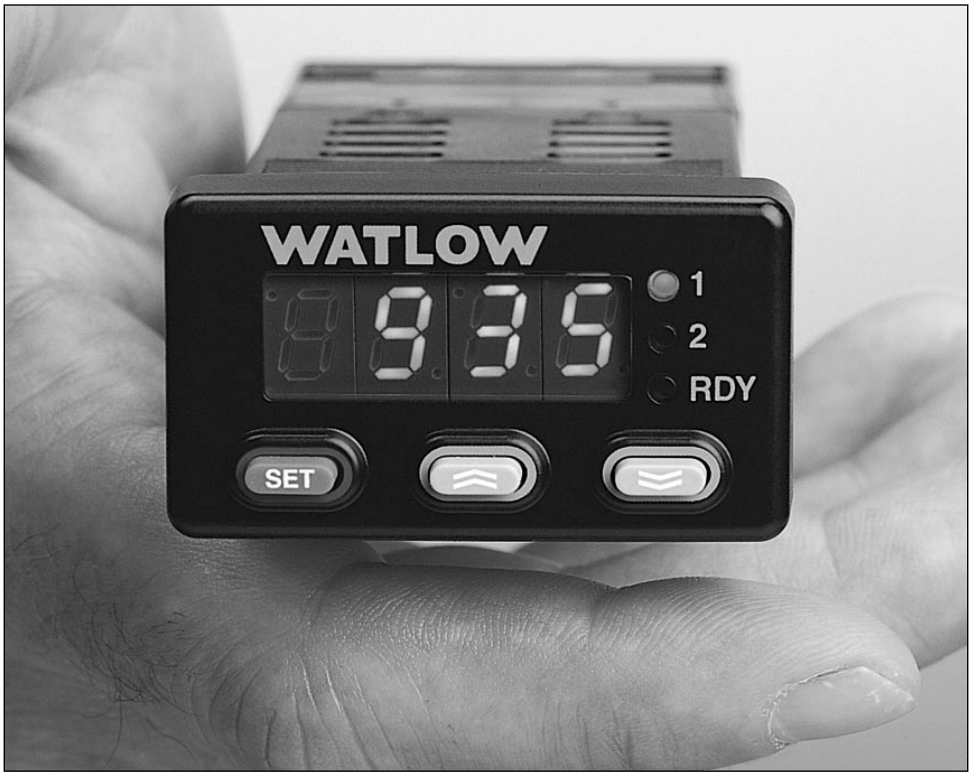
Series 935A

User's Manual



Temperature Controller with Countdown Timer

CE

TOTAL CUSTOMER SATISFACTION
3 Year Warranty

ISO 9001
Registered Company
Winona, Minnesota USA

WATLOW

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U.S. English

0600-0015-0000 Rev L **$15.00**
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Supersedes: 0600-0015-0000 Rev K

Safety Information in this Manual

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

Safety Alert

CAUTION or

WARNING

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.

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

Electrical Shock Hazard

CAUTION or

WARNING

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) 454-5300. 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 Winona, 1241 Bundy Boulevard, P.O. Box 5580, Winona, Minnesota, 55987-5580 U.S.; Telephone: +1 (507) 454-5300; fax: +1 (507) 452-4507.

Where to find it...

Table of Contents

Introduction

Welcome to the Watlow Series 935A!

General Description

The Series 935A 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. Outputs 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; IP65/NEMA 4X rated
- Reliable; built to UL, CUL approved safety standards with a three year warranty
- Accuracy with economy
- Universal power supply for worldwide application

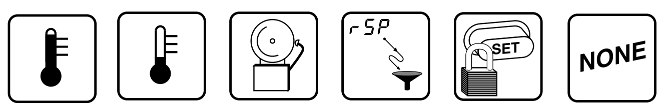
Unique Features

The Series 935A Output 1 can be configured as a remote set point input for a multi-loop control system, or, as an alternative, that output can be a front panel lock with your switch to further reinforce the 935A's lockout capability. The Series 935A timer functions include heat/timer or cool/timer countdown modes in hours:minutes or minutes:seconds.

Figure 1 - Series 935A Input and Output Overview

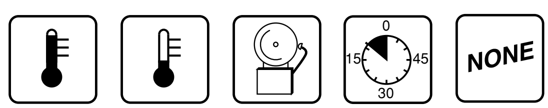
Single Input
Type J, K, T, N, S, E Thermocouple, 1° RTD, or 0.1° RTD

Output 1
Switched dc



Heat Cool Alarm Remote Set Point Front Panel Lockout 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
Remote Set Point	Heat, Cool
Front Panel Lock	Heat, Cool, Alarm
None	Heat, Cool, Alarm

Read or change

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. 16.

Figure 2 - Series 935A 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.16.
- Clears a latched alarm.

LED 1:

Lit when Output 1 is active.

LED 2:

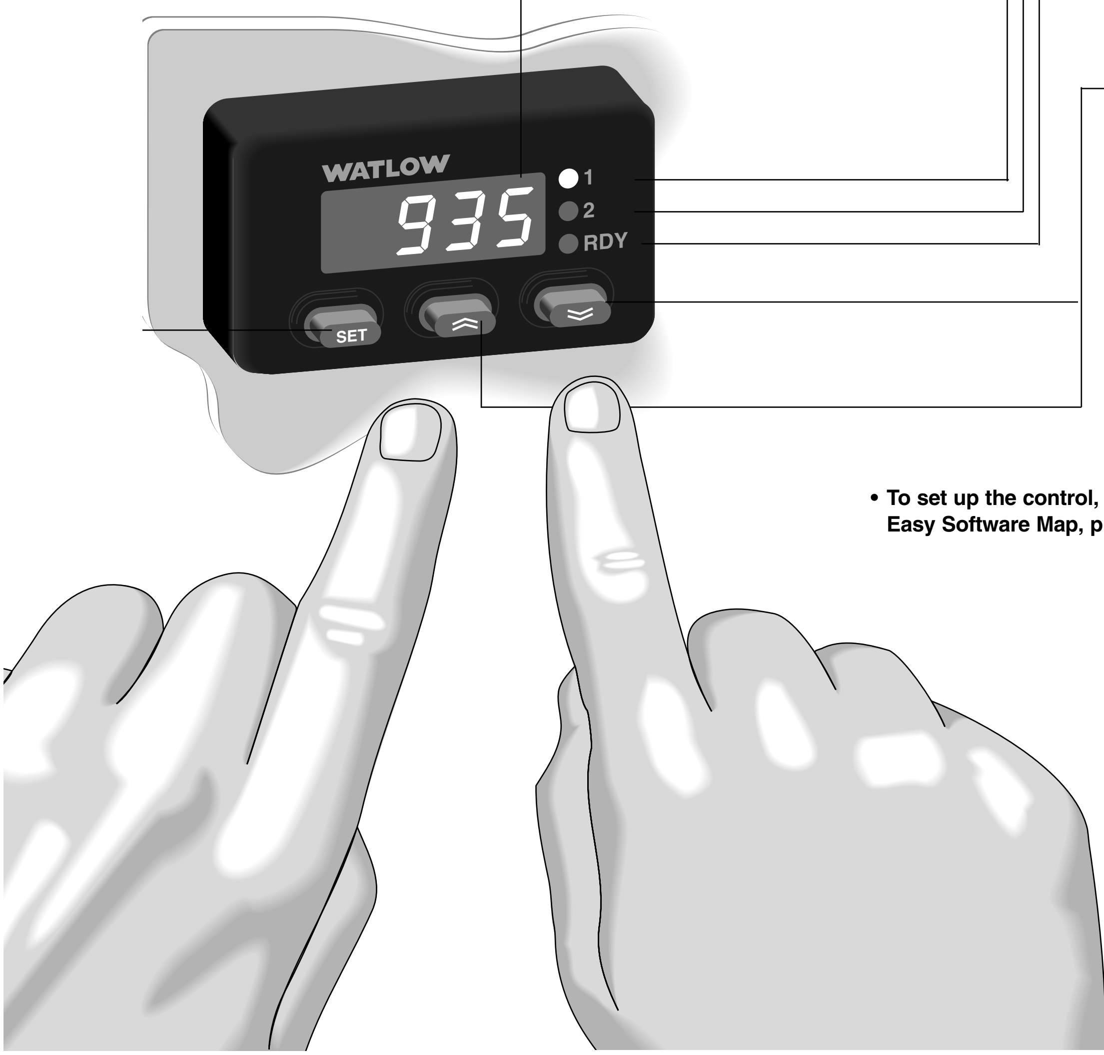
Lit when Output 2 is active.

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. 9.**

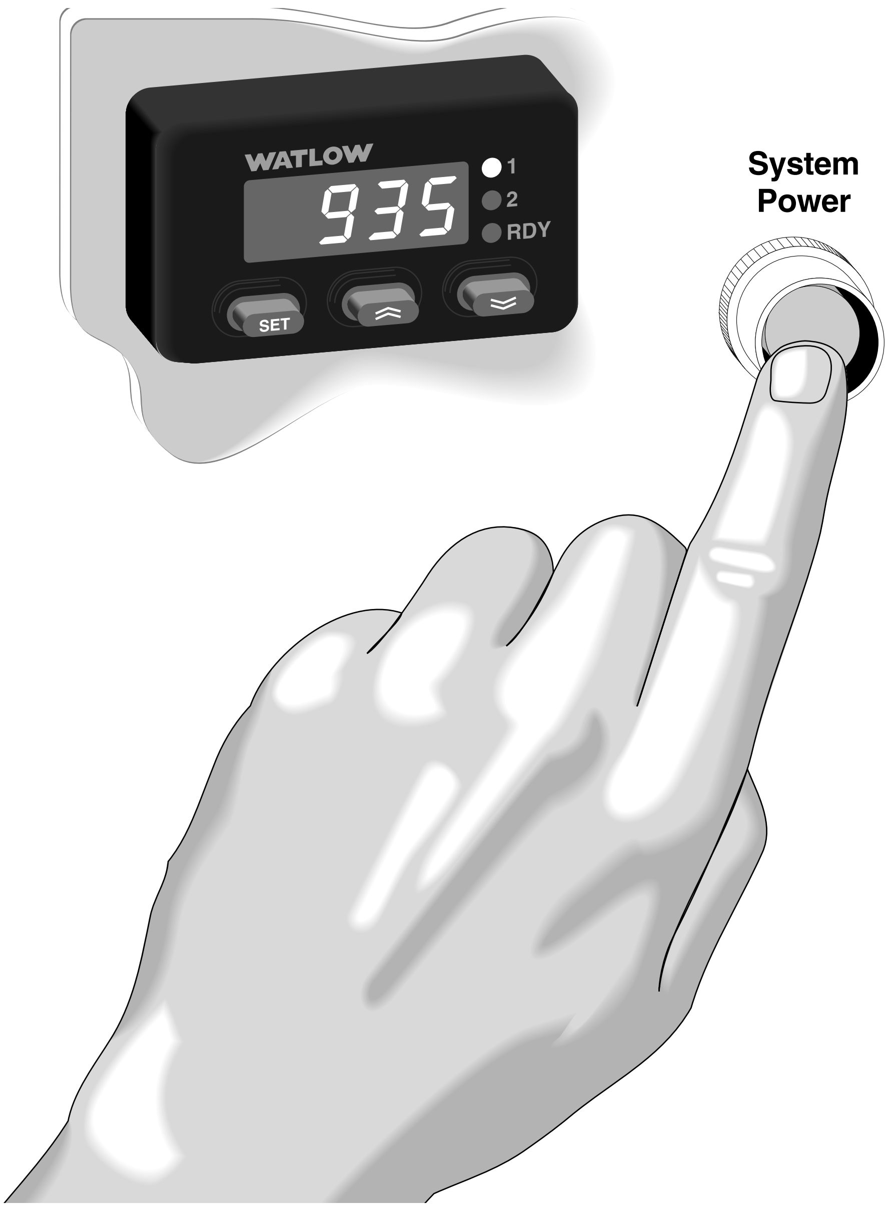
Begin Controlling

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

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

- To change set point, go to p. 7.
- The Series 935A will auto-tune when you tell it to, go to p. 32.
- If you see an error, go to p. 8.

