtS** = **tMr** **FPL** **oFF**
t 1M	**dLon**	**dLoF**	**S9on**	**S9oF**
Output 2 Timer Output Function; Choose one of four possible output actions for the end of the timer **tMr** / **St** time periods.	Delay ON Output 2 is ON before timing; OFF during timing; ON after timing.	Delay OFF Output 2 is OFF before timing; ON during timing; OFF after timing.	Signal ON  Output 2 is OFF before & during timing; ON after timing; then OFF.	Signal OFF  Output 2 is ON before & during timing; OFF after timing; then ON.
Start Timer Function	**1Md** Timer starts immediately on a ≫ key press at the normal display. **rdy** Timer only runs in the Ready Band. ≫ key starts timer sequence. **rdyA** Ready Acknowledge. ≫ key starts timer sequence. SET must be pressed once inside the Ready Band to start timer at the normal display. **PUdr** Timer starts immediately on control Power up. See p.57.			
rtS **Remote Start Timer**	**oFF** No remote timer start or front panel lock feature. **FPL** Front panel lock with a customer-supplied switch on Terminals 3 and 4; a closed switch=locked front panel. **tMr** Start timer via an external, cusomer-supplied switch on Terminals 3 and 4 closed switch=start.			
rdy **Timer Ready Band**				• **rdy** = 0, Disables Ready feature • The RDY front panel LED is lit inside Ready Band
St	**Signal Time**			Sets the signal time from 00:01 to 99:59 min:sec to run after Timer.

Operations Menu

tMr	**00.00** **99.59** Timer Function OFF.	• When **Ot2** = **tHM** or **tMS**, a 3 second SET press will display the **idLE** set point.
idLE **Idle Set Point**	**trAc** **rL** **rh** 	

• Idle is set point used when not timing.
• If Trac selected Idle is the same as Set Point.
• The Set Point value controls the process during the Timer sequence.

Setting the Countdown Timer

Configuration Menu

- In — Input Type
- C_F — Celsius/Fahrenheit
- rL — Input Range Low
- rh — Input Range High
- Ot1 — Output 1 Function
- Ot2 ✓ — Output 2 Function
- rtS ✓ — Remote Timer Start
- diSP ✓ — Display Default
- ALtY — Alarm Type
- AhyS — Alarm Hysteresis
- ⋮
- tIM ✓ — Timer Function
- Strt ✓ — Start Timer
- rdy ✓ — Timer Ready Band
- St ✓ — Signal Time

Operations Menu

- Aut — Auto-tune
- tMr ✓ — Countdown Timer
- IdLE ✓ — Idle

To Set Up the 935B Timer…

1. Plan a timer strategy.
2. Wire the Output 2 control output, associated switching devices and annunciators. See p. 44-45.
3. Go to the 935B's Configuration Menu CnFG.
4. Choose the Output 2 Ot2 function as time; hrs:min thrM, or time; min:sec tMnS.
5. Choose Remote Timer Start rtS to function as; manual oFF, or remote timer start tMr.
6. Choose a display default diSP (see page 18):
   - Actual Temperature only Ac
   - Actual; Set Point AcSP
   - Actual; Time Act1
   - Time; Actual t1Ac
   - Time; Set Point t1SP
7. Choose a Timer Output Function tIM:
   - Delay ON dLon
   - Delay off dLoF
   - Signal ON SGon
   - Signal off SGoF
8. Choose a start timer Strt function; either immediate IMMd, ready band rdy, Ready Acknowledge rdyA, or Power PwJr.
9. If you chose rdy or rdyA, then select a ready band rdy value.
10. If you chose SGon or SGoF, then select a signal time St value.
11. Go to the 935B's Operation Menu.
12. Set the countdown time tMr.
13. Choose the idle set point IdLE to track trAc the primary set point, or select a separate idle set point value between the range high rh and range low rL values.
14. Run the system, and test the timer start with a press or rtS signal.
15. Document the timer settings and system.

Timer Example Application

Convection Oven Application

Scenario

A master chef bakes bread at 350°F for 30 minutes. He wants the oven at the proper temperature with an indication when it is ready to begin baking. He isn't concerned if the oven is 10° cool at first. After he loads the oven, the chef wants to start the countdown time by pressing a key. When the baking time is complete, he wants a 10 second audible indication that the bread is done.

Recommended Control

A Series 935B-1CCX-000X control.

- Switched dc Output 1 wired to a dc input solid state relay (SSR) switches the heaters.
- Switched dc Output 2 wired to a DC SSR-T0 SSR-240-10A-DC1 or A External Mechanical Relay audible indicator provides “done” indication.

Configuration Menu Set-up			
C_F	=	°F	°F
diSP	=	Act.t	After a SET press, actual temperature appears for 15 seconds.
Ot1	=	HEAt	Heating output
Ot2	=	tr^S	Time; minutes:seconds
rtS	=	oFF	RTS must be set to OFF in this application
t1r^	=	59.00	Output 2 turns ON briefly at the end of the timing cycle.
Strt	=	rdyA	Timer waits to countdown until temperature deviation from set point < rdy value and the SET key is pressed.
rdy	=	10	Ready band; 10°F
St	=	10	Output 2 turns ON for 10 sec. at the end of the timing cycle.
Operations Menu Set-up			
tr^r	=	3000	Bake time; 30 minutes
IdLE	=	75	The set point temperature before a timing cycle starts and after a timing cycle completes.
Set Point = 350°F			

Operator/Control Actions

- With the oven "idling" at 75°F, the chef starts the preheat cycle with a press. The display immediately shows 30:00 with the colon ON steadily. The RDY LED is off. Series 935B begins to control to the 350°F bake set point.
- As the actual oven temperature increases to within the Ready Band at 350°F ±10°F, the RDY LED turns on. The chef loads the oven and presses SET to acknowledge the Ready Band and thereby start the bake cycle.
- Time starts counting down. Actual temperature displays for 15 seconds after the SET key is press. Then time displays with the colon flashing.
- If temperature deviates out of the Ready Band (less than 340°F or more than 360°F), timer countdown will pause, but will continue as soon as temperature re-enters the ready band.
- When time reaches 00:00, Output 2 turns on for 10 seconds sounding the audible indicator. The chef can stop the audible indicator by pressing . The Series 935B then automatically shifts to the 75°F idle set point.

Auto-tuning

Operations Menu

- Aut ✓ Auto-tune
- AL0 Alarm Range Low
- Ah1 Alarm Range High
- tMr Countdown Timer
- Idle Idle
- L-r Local / Remote
- Pid PID
- CnFg Configuration

NOTE:

Aut is not visible at factory default.

CAUTION:
Successful Series 935B auto-tuning requires 3 oscillations thru the 90% set point in 85 min. or less. If the system cannot perform the oscillations in that time, the control will revert to the previous PID values.

NOTE:

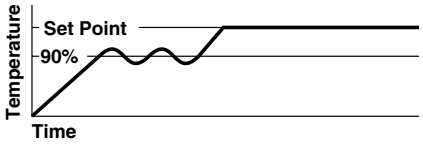
Manual tuning is a slow procedure, taking from minutes to hours to obtain optimum value.

Auto-tuning the Series 935B

Auto-tune automatically sets PID parameters for your system.

1. Press ≈ and ≈ for three seconds.
2. You'll see Aut.
3. Press and hold SET, then select yES with ≈ or ≈. tunE will flash to indicate auto-tuning. Display reverts to normal after auto-tuning.
4. Aut = no stops auto-tuning.

Figure 7 - Auto-tuning the Series 935B



Auto-tuning occurs at 90% of set point in less than or equal to 85 minutes ⚠

Manual Tuning

For optimum performance, tune the Series 935B to your thermal system. The settings here are for a broad spectrum of applications; your system may have different requirements.

Tune heating outputs at a set point above ambient temperature.
Tune cooling outputs at a set point below ambient temp.

1. Apply power to the 935B and enter a set point.
   In the Operations Menu, Aut must = no.
   Begin with these Configuration Menu settings:
   Pb h = 1, It = 000, dE = 000,
   Ct h = 50, CAL = 0.
2. Proportional Band Adjustment: Gradually increase Pb h until the upper display temp. stabilizes at a constant value.
3. Integral Adjustment: Gradually decrease It from 30.00 until the display temperature begins to oscillate or “hunt.” Then slowly increase It until the upper display stabilizes again near set point.
4. Cycle Time Adjustment: Set Ct h as required. Faster cycle times sometimes achieve the best system control. However, if a mechanical contactor or solenoid is switching power to the load, a longer cycle time will minimize wear on relays.
5. Derivative Adjustment: Increase dE to 0.10 minute. Then raise set point by 20° to 30°F, or 11° to 17°C. Observe approach to set point. If load temperature overshoots, increase dE by 0.50 minute. Raise set point by 20 to 30°F, or 11 to 17°C and watch approach again. Repeat until system rises to new set point appropriately.
6. Calibration Offset Adjustment: Enter the CAL offset value you want. Calibration offset adds or subtracts degrees from the value of the input signal.

Tweaking PID Settings

PID Menu

Set up Heat:

Pb h ✓ Proportional Band

hYSh ✓ Hysteresis

Ct h ✓ Cycle Time

db ✓ Dead Band

Set up Cool:

Pb c ✓ Proportional Band

hYSc ✓ Hysteresis

Ct c ✓ Cycle Time

Set up General:

It ✓ Integral

dE ✓ Derivative

CAL ✓ Calibration Offset

1. Set Pb h and Ct h in degrees.
2. If Proportional Band Heat Pb h = 0, Set Hysteresis Heat HYSh. The Series 935B will provide on/off control with the hysteresis value selected, and no proportioning action.
3. Proportional Bands should be decreased for tighter control but increased to eliminate oscillations.
4. Cycle Time Heat Ct h is limited to a minimum of 5.0 seconds for the electromechanical relay to help reduce wear. The electromechanical relay (D, Output 2) is not recommended for PID control. It is warranted to 100,000 contact closures only. Alarm or on/off control are appropriate applications for the Series 935B's electromechanical relay output.
5. Set Dead Band db to adjust the effective cool set point above the primary set point by the dead band value in degrees. In cool/heat applications, dead band prevents continuous cool output action by creating a buffer between heating and cooling output action.
6. Set Pb c and Ct c in degrees.
7. If Proportional Band Cool Pb c = 0, Set Hysteresis Heat HYSc. The Series 935B will provide on/off control with the hysteresis value selected, and no proportioning action.
8. Proportional Bands should be decreased for tighter control but increased to eliminate oscillations.
9. Cycle Time Heat Ct h is limited to a minimum of 5.0 seconds for the electromechanical relay to help reduce wear. The electromechanical relay (D, Output 2) is not recommended for PID control. It is warranted to 100,000 contact closures only. Alarm or on/off control are appropriate applications for the Series 935B's electromechanical relay output.
10. Set Integral It to eliminate droop in the system. Lower the value for more droop reduction. Adjustable from 0 to 99.9 minutes / repeat.
11. Set Derivative dE to prevent overshoot. Increasing the value slows the approach to set point. Adjustable from 0 to 9.99 minutes.
12. Calibration Offset CAL eliminates the difference between the displayed process temperature and the actual process temperature value.

Calibrating the 935B

Calibration Menu

- tc50 ✓
- tc00 ✓
- tc ✓
- r15 ✓
- r380 ✓
- rst ✓

Quick Calibration Restore:

Press all three keys simultaneously until tc50 appears in the display, press ≈ once and rSt will appear in the display. Press and hold SET, the display will show no, press ≈ to change display to YES. Press and hold ≈ and ≈ for 3 seconds to exit the CAL menu.

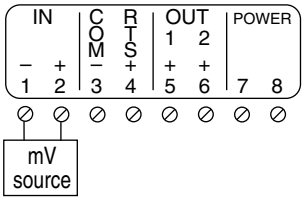
NOTE: Restore Factory Calibration rSt = YES restores factory calibration values to all calibration prompts.

Calibration Key Information

Calibration requires a precision millivolt source with thermocouple compensation, an adjustable 0-10 volt source, and a decade resistance box.

- trS0 and tr00 calibrate the thermocouple span.
- tc calibrates the ambient compensation.
- r380 and r 15 calibrate the RTD span.
- When calibrating, calibrate all points for consistency in results.
- Allow the unit to warm up for 15 minutes before calibrating.

Figure 8a - Thermocouple Calibration



tc50
mV source = 50.000mV

• Store TC counts at 50.000mV

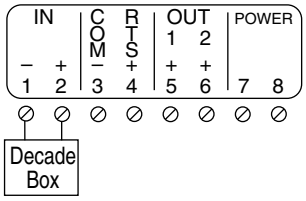
tc00
mV source = 0.000mV

• Store TC counts at 0.000mV

tc
mV source = Temp. Compensation

• Store ambient counts at 32° F. Type J.

Figure 8b - RTD Calibration



r 15
Decade Box = 15.00 ohms

• Store low end RTD counts

r380
mV source = 380.00 ohms

• Store high end RTD counts

rSt no YES
• Restore factory calibration

Calibrating the 935B

Thermocouple Input Field Calibration Procedure

Equipment Required:

- Type “J” Reference Compensator with reference junction at 32°F/0°C, or Type “J” Thermocouple Calibrator set at 32°F/0°C.
- Precision millivolt source, 0-50mV min. range, 0.01mV resolution.

Set Up:

1. Connect 100-240V~ (ac) to Terminal 7 and Terminal 8.
2. Connect the millivolt source to Terminal 1 negative and Terminal 2 positive.
3. Apply power to the unit and allow it to warm up for 15 minutes.

Move to the Calibration Menu:

1. Press ⩓ and ⩔ simultaneously for 3 seconds.
2. Press ⩓ or ⩔ until CnFg is displayed.
   Press and hold SET – press ⩓ or ⩔ to select YES, then release SET.
3. Press ⩓ or ⩔ until tAG is displayed.
   Press and hold SET. Press ⩓ or ⩔ 8 times (display shall be blank).

Calibration: (Thermocouple)

1. Press and hold SET, ⩓, and ⩔ simultaneously for 3 seconds until trSO is displayed.
2. Set the mV source to 50.00mV⎓ (dc). Allow 10 seconds for sources to stabilize. Press and hold SET. Press ⩓ or ⩔ until YES appears. Release SET.
3. Press ⩔ - tc00 shall be displayed.
4. Set the mV source to 0.00 mV⎓ (dc). Allow 10 seconds for sources to stabilize. Press and hold SET. Press ⩓ or ⩔ until YES appears. Release SET.
5. Press ⩔. tc shall be displayed.
6. Set the MV source to 0.00 mV (if using a temperature compensator). Set calibrator to 32°F/0°C.
   Allow 10 seconds for sources to stabilize.
   Press and hold SET. Press ⩓ or ⩔ until YES is displayed. Release SET.

Calibration: (RTD)

Equipment Required:

- Precision Resistance Box with 0.01Ω Resolution.

1. Remove thermocouple wires from Terminal 1 and Terminal 2.
2. Connect S2 to terminal 1. Connect S1 to Terminal 2.
3. Press ⩔. r 15 shall be displayed.
4. Set the Decade box to 15.00Ω (allow 10 seconds for sources to stabilize). Press and hold SET. Press ⩓ or ⩔ until YES appears. Release SET.
5. Press ⩔ - r380 shall be displayed.
6. Set the decade box to 380.00Ω (allow 10 seconds for sources to stabilize). Press and hold SET. Press ⩓ or ⩔ until YES appears. Release SET.
7. Press and hold ⩓ and ⩔ for 3 seconds to Exit calibration menu.

Configuration Menu

- In — Input Type
- C_F — Celsius/Fahrenheit
- rL — Input Range Low
- rh — Input Range High
- Ot1 — Output 1 Function
- Ot2 — Output 2 Function
- diSP — Display Default
- ALty — Alarm Type
- AhyS — Alarm Hysteresis
- LAt — Alarm Latch
- SIL — Alarm Silencing
- FAIL ✓ — Failure Mode
- tIMr — Timer Function
- Strt — Start Timer
- rdy — Timer Ready Band
- St — Signal Time
- SLOC — Set Point Lockout
- tAG — Lockout Tag

Key Error Information

Set up an input failure operation mode at the FAIL prompt in the CnFG menu; choose bumpless transfer bPLS for smooth output action transition to percent power control, or select a percent power output value.

FAIL bPLS

Bumpless Transfer

when errors occur, the control output will continue at a percent output learned while stable. Default = bPLS.

-100 100

Percent Power

(-100% to +100% , depending on heat/cool output configuration). The control will assume a specific output power when input errors occur.

- All except one of the possible displayed error messages are input related.
- If you see Ers, cycle power to the controller. If the error persists, call the factory.
- Be aware of the difference between U.S and European thermocouple color/colour codes.
- Reversed polarity input leads is one of the most common errors.
- Incorrect software input choice at the Configuration Menu CnFG input In prompt is another common error.

When calling the factory for help, please have:

1. The model number of the control.

2. A photocopy of pages 51-58 with the settings from your control, if possible.

3. Specifications of devices directly interfaced with the control.

Table 13 - Possible Displayed Error Codes and Actions

Display	Probable Cause	Recommended Action	
Er 1	Reversed thermocouple connection + to –.	Change the sensor leads on Terminals 1 and 2.	A-D under flow
Er 2	Sensor type mismatch or open RTD.	Go to In prompt, check selection (see p. 22), or check RTD, replace as necessary.	Sensor under range
Er 3	Sensor type mismatch.	Go to In prompt, check selection (see p. 22).	Sensor over range
Er 4	Open Thermocouple, bad	Check the sensor, connection, or broken wire.	A-D replace as necessary.
Er 5	Electrical noise.	Cycle power to system. See if error clears. Check system for electrical interference.	
	Control is inoperable.	Check for line voltage at terminals 7 and 8.	

To Troubleshoot Sensor

- Remove sensor wires from Terminals 1 and 2.
- For a thermocouple sensor Series 935B, place a jumper wire on Terminals 1 and 2. Control should display the ambient temperature at the back of the control.
- For an RTD sensor Series 935B, place a 110 +/- 10Ω resistor on Terminals 1 and 2. The control should read 100Ω = 32°F, 110Ω = 77°F, 120Ω = 127°F.
- An RTD sensor Series 935B can be configured in software as if it were a thermocouple unit, and then tested as above.
- You can restore factory calibration rSt, see p. 36-37.

Table 14 - Troubleshoot Control Outputs

When indications such as significant differences between set point and actual temperatures point to no output action, check output configurations as described on p. 23. Check wiring, p. 44.