Figure 3 - Begin Controlling



Change Set Point

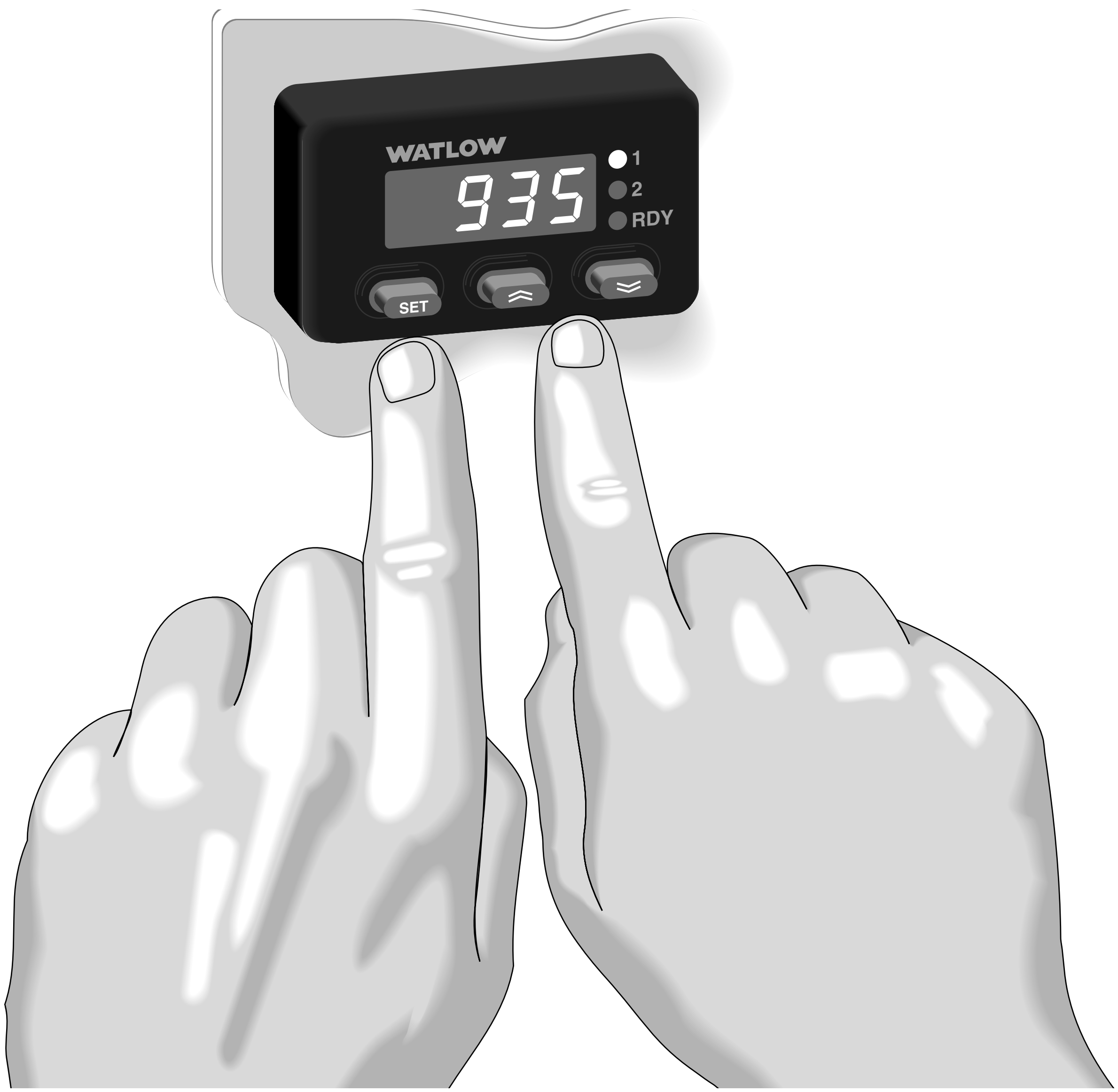
Your Series 935A displays the actual process temperature when it comes from the factory. You can change it to normally display the set point or time. Go to p. 16, see d ISP.

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



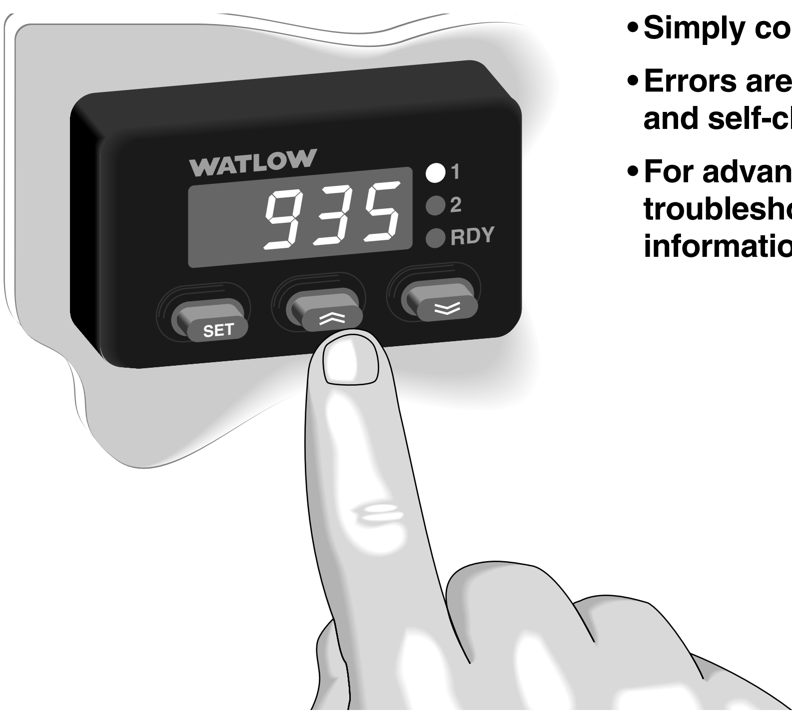
Respond to a simple error

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.
Er2	Sensor type mismatch or open RTD.	Go to In prompt, check selection (see p. 20), or check RTD, replace as necessary.
Er3	Sensor type mismatch.	Go to In prompt, check selection (see p. 20).
Er4	Open Thermocouple, bad connection, or broken wire.	Check the sensor, replace as necessary.
Er5	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.