Output	Measure Terminals	Load-on State	Load-off State
“C” Output 1	3 & 4	LED 1 on 3.0 to 7.0V⎓ (dc)	LED 1 off 0.0V⎓ (dc)
“C” Output 2	5 & 6	LED 2 on 3.0 to 7.0V⎓ (dc)	LED 2 off 0.0V⎓ (dc)

Figure 9- Panel Cut-out Dimensions

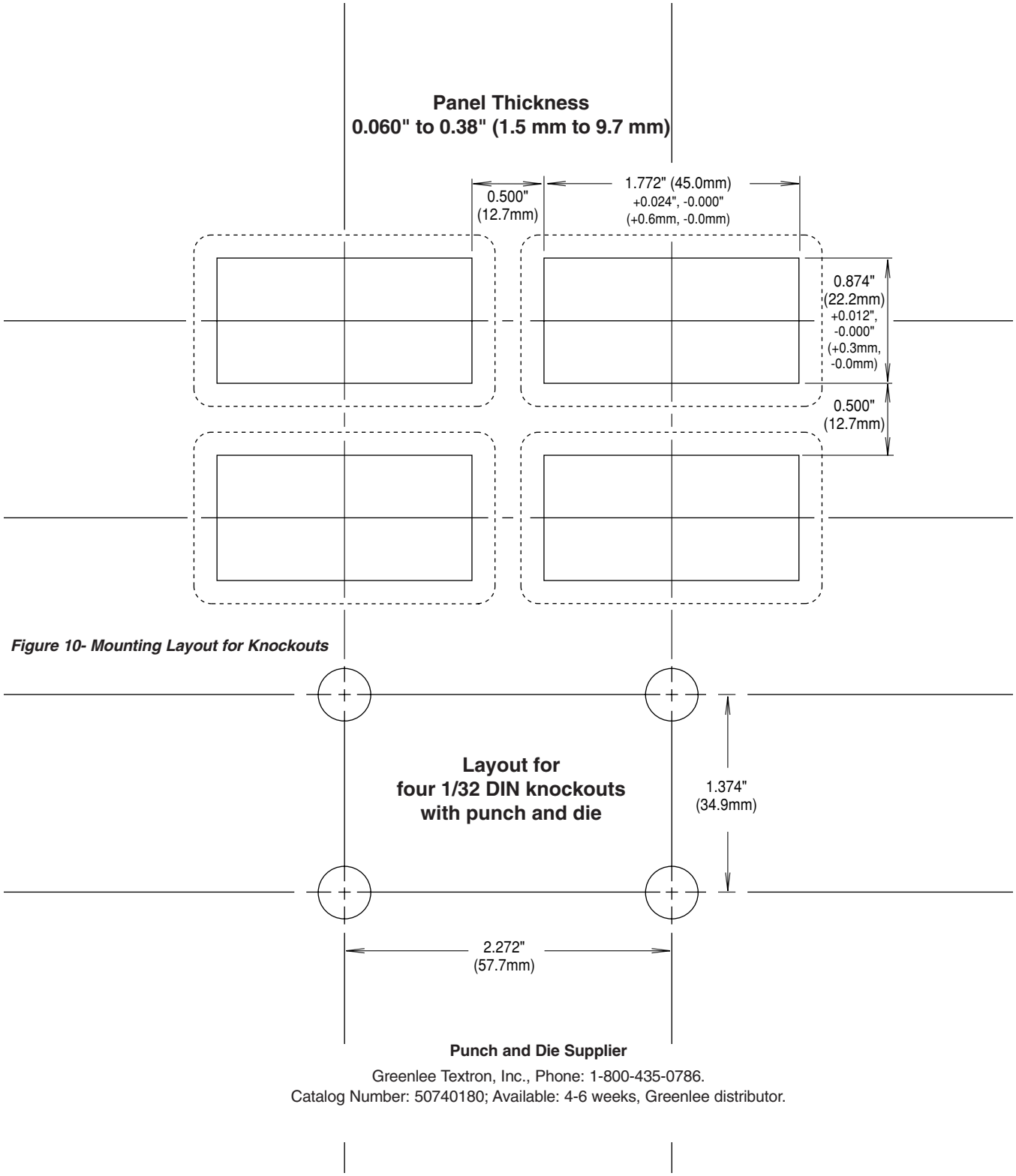


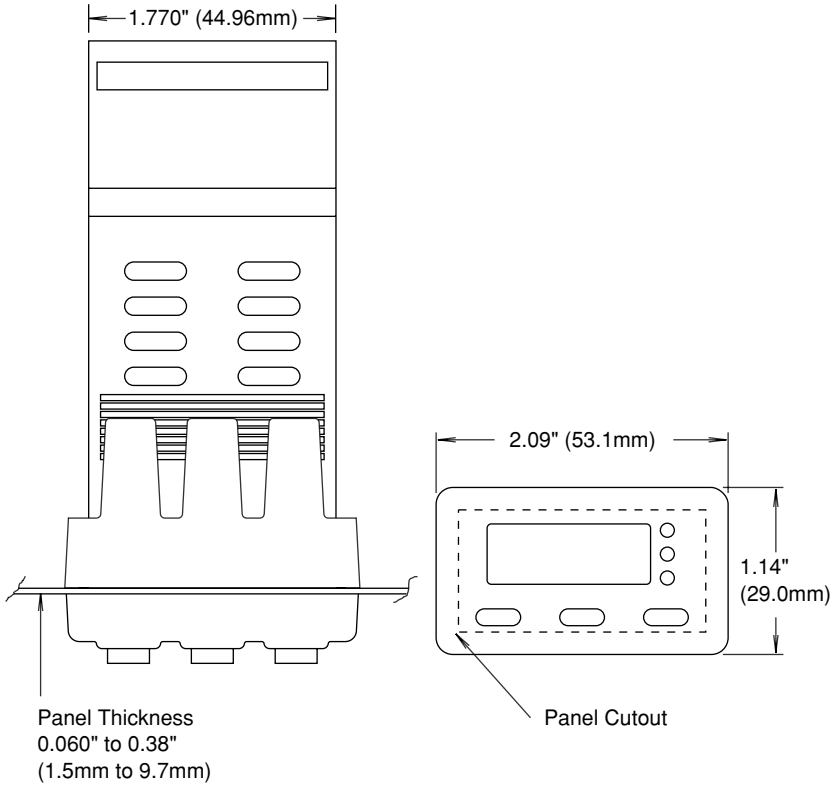
Figure 10- Mounting Layout for Knockouts

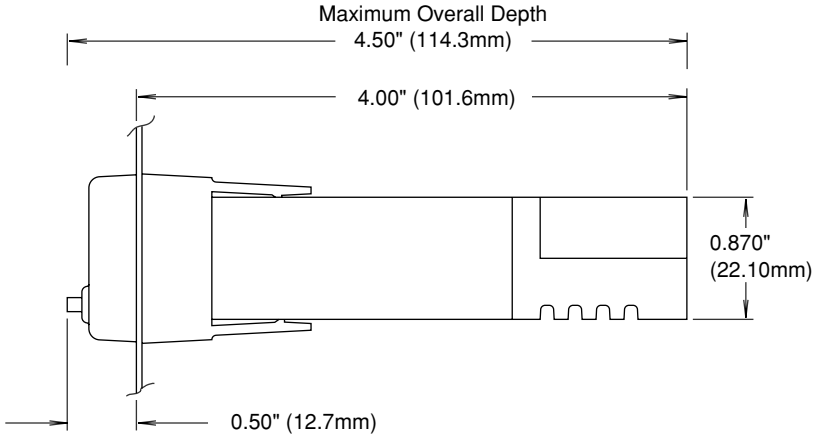
Punch and Die Supplier

Greenlee Textron, Inc., Phone: 1-800-435-0786.
Catalog Number: 50740180; Available: 4-6 weeks, Greenlee distributor.

Dimensions

Figure 11- Series 935B Dimensions





Installation Procedure

1. Make a panel cutout using the tear-out mounting template, or the dimensions in Figure 9, p. 40.
2. Insert the 935B into the cutout. Check to see that the gasket is not twisted. Make sure the rounded side of the D-shaped external case gasket faces the panel surface, and the gasket is fully seated in its bezel channel. See Figure 12.
3. While pressing the bezel firmly against the panel, slide the mounting collar over the back of the control. The tabs on the collar must line up with the mounting ridges on the case for secure installation. See Figure 12 again.
4. Slide the collar firmly against the back of the panel, getting it as tight as possible. Make sure you cannot move the case within the cutout, if you can, you do not have a NEMA 4X/IP65 seal!
5. Make sure you have a tight seal. Use your thumb to lock the tabs into place while pressing the case from side to side. Don't be afraid to apply enough pressure to install the control. The tabs on each side of the collar have teeth which latch into the ridges. See Figure 12. Each tooth is staggered at a different depth (from the front) so only one of the tabs on each side is ever locked into the ridges at any time.
6. Look at Figure 13; you see that the tabs on one side of the collar correspond with those on the opposite side. Be sure only the two corresponding tabs are locked in the ridges at the same time. If the matching tabs are not holding the case, no NEMA 4X/IP65 seal exists. Make a visual check, or use your finger nail to pull out on each tab. The space between the bezel and panel must be 0 to 0.019" (0.48 mm).

Figure 12- Mounting, Case Top View and Collar Cross Section.

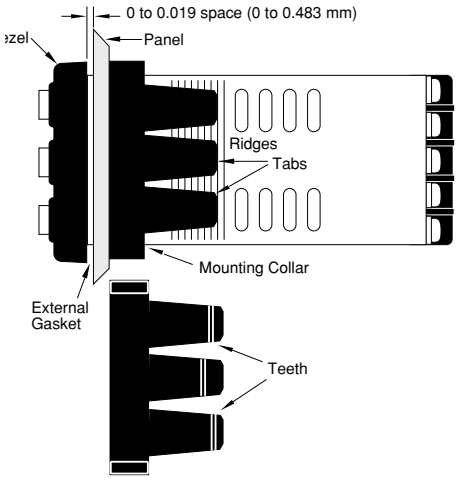
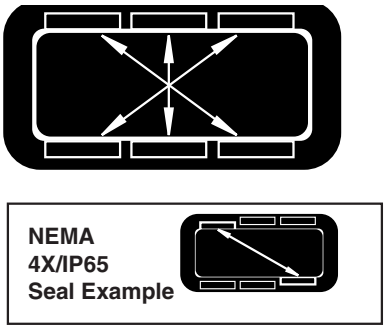


Figure 13- Case Rear View and NEMA 4X/IP65 Seal Example



Collar Removal

To remove the mounting collar:
Slide a thin, wide tool (putty knife) under all three mounting tabs, top then bottom, while pushing forward on the back of the case.

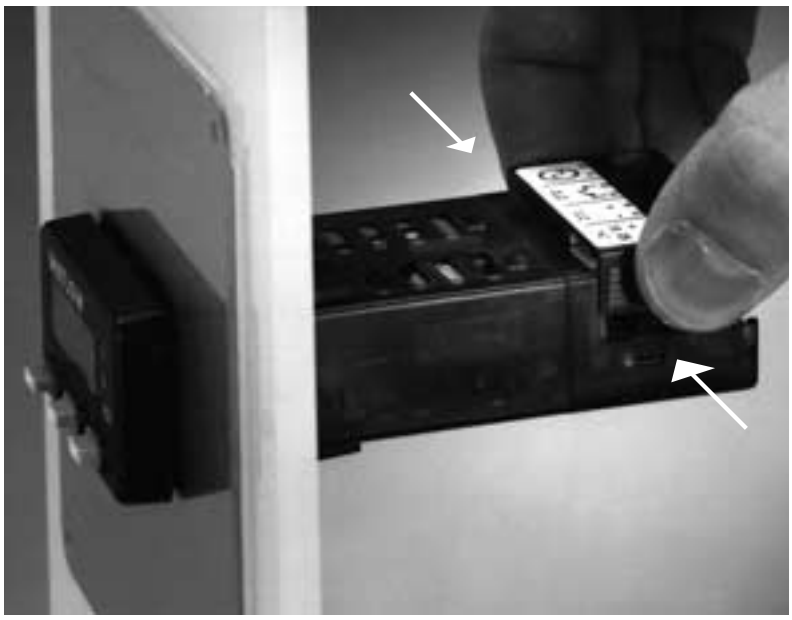
NOTE: To guarantee a proper NEMA 4X / IP65 seal, make sure the gasket between the panel and the rim of the case is not twisted and is seated properly. Press firmly.

NOTE: Make sure the rounded side of the D-shaped external case gasket faces the panel surface, and the gasket is fully seated in its bezel channel. See Figure 12.

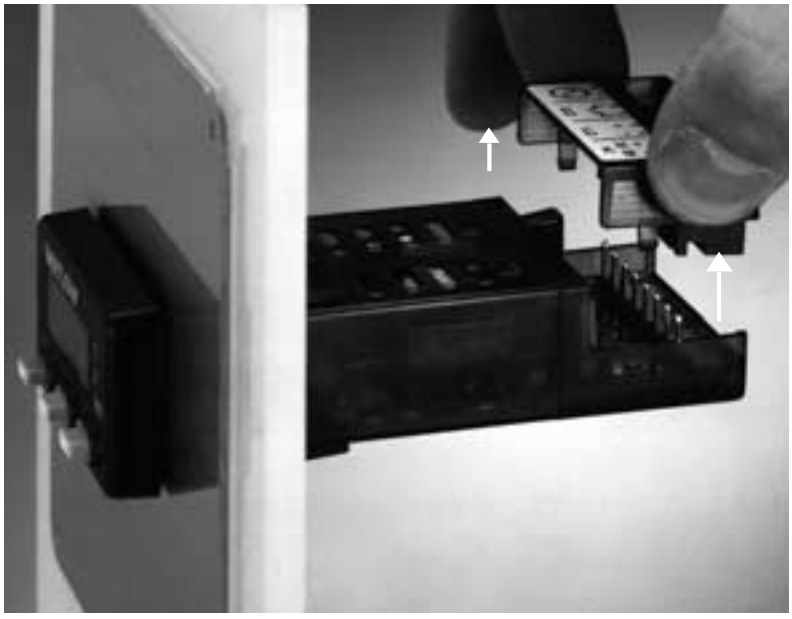
Terminal Block Removal

Figure 14- Terminal Block Removal Procedure

1. Press in on sides of cover to release the terminal cover hooks.



2. Move your grip rearward slightly, then lift the terminal cover straight up.

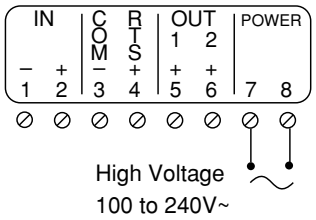


Wiring a 935B

Figure 15 - Wiring the Series 935B

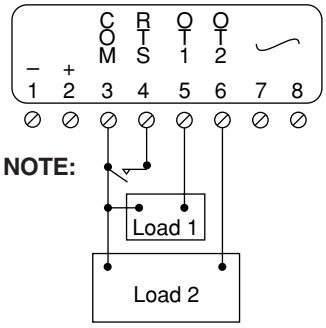
WARNING: All wiring and fusing must conform to local and national electric codes. Contact local authorities for further information. Failure to comply with electric codes could result in injury or death, or damage to property.

Power Wiring



Remote Timer Start

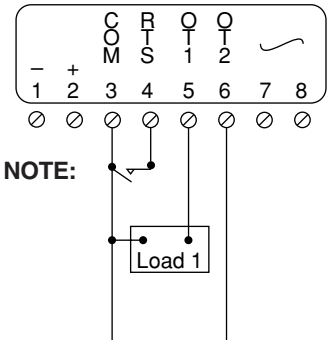
(Closed switch = Starts Timer)



NOTE: Customer-supplied N.O. momentary switch.

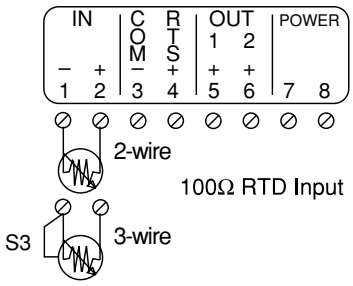
Front Panel Lock

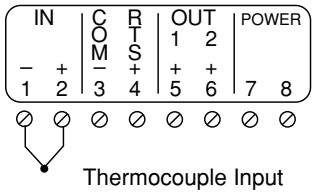
(Closed switch = locked panel)



NOTE: Customer-supplied two-position switch.

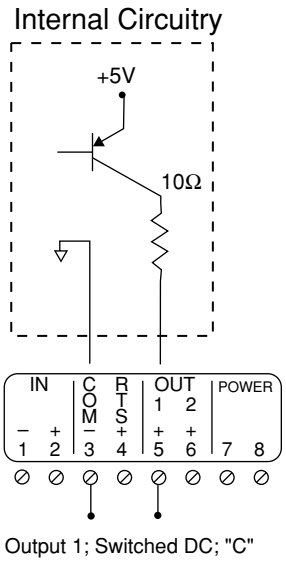
Input Wiring



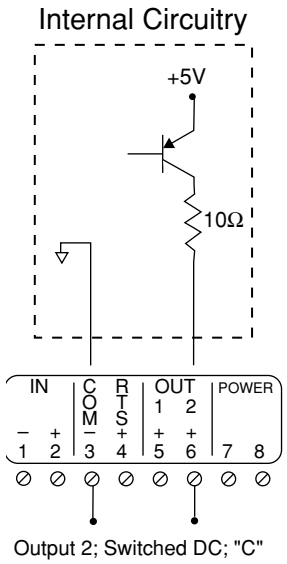


CAUTION: Using grounded thermocouples with non-isolated output switching devices could introduce ground loops into the control system, and possibly damage the controller and product.

Output 1 Wiring



Output 2 Wiring

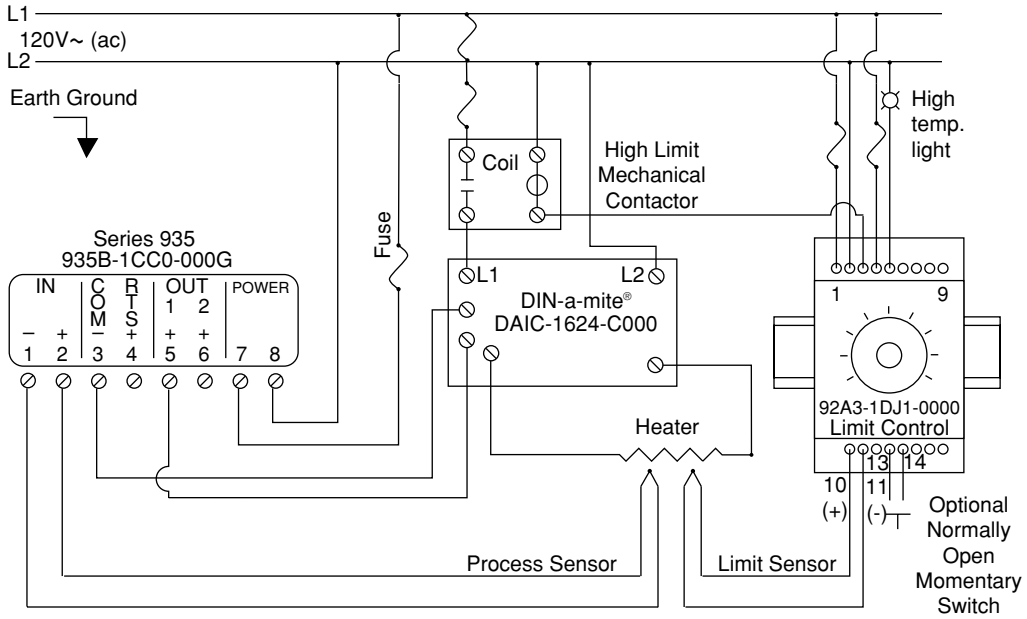


NOTE: Both Output 1 and Output 2 are DIN-a-mite® compatible.