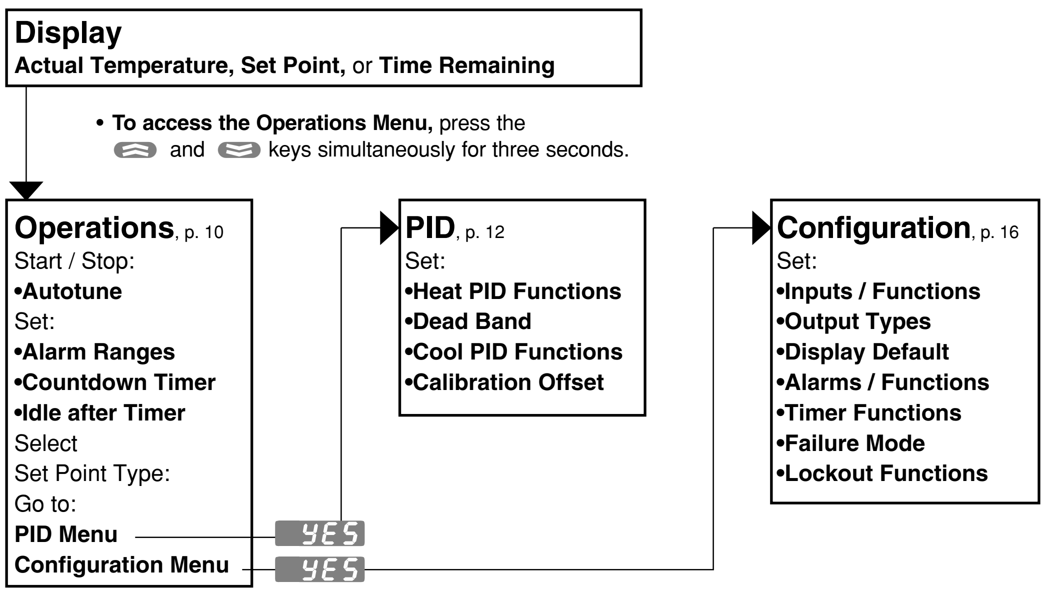
- **Simply correct the cause.**
- **Errors are non-latching and self-clearing.**
- **For advanced error and troubleshooting information, go to p. 37.**

Learn the Software Map

Software Organization

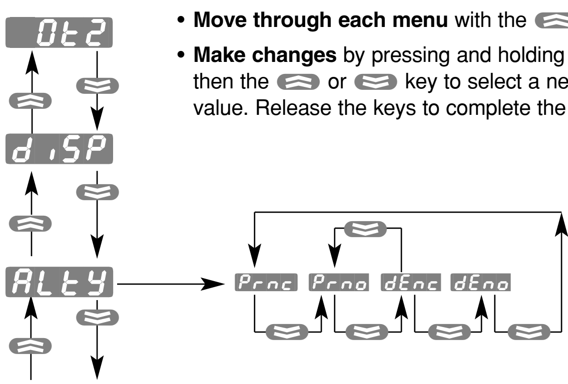
- The Series 935A has three primary menus in addition to a normal display.
- The software reverts to the normal display after 60 ± 5 sec.

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 935A 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** `AUt`: 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,** `ALO` and `AhI`: 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** `tMr`: Select a countdown time value between 00:00 and 99:59 hours:minutes or minutes:seconds. Time interval choices `thrM` and `tMS` reside in the Configuration Menu for Output 2.
- **Idle Set Point** `IdLE`: `trAc` or an adjustable value between `rL` and `rh`. Choose to have the Idle Set Point track `trAc`, or equal, the Primary Set Point; or select an Idle Set Point value in °F or °C between the range low `rL` and range high `rh` 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.
- **Local/Remote Set Point** `L-r`, `L` or `r`: Choose to maintain control with the Primary `L` (local) Set Point, or to enable the Remote `r` Set Point if the Output 1 `Ot1` choice equals Remote Set Point `rSP`.
- **Go to the PID Menu** `PId`: Choose `YES` to proceed to the PID Menu.
- **Go to the Configuration Menu** `CnFg`: Choose `YES` 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. 11 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 935A:

- Lockout function; the Lockout Tag `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. 18, 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. 3, or Setting Up Inputs and Outputs, p. 20.

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.

Aut	no	YES
	NO	YES

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

ALO	Ahi
	Alarm High

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

Ahi	ALO
	Alarm Low

Countdown Timer - Select a countdown time duration.

tMr	00.00	99.59
	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 = thM or tMS, view the idle set point from the set point display with a three second SET press.

IdLE	trAc	rL	rh
	Track Set Point	Range Low	Range High

Local / Remote Set Point - Choose to use the remote set point input.

L-r	L	r
	Local	Remote

PID Menu - Go to the PID Menu.

Pid	no	YES
	NO	YES

Configuration Menu - Go to the Configuration Menu.

CnFg	no	YES
	NO	YES

Learn the PID Menu

Choose the PID Strategy

You may rely solely on the Auto-tune `Aut` function (p. 32) 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 935A 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 935A 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. 18.
- 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. 3, or Setting Up Inputs and Outputs, p. 20.

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.

Set the 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. 33.

  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.

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

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

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

Cycle Time Heat - Select a cycle time for the heat output.

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

Dead Band - Select a dead band value.

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

Set-Up Cool

Proportional Band Cool - Select a cool proportional band value.

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

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

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

Cycle Time Cool - Select a cool output cycle time.

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

Set-Up General

Integral Function - Select an integral value.

It

0.00 99.99

0.00 to 99.99 minutes/repeat

Derivative Function - Select a derivative value.

dE

0.00 9.99

0.00 to 9.99 minutes

Calibration Offset - Select a calibration offset value.

CAL

-999 9999 -99.9 999.9

-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 935A 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. 18.
- 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. 3, or Setting Up Inputs and Outputs, p. 20.

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. 21 for sensor ranges.

In	J	H	t	n	E	S	rtd	rt.d
	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. 21.

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. 21.

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. 21.

Ot 1	hEAt	COOL	ALM	rSP	FPL	nonE
	Heat	Cool	Alarm	Remote Set Point	Front Panel Lock	None

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

Ot2	hEAt	COOL	ALM	thM	tMS	nonE
	Heat	Cool	Alarm	Timer Hr./Min.	Timer Min./Sec	None

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	Act i	t iAc	t iSP
	No secondary Actual temp.	Actual temp. Set point 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. 19.**

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

tIM

dLon	dLoF	S9on	S9oF
Delay on	Delay Off	Signal On	Signal Off

Start Timer Function - Choose the start timer conditions:
IMd = 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;
PUUr = immediate start on power-up without waiting for the Ready Band temp. or a press.

Strt

IMd	rdY	rdYA	PUUr
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 tIM = S9on or S9oF, 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.

tA9

PCOA	PCO	PC A	PC	P OA	P O	P A	P
COA	CO	C A	C	OA	O	A	

Choose the menus / function that will not be displayed, and therefore cannot be changed.
P = PID Menu, C = Configuration Menu (except tA9), O = Operations Menu (except CnF9), A = Auto-tune.

Using Lockout Functions

Configuration Menu

In
Input Type

C_F
Celsius/Fahrenheit

rL
Input Range Low

rh
Input Range High

Ot 1 ✔
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

tIM
Timer Function

Strt
Start Timer

rdy
Timer Ready Band

St
Signal Time

SLOC ✔
Set Point Lockout

tAg ✔
Lockout Tag

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

- **Front Panel Lock** FPL uses a control output as an input for an external hardware switch; it requires wiring, see p. 23. Choose Front Panel Lock FPL as an exclusive Output 1 choice. Output 2 offers heat, cool, or alarm.
- **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 935A software menus from view. By selecting all or part of the four-digit binary acronym, PCOA (Proportional / Configuration / Operation / Auto-tune), 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:

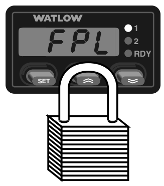
  "C" does not lock out tAg.