System Wiring Examples

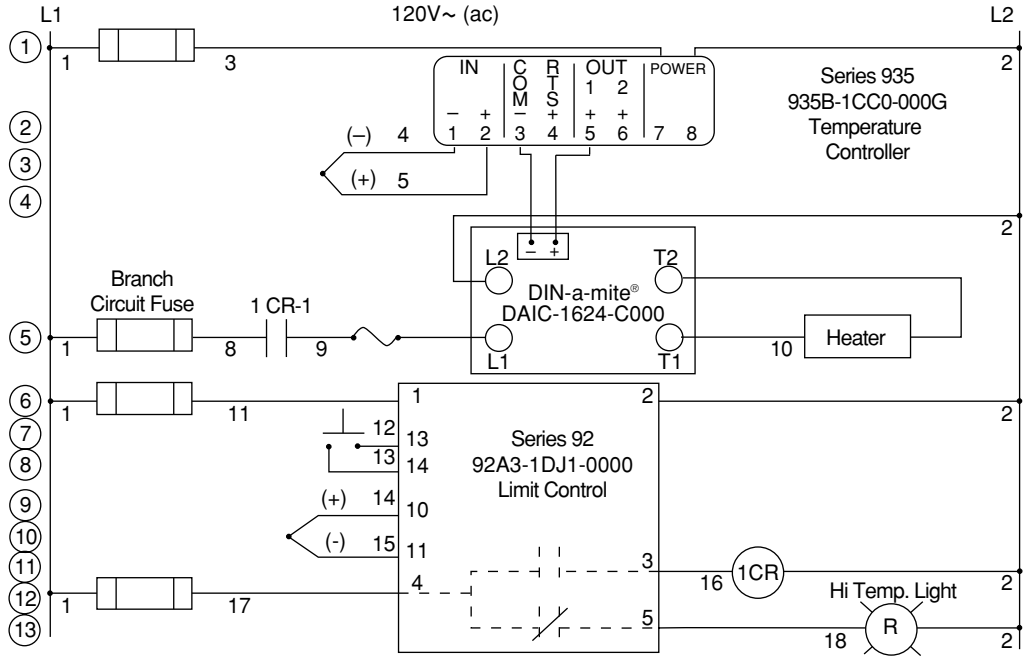
WARNING: All electrical wiring and fusing must conform to local and national electric codes. Contact local authorities for further information. Failure to comply with electric codes could result in injury or death, or damage to property.

Figure 16 - Series 935B System Wiring Examples



CAUTION: Using grounded thermocouples with non-isolated output switching devices could introduce ground loops into the control system, and possibly damage the grounder and product.

Figure 17 - Series 935B Ladder Diagram Wiring Example



Glossary

Alarm
A condition, generated by the controller, indicating that the process has exceeded or fallen below the set or limit point.

Alarm Hysteresis
A change in the process variable required to re-energize the alarm output.

Ambient Temperature
Temperature surrounding the components of a thermal system.

Auto-tune
Automatically sets PID values to fit a particular thermal system.

Bumpless Transfer
When transferring from auto to manual operation, the control output(s) will maintain the same output level.

Calibration
Adjusting an instrument to a known value.

Configuration Menu -The second software sub menu of the Series 935B Operations Menu; provides a location to set inputs, ranges, output types, alarm type, timer function, failure mode, and lockout types.

Control Mode
The method of control, i.e. ON/OFF, time proportioning, PI, PID or manual.

Cycle Time
Time required for a control to complete one ON through OFF cycle.

Dead Band
Adjusts the effective cool set point above the primary set point by the dead band value in degrees. In cool/heat applications, dead band prevents continuous cool output action by creating a buffer between heating and cooling output action.

Delay OFF
A Series 935B timer output (Output 2) choice that turns the output OFF at the end of the countdown timer time.

Delay ON
A Series 935B timer output (Output 2) choice that turns the output ON at the end of the countdown timer time.

Derivative
Limits the rate of change of the process to eliminate overshoot in slow or lagging loads (de=ra).

Deviation Alarm
An offset value which tracks the set point. Process changes beyond this value register an alarm condition.

DIN-a-mite®
Watlow family of DIN rail-mounted SCR power controllers.

Droop
The difference between the set point and actual values once the system stabilizes.

Hysteresis
A change in the process variable required to re-energize the control or alarm output.

Idle Set Point
Desired control value before and after timing period.

Integral
Accumulates error to eliminate offset or droop (It=1/re).

Local Set Point
Primary set point, not remote.

ON/OFF
Control by turning the output full ON until set point is reached, and then turning OFF until the process error exceeds the hysteresis.

Operations Menu
Series 935B software menu; provides a location to start auto-tune, set alarm points, set countdown time, choose an idle or normal set point type, choose a local or remote set point input, and to go to the PID or Configuration Menus.

Overshoot
The amount a process variable exceeds set point before stabilizing.

Percent Power Control
Open loop control with output power set at a particular level.

PID
(Proportional, Integral, Derivative). A control mode: proportional action sets the system, integral reduces droop, derivative reduces overshoot and undershoot.

PID Menu
The first software sub menu of the Series 935B Operations Menu; provides a location to manually set values for proportional band, hysteresis, cycle time, integral, derivative, and calibration offset.

Process Alarm
A fixed value independent of set point. Process changes beyond this value register an alarm condition.

Process Error
The difference between the set point and the actual process.

Proportional
Output effort proportional to the error from set point. If the proportional band is 20° and the process is 10° below set point, the heat proportioned effort is 50%. The lower the Pb value, the higher the gain.

Proportional Band
A range in which a control's proportioning function is active (See PID).

Range
The area between two limits in which a quantity or value is measured. Usually expressed in terms of lower and upper limits.

Ready Acknowledge
A Series 935B countdown timer start choice that pre-initiates the timer with a down key press, and then starts it with a SET press when the actual temperature is within the Ready Band.

Ready Band
Thermal area above and below primary set point in which the timer will count down.

Relay, Electromechanical
A power switching device that completes or interrupts a circuit by physically moving electrical contacts. Not recommended for PID control.

RTD
Resistive Temperature Detector. A sensor whose resistance increases with increasing temperature.

Remote Timer Start
Activation of the timer functions using an external remotely mounted switch connected to the 935B RTS input.

Set Point
The desired process value programmed into a control.

Signal
Any electrical transmittance that conveys information.

Signal OFF
A Series 935B timer output (Output 2) choice that toggles the output OFF, then ON at the end of the countdown timer cycle for a period equal to the signal time.

Signal ON
A Series 935B timer output (Output 2) choice that toggles the output ON, then OFF at the end of the countdown timer cycle for a period equal to the signal time.

Signal Time
Time duration the timer output will turn ON or OFF after a complete timing period.

SCR
Silicon controlled rectifier. A solid state device, or thyristor, with no moving parts, that is used in pairs to control AC voltages within one cycle. SCRs control voltage from a power source to the load by burst firing (also called zero-cross firing) or phase angle firing.

SSR
Solid State Relay. A solid state switching device that switches current ON and OFF. It has no moving parts.

Thermal System
A regulated environment consisting of a heat source, heat transfer medium, sensing device, a control instrument, and a redundant control device (limit).

Thermocouple
A temperature sensing device made by joining two dissimilar metals. This junction produces an electrical voltage in proportion to the difference in temperature between the hot junction and lead wire connection to the sensing device (cold junction).

Undershoot
The amount a process variable falls below set point before stabilizing.