  "O" does not lock out CnFg.

WARNING: When Output 1 is a Front Panel Lock Ot 1 = FPL , the output is energized! Do not connect a power switching device to Output 1; injury or death or damage to equipment or property could result.

Table 7 - Series 935A Lockout Options

Three Lockout Options



= No Lockout

PCOA = Fully Locked

= Operator's Perspective

	Front Panel Lockout OtI	Set Point Lockout SLOC		Security Tag tAg			
	FPL	no	YES	P	C	O	A
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

P = PID Menu

C = Configuration Menu (except tAg)

O = Operations Menu (except CnFg)

A = Auto-tune

Note: Front Panel Lockout requires an external hardware switch. For FPL set-up and wiring information, see p. 23. For more wiring information, see p. 43.

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
- 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 Input/Output Set-up Information

- All initial input and output set-up occurs in the Configuration Menu.
- The 935A requires a thermocouple or RTD input connection to the S1 and S2 Terminals, including when using the remote set point rSP option.
- Remote Set Point rSP is a second input, wired to OT1 Terminals 3 and 4.
- Indication of °C or °F units of measure occurs only in the C_F prompt.
- Sensor input type minimum and maximum range (see p. 51) 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 935A, they are the "golden" prompts.
- Output 1 must be heat or cool to use Output 2 as a timer.
- Remote Set Point rSP enables Output 1 to act as an input for 0-5⎓ (dc) from another controller or a transmitter.
- Front Panel Lock FPL requires an external switch and 62Ω 0.5 watt resistor wired in parallel on Output 1. Switch open = unlocked; closed = locked. See p. 23.
- Output 2 sets timer interval in hours:minutes thM or minutes:seconds tMS.
- 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

  Acti = Normal Display: Time Remaining
  Secondary: Actual Temperature

  tiAc = Normal Display: Actual Temperature
  Secondary: Time Remaining

  tiSP = Normal Display: Set Point Temperature
  Secondary: Time Remaining

Note: Access to Configuration Menu varies with lockout function. **See p. 19.**

Table 8 - Setting Inputs and Outputs

Input Type - Choose sensor type.

`In`

`J`	`H`	`t`	`n`	`E`	`S`	`rtd`	`rt.d`
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.

`C_F`

`oF`	`oC`
°F	°C

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

`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, dependent on `In`.

`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.

`Ot 1`

`hEAt`	`COOL`	`ALrM`	`rSP`	`FPL`	`nonE`
Heat	Cool	Alarm	Remote Set Point	Front Panel Lock	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
Remote Set Point	Heat, Cool
Front Panel Lock	Heat, Cool, Alarm
None	Heat, Cool, Alarm

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

`Ot 2`

`hEAt`	`COOL`	`ALrM`	`thrM`	`trMS`	`nonE`
Heat	Cool	Alarm	Timer Hr./Min.	Timer Min./Sec	None

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`	`Act i`	`t iAc`	`t iSP`
No secondary Actual temperature	Actual temperature Set point temperature	Actual temperature Time remaining	Time remaining Actual temperature	Time remaining Set point temperature

Set Up Remote Set Point Input

Configuration Menu

- In — Input Type
- C-F — Celsius/Fahrenheit
- rL — Input Range Low
- rh — Input Range High
- Ot 1 — Output 1 Function
- Ot2 — Output 2 Function
- 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 Set Point…

1. Wire the control per the example below and the information on p. 42-45.
2. Go to CnFg, make In and C_F choices, then
3. Make In and C_F choices, then
4. Scale the 0-5V⎓ (dc) input with rL and rh.
5. Go to Ot 1, and choose rSP.
6. Go to the Operations Menu; L-r, choose r.

Output 1

Ot 1	rSP	Select Remote Set Point for Output 1

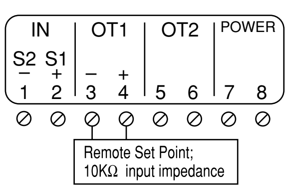
Local / Remote

L-r	L	Local set point active
	r	Remote set point active

- Remote Set Point is scaled by rh and rL.
- 0V input results in a set point of rL.
- 5V input results in a set point of rh.
- Adjust rL and rh to match your input to desired set point adjustment.
- The Remote Set Point will display instead of Primary Set Point.
- Auto-tune always uses the Primary Set Point.
- Deviation Alarm uses the active Set Point.

Figure 5 - Remote Set Point Wiring

See p. 42-45 for more wiring information.



NOTE: Sensor required on Terminals 1 and 2.

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.

Set Up Front Panel Lockout

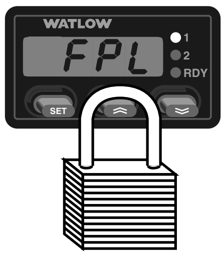
Configuration Menu

- In — Input Type
- C_F — Celsius/Fahrenheit
- rL — Input Range Low
- rh — Input Range High
- Ot 1 ✓ — Output 1 Function
- Ot 2 — Output 2 Function
- 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. 42-45.
3. Go to CnFg, then Ot 1, and choose FPL.

Table 9 - Using Front Panel Lock



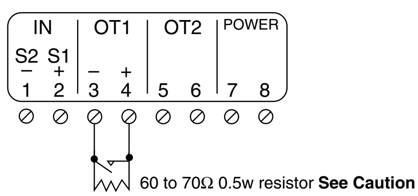
Ot 1 FPL

Ot 1 = 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. 43 for more wiring information.

(Closed switch = locked)



Output 1; Front Panel Lock

WARNING: When Output 1 is a Front Panel Lock Ot 1 = FPL, the output is energized! Do not connect a power switching device to Output 1; injury or death, or damage to equipment or property could result.

CAUTION: Failure to install a 60 to 70Ω, 0.5 watt resistor across the customer-supplied Front Panel Lock switch will cause the panel to lock out even when the switch is open. Injury to personnel, or damage to equipment or property could result.