Index

A

Auto-tune AUt 12, 34
Alarms
- Alarm High AH1 . . . . . 12, 26
- Alarm Low ALO 12, 26
- Alarm Type ALTY 26, 27
- Clearing 28, 29
- Deviation dEnc, dEno 26, 27
- Hysteresis AHYS 26, 27
- Latch LAt 26, 29
- Learning 26
- Process Pnc, Pno 26, 27
- Setting 28, 29
- Silencing SIL 26, 29

B

Bumpless Transfer bPLS 38

C

Calibration 36, 37
- Factory Restore rSt 36

Calibration Offset CAL 15, 17
Celsius / Fahrenheit C_F 22, 23
Clearing Alarms 28, 29
Configuration CnFG 11, 18
Cycle Time 15
- Heat Ct h 15
- Cool Ct c 15

D

Dead Band db 15
Derivative dE 15, 17
Dimensions 40, 41
DIN-a-mite® compatibility 44, 48
Display Default diSP 18, 22

E

Errors 10, 39

F

Failure Mode FAIL 19, 38
Front Panel Lock FPL 22, 25

G

Glossary 46

H

Hours/Minutes tHrM 30-32
Hysteresis
- Alarm AHYS 19, 26
- Heat hYSh 15
- Cool hYSc 15

I

Idle IdLE 12
Idle Set Point Track trAc 12
Input Range Low rL 22, 23
Input Range High rh 22, 23
Input Type In 23
Integral It 15, 17

K

Keys 7

L

Latch LAt 19, 26, 29
Lockout Functions 20
- Front Panel FPL 20, 25
- Security Tag tAG 20
- Set Point SLOC 20

M

Minutes/Seconds trMS 19, 30
Mounting 40

O

Operations, Learning 12
Ordering Information 49
Output 1 Function Ot1 . . . . . 5, 22, 23
Output 2 Function Ot2 . . . . . 5, 22, 23

P

PID Menu, Learning 14
PID Settings, Tweaking 15, 35
Proportional Band
- Heat Pb h 15
- Cool Pb c 15

R

Remote Timer Start rtS 22, 24

S

Set Point
- Change 9
- Lock SLOC 20
- Range High rh 22
- Range Low rL 22

Silencing Alarms 29
Software Maps
- Easy 11
- Advanced 51-58

Specifications 48

T

Terminal Block Removal 43
Timer
- Countdown tMr 12, 30-33
- Delay off dLoF 19, 30, 31
- Delay on dLon 19, 30, 31
- Function t1FN 19, 30, 31
- Hours/Minutes tHrM 19, 30, 31
- Idle IdLE 19, 30, 31
- Minutes/Seconds trMS . . 19, 30, 31
- Ready Band rdy 19, 30, 31
- Signal off SGoF 19, 30, 31
- Signal on SGon 19, 30, 31
- Signal Time St 19, 30, 31
- Start Timer Strt 19, 30, 31
  - Immediate Imd 19, 30, 31
  - Ready Band rdy 19, 30, 31
  - Ready Band-Acknowledge rdyA . . . 19, 30, 31

Tuning
- Auto-tuning 12, 34
- Manual tuning 34, 35

Troubleshooting 38, 39

W

Wiring 44
Wiring Examples 45

• Height
• Length
• Width

Specifications

Specifications—(1951)

Control Mode
- Auto-tune PID.
- PID, PD, PI, on/off.
- Countdown timer; hours:minutes, minutes:seconds.
- Timer output modes; Delay-off, Delay-on, Signal-off, Signal-on.

Agency Approvals
- UL/C-UL 508, File #E102269.
- NEMA $4X_1$ (IP65) rated front panel.
- 89/336/EEC Electromagnetic Compatibility Directive:
  EN 50081-2: 1994 Emissions;
  EN 50082-2: 1995 Immunity.
- 73/23/EEC Low-voltage Directive:
  EN 61010-1: 1993 Safety.

Operator Interface
- Single, seven-segment digital display, factory selectable red or green.
- Outputs/operation annunciators, three discrete LEDs.
- Three tactile feedback momentary switches.
- Front panel lock dry contact closure disables front panel operation.

Accuracy
- ±0.25% of span +/- 1 LSD, or
- Types S and T thermocouple @ < 200°C, ±0.32% of span +/- 1 LSD, typical.

Ambient Rejection
- < 0.15°C/°C rise in ambient, or
- Types S and T thermocouple, @ < 0.47°C/°C rise in ambient typical.

Sensors/Inputs
- Sensor input sampling rate: 10 samples/second (10Hz).
- Type E, J, K, N, S and T thermocouple, grounded or ungrounded junction.
- RTD, two-wire 100Ω base (DIN) resistance.
- Dry contact closure on RTS input enables remote timer start function or front panel lock, depending on menu selection.

Input Range

Specified temperature ranges represent the controller's operational span.

Thermocouple

Type E	-328	to	1470°F
	(-200	to	799°C)
Type J	32	to	1382°F
	(0	to	750°C)
Type K	-328	to	2282°F
	(-200	to	1250°C)
Type N	32	to	2282°F
	(0	to	1250°C)
Type S	32	to	2642°F
	(0	to	1450°C)
Type T	-328	to	662°F
	(-200	to	350°C)

RTD Resolution (DIN)

1°	-328	to	1292°F
	(-200	to	700°C)
0.1°	-199.9	to	999.9°F
	(-128.8	to	537.7°C)

Control Output
- Output update rate: 1/second (1Hz).

1 Output
- Switched dc logic signal, 6VÎ (dc) @ 60mA nominal, short circuit protected, non-isolated (Watlow *DIN-a-mite*® power controller compatible).

2 Output
- Switched dc logic signal, 6VÎ (dc) @ 60mA nominal, short circuit protected, non-isolated (Watlow *DIN-a-mite*® power controller compatible).

Output Cycle Time
- Switched dc; 5.0 second default, 0.1 second minimum.

Line Voltage/Power
- 100-240V~ (ac) +10%, -15%; (85-264V~ [ac]) 50/60Hz, ±5%.
- Fused internally (factory replaceable only) time-lag type, 2A, 250V.
- Power consumption 6VA maximum.
- Data retention upon power failure via non-volatile memory.

Operating Environment
- 32 to 149°F (0 to 65°C).
- 0 to 90% RH, non-condensing.

Storage Temperature
- -40 to 185°F (-40 to 85°C).

Terminals
- Touch-safe set screw type, accepts 22 to 12-gauge wire.

Controller Weight
- 4.0 oz (113.4 g).

Shipping Weight
- 7.3 oz (208 g).

These specifications are subject to change without prior notice.

Ordering a 935B

Ordering Information—(1952)

Single thermocouple or RTD (DIN) input, dual output, single display temperature control with time function

9 3 5 B - 1 C C 0 - _ _ 0 _

Output 1/Remote Input

C = Switched dc, logic signal, non-isolated

Output 2

C = Switched dc, logic signal, non-isolated

Power Supply

0 = 100 to 240V~ (ac)

Custom Options

00 = None

AA-ZZ = Consult factory for options

Display

R=Red Displays

G=Green Displays

Table 15 - Input Range Information

J t/c:	32	to	1382°F	or	0	to	750°C
K t/c:	-328	to	2282°F	or	-200	to	1250°C
T t/c:	-328	to	662°F	or	-200	to	350°C
N t/c:	32	to	2282°F	or	0	to	1250°C
S t/c:	32	to	2642°F	or	0	to	1450°C
E t/c:	-328	to	1470°F	or	-200	to	799°C
1° RTD (DIN):	-328	to	1292°F	or	-200	to	700°C
0.1° RTD:	-99.9	to	999.9°F	or	-99.9	to	700.0°C

[1] To effect NEMA 4X (IP65) rating requires a minimum mounting panel thickness of 0.06 inch (1.5mm) and a surface finish not rougher than 0.000032 inch (0.000812 mm).

CE Compliant Product

Declaration of Conformity

Series 935 CE

WATLOW CONTROLS
1241 Bundy Boulevard
Winona, Minnesota 55987 USA

Declares that the following product: ***English***

Designation:	Series 935
Model Number(s):	935A or B - 1C (C D or K) (0 or 1) - (Any four numbers or letters)
Classification:	Control, Installation Category II, Pollution Degree II
Rated Voltage:	100 to 240V~ **or** 24 to 28V≈
Rated Frequency:	50/60 Hz
Rated Power Consumption:	6VA maximum

Meets the essential requirements of the following European Union Directive(s) using the relevant section(s) of the normalized standards and related documents shown:

89/336/EEC Electromagnetic Compatibility Directive

EN 50082-2:	**1995**	**EMC Generic immunity standard, Part 2: Industrial environment**
EN 61000-4-2:	1995	Electrostatic discharge
EN 61000-4-4:	1995	Electical fast transients
EN 61000-4-3:	1996	Radiated immunity
EN 61000-4-6:	1996	Conducted immunity
ENV 50204:	1995	Cellular phone
EN 50081-2:	**1994**	**EMC Generic emission standard, Part 2: Industrial environment**
EN 55011:	1991	Limits and methods of measurement of radio disturbance characteristics of industrial, scientific and medical radio-frequency equipment (Group 1, Class A)
EN 61000-3-2:	1995	Limits for harmonic current emissions
EN 61000-3-3:	1995	Limitations of voltage fluctuations and flicker

73/23/EEC Low-Voltage Directive

EN 61010-1:	**1993**	**Safety requirements for electrical equipment for measurement, control, and laboratory use, Part 1: General requirements**

Déclare que les produits suivants : ***Français***

Désignation :	Série 935
Numéro de modèle :	935A or B - 1C (C D ou K) (0 ou 1) - (N'importe lesquels des quatre chiffres ou lettres)
Classification :	Réglage, installation de catégorie II, taux de pollution II
Tension nominale :	100 à 240 V ~ **ou** 24 à 28 V ≈
Fréquence nominale :	50/60 Hz
Consommation d'énergie nominale:	6 volt-ampères maximum

Sont conformes aux principales normes des directives de l'Union Européenne au regard de la (des) section(s) pertinente(s) des normes standards et documents apparentés présentés :