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
- dISP — Display Default
- ALtY — Alarm Type ✔
- AhYS — Alarm Hysteresis ✔
- LAt — Alarm Latch ✔
- SIL — Alarm Silencing ✔
- FAIL — Failure Mode

Operations Menu

- Aut — Auto-tune
- ALO — Alarm Range Low ✔
- AhI — Alarm Range High ✔
- PId — PID
- CnFG — Configuration

Alarms signal an excursion from normal operating conditions. In general, audible alarms or lights connected to alarm outputs will signal a problem. In the 935A the front panel LED "1" or "2" indicates an alarm with hI 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 AhI and ALO 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 AhI is the deviation above set point, and the low value ALO 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 ALO and AhI 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 ß press after the process returns to a safe, or non-alarm condition. Non-latching alarms self-clear. See Table 11: LAt, p. 27.
- **Silenced Alarms** provide a means to clear the alarm output with a SET press even if the alarm condition still exists. The flashing hI] or LO message will persist until the alarm condition ceases. See Table 11: SIL, p. 27. If SIL = YES, alarms are disabled (no message or output) on startup until the safe area is reached.
- **Alarm High and Low** Points, AhI and ALO, in the Operations menu determine where alarms will trigger. Alarm hysteresis AhYS determines where an alarm condition clears. See Table 11, page 27.
- 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. 27.

Table 10 (p. 25) and Table 11 (p. 27) illustrate the Series 935A alarm features.

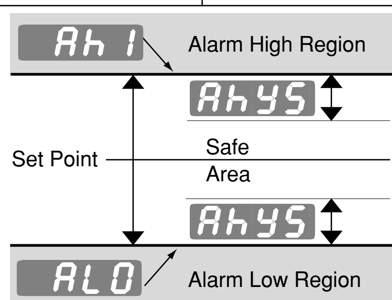
Table 10 - Alarm Functions

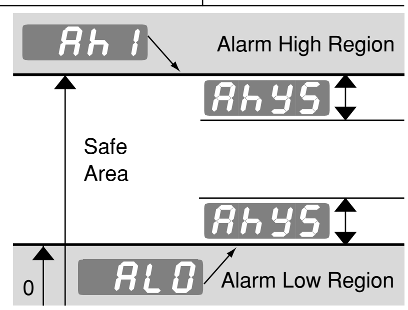
ALty Alarm Type	Deviation Alarm		Process Alarm	
	dEnc Deviation normally closed	dEno Deviation normally open	Prnc Process normally closed	Prno Process normally open
Non-Alarm State LED off Alarm Output:				
Alarm State LED on Alarm Output Status:				
Silenced-Alarm State LED off Alarm Output Status:				
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.





AhYS Alarm Hysteresis is the change in the process variable (actual) required to clear the alarm relay after an alarm occurs.

Setting Alarms

Configuration Menu

In
Input Type

C_F
Celsius/Fahrenheit

rL
Input Range Low

rh
Input Range High

Ot 1
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

Operations Menu

Aut
Auto-tune

ALO ✓
Alarm Range Low

AhI ✓
Alarm Range High

PId
PID

CnFg
Configuration

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. 42-45 for wiring information.
3. Go to the 935A's Configuration Menu CnFg. See p. 16.
4. Set either Output 1 Ot 1 or Output 2 Ot2 as the ALM 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. 36-37.
10. Go to the 935A's Operation Menu. See p.10.
11. Set the alarm high and low ALO and AhI points.
12. Test and adjust the alarm system.
13. Document the alarm settings and system.

⚠

CAUTION: Verify, in Table 10, p. 25, 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 935A 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 935A 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. 25) illustrate the Series 935A 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 935A 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 Ah I. At the Range Low value, a ▽ press displays oFF and Ah I disables.	
Ah I **Alarm High**	A value from ALo to input Range High At the Range High value, a △ press displays oFF and Ah I disables.	

Learn the Countdown Timer

Configuration Menu

In	Input Type	
C_F	Celsius/Fahrenheit	
rL	Input Range Low	
rH	Input Range High	
Ot 1	Output 1 Function	
Ot2	Output 2 Function	✓
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	✓

- The timer requires Output 1 to work as either a heat or as a cool output.
- The 935A timer is a function of Output 2, which, depending on your unit's model number, can be either switched dc, electromechanical relay, or solid state relay.
- 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. 16).
- LED colon flashes when timer runs.
  LED colon ON steadily when timer is not running.

Configuration Menu set-up includes: (see p. 16)

- Output 1 Ot 1; heat hEAt or cool COOL.
- Output 2 Ot2; timing interval,
  hours:minutes thM, or minutes:seconds tMS.
- Timer (Output 2) function tIM 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. Immediately 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 PWr without waiting for the Ready Band temp. or a ▼ press.
- Ready band width rdY above and below set point: degrees.
- Signal time St (if applicable) duration: seconds.

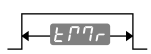
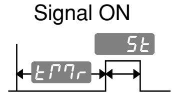
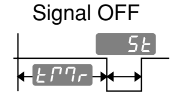
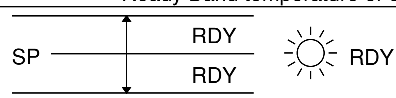
Operations Menu set-up includes: (see p. 10)

- Countdown Time tMr:
  hours:minutes or minutes:seconds.
- Idle Set Point Type IdLE, two choices:
  1. Track primary set point (always controls at the set point value).
  2. Set an idle set point for control when not timing.

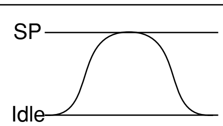
The next page presents this information in graphic format with additional detail.

Table 12 - Series 935A Timer Functions/Settings

Configuration Menu

Ot2	thM / tMS Choose time in hr:min or min:sec.		Timer set-up available only when Ot2 = thM or tMS	
tIM **Output 2 Timer Output Function;** Choose one of four possible output actions for the end of the timer tMr / St time periods.	dLon Delay ON  Output 2 is ON before timing; OFF during timing; ON after timing.	dLoF Delay OFF  Output 2 is OFF before timing; ON during timing; OFF after timing.	SGon Signal ON  Output 2 is OFF before & during timing; ON after timing; then OFF.	SGoF Signal OFF  Output 2 is ON before & during timing; OFF after timing; then ON.
Strt **Start Timer Function**	IMd Timer starts immediately on a [key] key press at the normal display without waiting for the Ready Band temperature. rdy Timer only runs in the Ready Band. [key] key starts timer sequence. rdyA Ready Acknowledge. [key] key starts timer sequence. SET must be pressed once inside the Ready Band to start timer at the normal display. PWr Timer starts immediately on control power up without waiting for the Ready Band temperature or a [key] press. See p. 61.			
rdy **Timer Ready Band**	 • rdy = 0, Disables Ready feature. • The RDY front panel LED is lit inside Ready Band for all Timer Start functions.			
St	**Signal Time**		Sets the signal time from 00:01 to 99:59 min:sec to run after Timer.	

Operations Menu

tMr	00:00 Timer Function OFF. 99:59 **Countdown Time**
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
- `Ot 1` Output 1 Function
- `Ot 2` ✓ Output 2 Function
- `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

1. Plan a timer strategy.
2. Wire the Output 2 control output, associated switching devices and annunciators. See p. 42-45.
3. Go to the 935A's Configuration Menu `CnFg`.
4. Choose the Output 2 `Ot 2` function as time; hrs:min `thm`, or time; min:sec `tmS`.
5. Choose a display default `dISP` (see page 16):
   - Actual Temperature only `Ac`
   - Actual; Set Point `AcSP`
   - Actual; Time `Act i`
   - Time; Actual `t iAc`
   - Time; Set Point `t iSP`
6. Choose a Timer Output Function `tIm`:
   - Delay ON `dLon`
   - Delay off `dLoF`
   - Signal ON `SGon`
   - Signal off `SGoF`
7. Choose a start timer `Strt` function; either immediate `Imd`, ready band `rdy`, Ready Acknowledge `rdyA`, or Power `PUdr`.
8. If you chose `rdy` or `rdyA`, then select a ready band `rdy` value.
9. If you chose `SGon` or `SGoF`, then select a signal time `St` value.
10. Go to the 935A's Operation Menu.
11. Set the countdown time `tmr`.
12. 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.
13. Run the system, and test the timer start with a SET press.
14. Document the timer settings and system.

Timer Example

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 935A-1CD0-000G control.

- Switched dc Output 1 wired to a dc input solid state relay (SSR) switches the heaters.
- Electromechanical relay Output 2 wired to an AC audible indicator provides “done” indication.

Configuration Menu Set-up			
C_F	=	°F	°F
dISP	=	Act i	After a SET press, actual temperature appears for 15 seconds.
Ot1	=	hEAt	Heating output
Ot2	=	tMS	Time; minutes:seconds
tIM	=	Sgon	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			
tMr	=	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 935A 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 ß 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 935A then automatically shifts to the 75°F idle set point.

Operations Menu

- AUt ✔ — Auto-tune
- ALO — Alarm Range Low
- AhI — 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 935A 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.

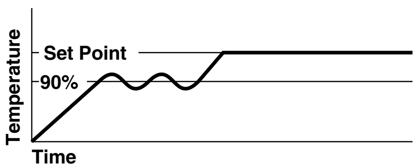
NOTE:
Manual tuning is a slow procedure, taking from minutes to hours to obtain optimum value.

Auto-tuning

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 935A



⚠

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

Manual Tuning

For optimum performance, tune the Series 935A 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 935A 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 = 5.0, 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.

Fine Tune the 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 935A 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 935A'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 935A 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 935A'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 935A

Calibration Menu

tc50	✓
tc00	✓
tc	✓
r15	✓
r380	✓
rst	✓

Quick Calibration Restore:

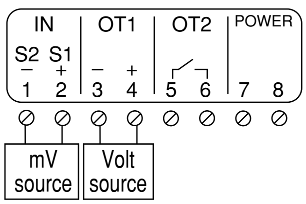
Press all three keys simultaneously until tc50 appears in the display, press ▲ once and rst will appear in the display. Press and hold SET, the display will show no, press ▲ to change display to YES. Press and hold ▲ and ▼ for 3 seconds to exit the CAL menu.

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

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

- tr50 and tr00 calibrate the thermocouple span.
- tc calibrates the ambient compensation.
- r380 and r 15 calibrate the RTD span.
- 0V is required when calibrating tc00 and r 15 for remote set point calibration.
- 5V is required when calibrating tc50 and r380 for remote set point calibration.
- 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
Volt source = 5V

- Store TC counts at 50.000mV
- Store 5V remote set point counts for use with TC

tc00

mV source = 0.000mV
Volt source = 0V

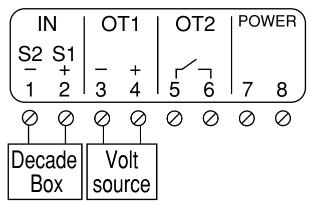
- Store TC counts at 0.000mV
- Store 0V remote set point counts for use with TC

tc

mV source = Temp. Compensation
Volt source = 0V

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

Figure 8b - RTD Calibration



r 15

Decade Box = 15.00 ohms
Volt source = 0V

- Store low end RTD counts
- Store 0V remote set point counts for use with RTD

r380

mV source = 380.00 ohms
Volt source = 5V

- Store high end RTD counts
- Store 5V remote set point counts for use with RTD

rSt no / YES

- Restore factory calibration

Calibrating the 935A and Remote Set Point Input

Thermocouple and Remote Set Point 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 100-240~ (ac), or 24-28V≂ (ac/dc) to Terminal 7 and Terminal 8.
2. Connect the millivolt source to Terminal 1 negative and Terminal 2 positive.
3. Connect voltage source to Terminal 3 negative and Terminal 4 positive.
4. 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 `tr50` is displayed.
2. Set the mV source to 50.00mV⎓ (dc). Set the voltage source to 5.00V⎓ (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), set voltage source to 0.00V⎓ (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.
Set voltage source to 0.00V. 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. Connect voltage source to Terminal 3 negative and Terminal 4 positive.
5. Set the Decade box to 15.00Ω, set the voltage source to 0.00V (Allow 10 seconds for sources to stabilize). Press and hold **SET**.
Press ▲ or ▼ until `YES` appears. Release **SET**.
6. Press ▼ - `r380` shall be displayed.
7. Set the decade box to 380.00Ω, set the voltage source to 5.00V. (Allow 10 seconds for sources to stabilize). Press and hold **SET**.
Press ▲ or ▼ until `YES` appears. Release **SET**.
8. Press and hold ▲ and ▼ for 3 seconds to Exit calibration menu.

Errors and Troubleshooting

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
- tIM — Timer Function
- Strt — Start Timer
- rdY — Timer Ready Band
- St — Signal Time
- SLOC — Set Point Lockout
- tAG — Lockout Tag

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 55 to 62 with the settings from your control, if possible.

3. Specifications of devices directly interfaced with the control.

Table 13 - 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. 20), or check RTD, replace as necessary.	Sensor under range
Er 3	Sensor type mismatch.	Go to In prompt, check selection (see p. 20).	Sensor over range
Er 4	Open Thermocouple, bad connection, or broken wire.	Check the sensor, replace as necessary.	A-D over flow
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 935A, 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 935A, 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 935A 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. 34-35.