89/336/EEC Directive de compatibilité électromagnétique

EN 50082-2 :	**1995**	**Norme générique immunité 2e partie : Environnement industriel**
EN 61000-4-2 :	1995	Décharge électrostatique
EN 61000-4-4 :	1995	Transitoires rapides électriques
EN 61000-4-3:	1996	Immunité rayonnée
EN 61000-4-6 :	1996	Immunité conduite
ENV 50204 :	1995	Téléphone cellulaire
EN 50081-2 :	**1994**	**Norme générique émission - 2e partie**
EN 55011 :	1991	Limites et méthodes de mesure des caractéristiques des perturbations radioélectriques des appareils industriels, scientifiques et médicaux (I.S.M.) à fréquence radioélectrique (Groupe 1, Catégorie A)
EN 61000-3-2 :	1995	Limites d'émission d'harmoniques
EN 61000-3-3 :	1995	Limitations d'écarts de tension et de papillotement

73/23/EEC Directive de basse tension

EN 61010-1 :	**1993**	**Normes de sécurité des équipments électriques de mesure, de contrôle et à usage laboratoire, section 1: normes générales**

(1226)

Erklärt, daß das folgende Produkt: ***Deutsch***

Beschreibung:	Serien 935
Modellnummern:	935A or B - 1C (C D oder K) (0 oder 1) - (4 beliegibe Buchstaben)
Klassifikation:	Regelsystem, Installationskategorie II, Emissionsgrad II
Nennspannung:	100 bis 240 V~ **oder** 24 bis 28 V≈
Nennfrequenz:	50/60 Hz
Stromverbrauch:	Max. 6 VA

Erfüllt die wichtigsten Normen der folgenden Anweisung der Europäischen Gemeinschaft unter Verwendung des wichtigen Abschnitts der normalisierten Spezifikationen und der untenstehenden einschlägigen Dokumente:

89/336/EEC Elektromagnetische Übereinstimmungsanweisung

EN 50082-2:	**1995**	**EMC Rahmennorm für Störsicherheit, Teil 2: Industrielle Umwelt**
EN 61000-4-2:	1995	Elektrostatische Entladung
EN 61000-4-4:	1995	Elektrische schnelle Stöße
EN 61000-4-3:	1996	Strahlungsimmunität
EN 61000-4-6:	1996	Leitungsimmunität
ENV 50204:	1995	Mobiltelefon
EN 50081-2:	**1994**	**EMC-Rahmennorm für Emissionen, Teil 2: Industrielle Umgebung**
EN 55011:	1991	Beschränkungen und Methoden der Messung von Funkstörungsmerkmalen industrieller, wissenschaftlicher und medizinischer Hochfrequenzgeräte (Gruppe 1, Klasse A)
61000-3-2:	1995	Grenzen der Oberwellenstromemissionen
EN 61000-3-3:	1995	Grenzen der Spannungsschwankungen und Flimmern

72/23/EEC Niederspannungsrichtlinie zu entsprechen

EN 61010-1:	**1993**	**Grenzwerte und Methoden zur Messung von Funkstörungseigenschafter von industriellen, wissenschaftlichen und medizinischen Hochfrequenzgeräten (Klasse A)**

Declara que el producto siguiente: ***Español***

Designación:	Serie 935
Números de modelos:	935A or B - 1C (C D o K) (0 o 1) - (Cualquier combinación de cuatro números y letras)
Clasificación:	Control, Categoría de instalación II, Grado de Contaminación Ambiental II
Tensión nominal:	100 a 240 V~ **o** 24 a 28V ≈
Frecuencia nominal:	50/60 Hz

Consumo nominal de energía: 6 VA máximo

Cumple con los requisitos esenciales de las siguientes Directivas de la Unión Europea, usando las secciones pertinentes de las reglas normalizadas y los documentos relacionados que se muestran:

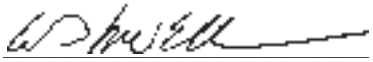
89/336/EEC - Directiva de Compatibilidad Electromagnética

EN 50082-2:	**1995**	**Norma de inmunidad genérica del EMC, Parte 2: Ambiente industrial**
EN 61000-4-2:	1995	Descarga electrostática
EN 61000-4-4:	1995	Perturbaciones transitorias eléctricas rápidas
EN 61000-4-3:	1996	Inmunidad radiada
EN 61000-4-6:	1996	Inmunidad conducida
ENV 50204:	1995	Teléfono portátil
EN 50081-2:	**1994**	**Norma de emisión genérica del EMC, parte 2: Ambiente industrial**
EN 55011:	1991	Límites y métodos de medición de características de perturbaciones de radio correspondientes a equipos de radiofrecuencia industriales, científicos y médicos (Grupo 1, Clase A)
EN 61000-3-2:	1995	Límites para emisiones de corriente armónica
EN 61000-3-3:	1995	Limitaciones de fluctuaciones del voltaje

73/23/EEC Directiva de baja tensión

EN 61010-1:	**1993**	**Requerimientos de seguridad para equipos eléctricos de medición, control y uso en laboratorios, Parte 1: Requerimientos generales**

Erwin D. Lowell	Winona, Minnesota, USA
Name of Authorized Representative	Place of Issue
General Manager	May 14, 1996
Title of Authorized Representative	Date of Issue



Signature of Authorized Representative

935B Software Map

Operations Menu

Prompt	Range	Default	Hidden if *	Your Settings
SP Primary Set Point	rL rh Select a value, adjustable between Input Type Range Low and Input Type Range High.	75°F or 23°C	Appears always	
Aut Auto-tune	no YES Choose YES to Auto-tune the 935A.	no	tAG = A	
AL0 Alarm Low	Ah1 Select a value, adjustable between Range Low and Alarm High.	Type J Range Low	tAG = 0; or if Ot1 and Ot2 ≠ ALrM	
Ah1 Alarm High	rL0 Select a value, adjustable between Alarm Low and Range High.	Type J Range High	tAG = 0; or if Ot1 and Ot2 ≠ ALrM	
tMr Countdown Timer	0000 Select a countdown time value, adjustable between 00:00 and 99:59 hrs:mins or min:sec.	0	tAG = 0; or if Ot2 ≠ thrM or trMS	
idLE Idle Set Point Type	trAc rL rh Choose an idle Set Point. Trac is an Idle Set Point equal to the Primary Set Point; or select a value between Input Type Range Low and Input Type Range High.	trAc	tAG = 0; or if Ot2 ≠ thrM or trMS *NOTE: All prompts, except SP and tAG, are hidden if Ot1 = FPL.	

Prompt	Range	Default	Hidden if *	Your Settings
Operations Menu				
PID PID Menu	no YES Choose YES to move to the PID Menu.	no	tAG = P	
CnFG Configuration Menu	no YES Choose YES to move to the Configuration Menu.	no	The front panel is locked out.	
PID Menu				
Pb h Proportional Band Heat	0 999 0 555 0.0 999.0 0.0 555.0 Select a value in whole degrees (0°F to 999°F or 0°C to 555°C) or in tenths of degrees (0.0°F to 999.0°F or 0.0°C to 555.0°C).	25°F or 17°C	tAG = P; or if Ot1 and/or Ot2 ≠ HEAt	
HYSh Hysteresis Heat	1 999 1 555 0.1 999.0 0.1 555.0 Select a value in whole degrees (1°F to 999°F or 1°C to 555°C) or in tenths of degrees (0.1°F to 999.0°F or 0.1°C to 555.0°C).	3°F or 2°C	tAG = P; or if Pb h ≠ 0	

Prompt	Range	Default	Hidden if *	Your Settings
[Ct h] Cycle Time Heat	[0.1] [60.0] [5.0] [60.0] Select a value between 0.1 and 60.0 seconds (Solid-State Relay or Switched DC) or 5.0 and 60.0 seconds (Electromechanical Relay).	1.0 second	[tAg] = [P]; or if [Pb h] = 0	
[db] Dead Band	[0] [999] [0] [555] [0.0] [999.0] [0.0] [555.0] Select a value in whole degrees (0°F to 999°F or 0°C to 555°C) or in tenths of degrees (0.0°F to 999.0°F or 0.0°C to 555.0°C).	0°F or 0°C	[tAg] = [P]; or if [Ot 1] = [cool] and [Ot2] ≠ [hEAt]; or if [Ot 1] = [hEAt] and [Ot2] ≠ [cool]	
[Pb c] Proportional Band Cool	[0] [999] [0] [555] [0.0] [999.0] [0.0] [555.0] Select a value in whole degrees (0°F to 999°F or 0°C to 555°C) or in tenths of degrees (0.0°F to 999.0°F or 0.0°C to 555.0°C).	25°F or 17°C	[tAg] = [P]; or if [Ot 1] ≠ [cool] and/or [Ot2] ≠ [cool]	
[hYSc] Hysteresis Cool	[1] [999] [1] [555] [0.1] [999.0] [0.1] [555.0] Select a value in whole degrees (1°F to 999°F or 1°C to 555°C) or in tenths of degrees (0.1°F to 999.0°F or 0.1°C to 555.0°C).	3°F or 2°C	[tAg] = [P]; or if [Pb c] ≠ 0	

PID Menu

Prompt	Range	Default	Hidden if *	Your Settings
[Ct c] Cycle Time Cool	[0.1] [60.0] [5.0] [60.0] Select a value between 0.1 and 60.0 seconds (Solid-State Relay or Switched DC) or 5.0 and 60.0 seconds (Electromechanical Relay).	5.0 seconds	[tAG] = [P]; or if [Pb c] = 0 or if [Pb c] is hidden	
[It] Integral Function	[0.0] [99.99] Select a value, adjustable between 0.0 and 99.99 minutes/repeat.	5.00 minutes/repeat	[tAG] = [P]; or if [Pb h] = 0; or if [Pb h] is hidden; and if [Pb c] = 0; or if [Pb c] is hidden	
[dE] Derivative Function	[0.00] [9.99] Select a value, adjustable between 0.00 and 9.99 minutes.	0 minutes	[tAG] = [P]; or if [Pb h] = 0; or if [Pb h] is hidden; and if [Pb c] = 0; or if [Pb c] is hidden	
[CAL] Calibration Offset	[-999] [9999] [-99.9] [999.9] Select a value, adjustable between -999° and 9999°F or C or -99.9° and 999.9°F or C to eliminate a difference between the displayed temperature and the actual temperature.	0°F or 0°C	[tAG] = [P]	

Prompt	Range	Default	Hidden if *	Your Settings
In Input Type	J J t/c H K t/c t T t/c n N t/c E E t/c S S t/c rtd 1.0°RTD rtd 0.1°RTD	J	tAG = C	
C_F Celsius/Fahrenheit	°F °C Choose to indicate temperature in °Fahrenheit or °Celsius.	F	tAG = C	
rL Range Low	In rh Select a value between Input Type Range Low and Input Range High.	Type J range low value	tAG = C	
rh Range High	rL In Select a value between Input Type Range High and Input Range Low.	Type J range high value	tAG = C	
Ot1 Output 1 Function	hEAt COOL ALrM rSP FPL nonE Choose Heat, Cool, Alarm, Remote Set Point, Front Panel Lock or No output action.	heat	tAG = C	

Prompt	Range	Default	Hidden if *	Your Settings
Ot2 Output 2 Function	HEAt COOL ALM1 tHM1 tM1S nonE Choose Heat, Cool, Alarm, Timer (Hrs:Min), Timer (Min:Sec) or No output action.	none	tAG = C	
rtS Remote Timer Start	oFF FPL tM1r Choose Off, Front Panel Lock, or Timer (Hrs:Min)	Off	tAG = 0	
diSP Display Default	Ac AcSP Act1 t1Ac t1SP Choose the primary (last 2 characters) and secondary (first 2 characters) Default displays. Press SET to toggle to the secondary display for 15 seconds.	Ac	tAG = C	
ALtY Alarm Type	Pnnc Pnno dEnc dEno Choose an alarm type: Process normally closed, Process normally open, Deviation normally closed or Deviation normally open.	Prnc	tAG = C; or if Ot1 and/or Ot2 ≠ ALM1	
AHyS Alarm Hysteresis	1 999 1 555 0.1 999.0 0.1 555.0 Select a value in whole degrees (1°F to 999°F or 1°C to 555°C) or in tenths of degrees (0.1°F to 999.0°F or 0.1°C to 555.0°C).	3°F or 2°C	tAG = C; or if Ot1 and/or Ot2 ≠ ALM1	

Prompt	Range	Default	Hidden if *	Your Settings
LAt Alarm Latch	no YES Choose YES for a Latching Alarm.	no	tA9 = C; or if Ot1 and/or Ot2 ≠ ALM1	
SIL Alarm Silencing	no YES Choose YES for a Silenced Alarm on start-up or silencing during operation.	no	tA9 = C; or if Ot1 and/or Ot2 ≠ ALM1	
FAIL Input Failure Mode	bPLS -100 100 Choose Bumpless Transfer or Percent Power.	Bumpless	tA9 = C; or if Ot1 and Ot2 ≠ hEAt or cooL	
t1M1 Timer Output Function	dLon dLoF S9on S9oF Choose Delay ON, Delay OFF, Signal ON, or Signal OFF.	Delay OFF	tA9 = C; or if Ot2 ≠ tHM1 or tM1S	
Strt Start Timer Function	IM1d rdY rdYA PwJr Choose Immediate, Ready Band, Ready Band Acknowledge, or Power.	Immediate	tA9 = C; or if Ot2 ≠ tHM1 or tM1S	
rdY Timer Ready Band	0 999 0 555 0.0 999.0 0.0 555.0 If Strt = rdYA or rdY, then select a value in whole degrees (0°F to 999°F or 0°C to 555°C) or in tenths of degrees (0.0°F to 999.0°F or 0.0°C to 555.0°C).	0°F or 0°C	tA9 = C; or if Ot2 ≠ tHM1 or tM1S	

Prompt	Range	Default	Hidden if *	Your Settings
St Signal Time	1 99:59 If t IM7 = S9on or S9oF, then select a value between 00:01 and 99:59 min:sec.	00:01	tA9 = C; or if t IM7 ≠ S9on or S9oF	
SLOC Set Point Lockout	no YES Choose YES to Lock the Primary Set Point.	no	tA9 = C	
tA9 Lockout Tag	PCOA COA PCO CO PC A C A PC C P OA OA P O O P A A P Choose the menus/functions that will not be displayed, and therefore cannot be changed. P = PID Menu C = Configuration Menu (except tag) O = Operations Menu (except CnF9) A = Auto-tune	P	Always appears	

About Watlow Winona

Watlow Winona is a U.S. division of Watlow Electric Manufacturing Company, St. Louis, Missouri, a manufacturer of industrial electric heating products since 1922. Watlow products include electric heaters, sensors, controllers and switching devices. The Winona operation has been designing solid-state electronic control devices since 1962, and has earned the reputation as an excellent supplier to original equipment manufacturers. These OEMs and end users depend upon Watlow Winona to provide compatibly engineered controls that they can incorporate into their products with confidence. Watlow Winona resides in a 100,000-square-foot marketing, engineering and manufacturing facility in Winona, Minnesota.

Warranty

The Watlow Series 935 is warranted to be free of defects in material and workmanship for 36 months after delivery to the first purchaser for use, providing that the units have not been misapplied. Since Watlow has no control over their use, and sometimes misuse, we cannot guarantee against failure. Watlow's obligations hereunder, at Watlow's option, are limited to replacement, repair or refund of purchase price, and parts which upon examination prove to be defective within the warranty period specified. This warranty does not apply to damage resulting from transportation, alteration, misuse, or abuse.

Returns

- Call or fax your distributor or the nearest Watlow sales office for best information about returns. (See outside back cover.)
- To return directly to Watlow Winona in the U.S., first call or fax Customer Service for a Return Material Authorization (RMA) number (telephone: +1 (507) 454-5300; fax: +1 (507) 452-4507).
- Put the RMA number on the shipping label, along with on a written description of the problem.
- A restocking charge of 20% of the net price is charged for all standard units returned to stock.

How to Reach Us

TOTAL CUSTOMER SATISFACTION
3 Year Warranty

Quality and Mission Statement:

To position Watlow Winona as the world's best supplier of superior thermal solutions, by exceeding the expectations of our customers, shareholders, and employees.

Your Authorized Watlow Distributor:

Europe:

Watlow Electric GmbH
Lauchwasenstr. 1, Postfach 1165,
Kronau 76709 Germany
Telephone: +49 (0) 7253 9400
Fax: +49 (0) 7253 9400 99

Watlow France S.A.R.L.
Immeuble Somag,16 Rue Ampère,
Cergy Pontoise Cedex 95307 France
Telephone: +33 (1) 3073 2425
Fax: +33 (1) 3073 2875

Watlow Italy S.r.l.
Via Meucci 14
20094 Corsico, Milano Italy
Telephone: +39 (02) 458 8841
Fax: +39 (02) 458 69954

Watlow Limited
Robey Close, Linby Industrial Estate,
Linby, Nottingham NG15 8AA England
Telephone: +44 (0) 115 9640777
Fax: +44 (0) 115 9640071

Asia/Pacific:

Watlow Australia Pty., Ltd.
3 Belmont Place, Gladstone Park,
Tullamarine, Victoria 3043 Australia
Telephone: +61 (3) 9335 6449
Fax: +61 (3) 9330 3566

Watlow China, Inc.
179, Zhong Shan
Hong Qiao Cointek Bldg, Fl. 4, Unit P
Shanghai 200051 China
Telephone: +86 21-6229-8917
Fax: +86 21-6228-4654

Watlow Japan Ltd. K.K.
Azabu Embassy Heights 106,
1-11-12 Akasaka,
Minato-ku, Tokyo 107-0052 Japan
Telephone: +61 (3) 9335 6449
Fax: +61 (3) 9330 3566

Watlow Korea
3rd Fl. DuJin Bldg.
158 Samsun-dong, Kangnam-ku
Seoul, 135-090 Korea
Telephone: +82 (02) 563 5777
Fax: +82 (02) 563 5779

Watlow Singapore Pte. Ltd.
Blk, 55, Ayer Rajah Crescent, #3-23,
Ayer Rajah Industrial Estate,
Singapore 139949
Telephone: +65 777 5488
Fax: +65 778 0323

Watlow Electric Taiwan
10F-1 No. 189,
Chi-Shen 2nd Road,
Kaohsiung, Taiwan
Telephone: +886 (0) 7 261 8397
Fax: +886 (0) 7 261 8420

Watlow-Penang
38-B Jalan Tun Dr. Awang
Bayan Lepas
Penang, Malaysia 11900
Telephone: +60 (4) 641-5977
Fax: +60 (4) 641-5979

Latin America:

Watlow de México
Av. Fundición #5,
Col. Parques Industriales,
Querétaro, Qro. México CP-76130
Telephone: +52 (42) 17 6235
Fax: +52 (42) 17 6403

For other information:

Watlow FAX REPLY: (908) 885-6344 (outside the U.S.); or (800) 367-0430 (inside the U.S.)