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)
"D" Output 2	5 & 6	LED 2 on 0V⎓ (dc) Load sees line voltage	LED 2 off line voltage. Load sees 0V⎓ (dc)
"K" Output 2	5 & 6	LED 2 on <2V⎓ (dc) Load sees line voltage	LED 2 off line voltage Load sees 0V⎓ (dc)

Figure 9- Panel Cut-out Dimensions

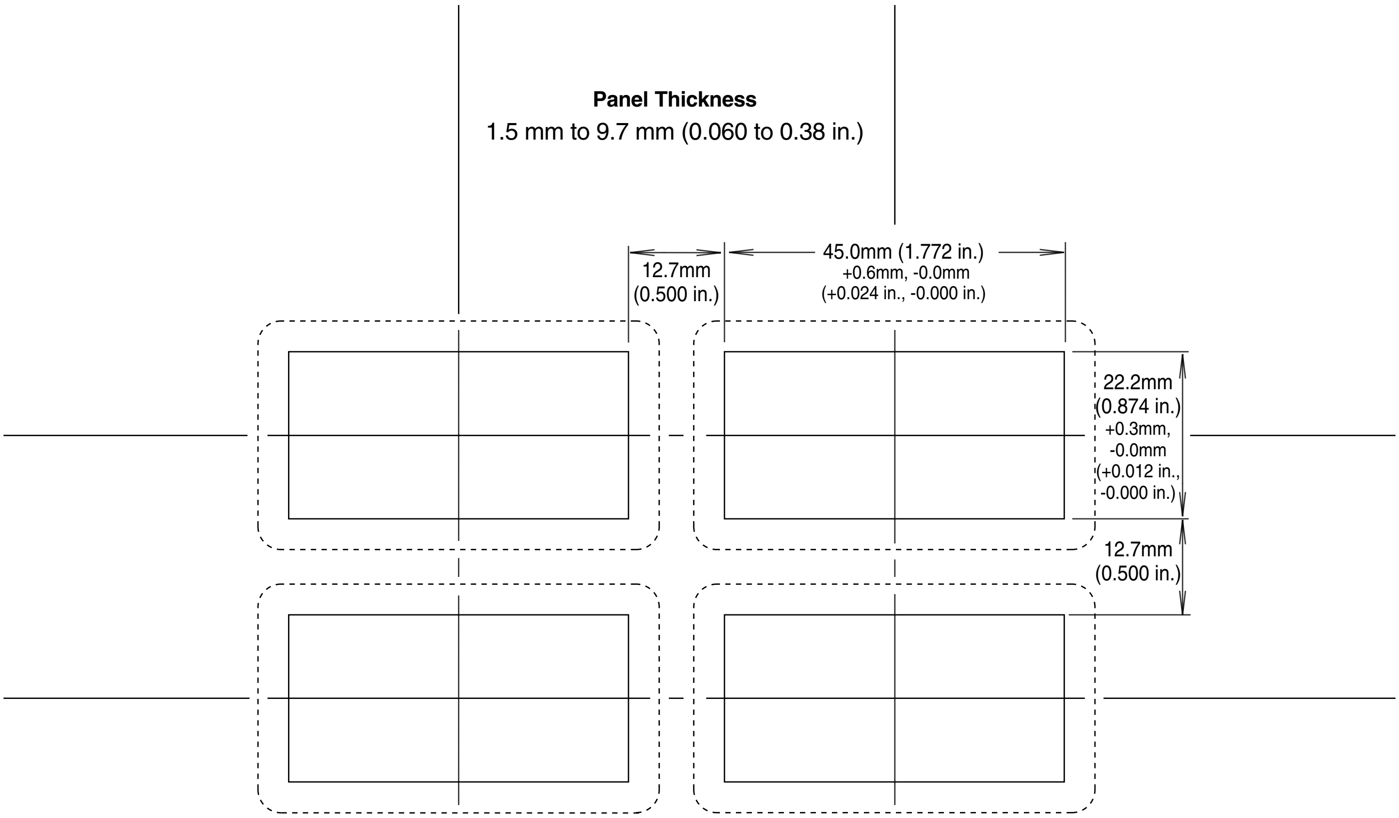
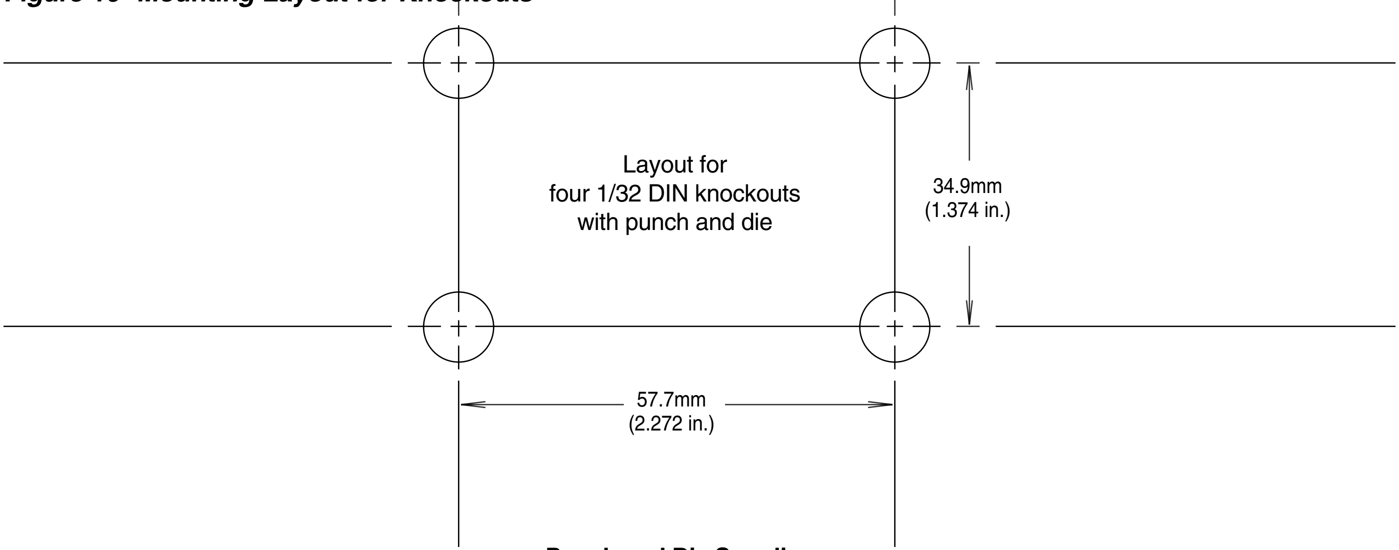


Figure 10- Mounting Layout for Knockouts

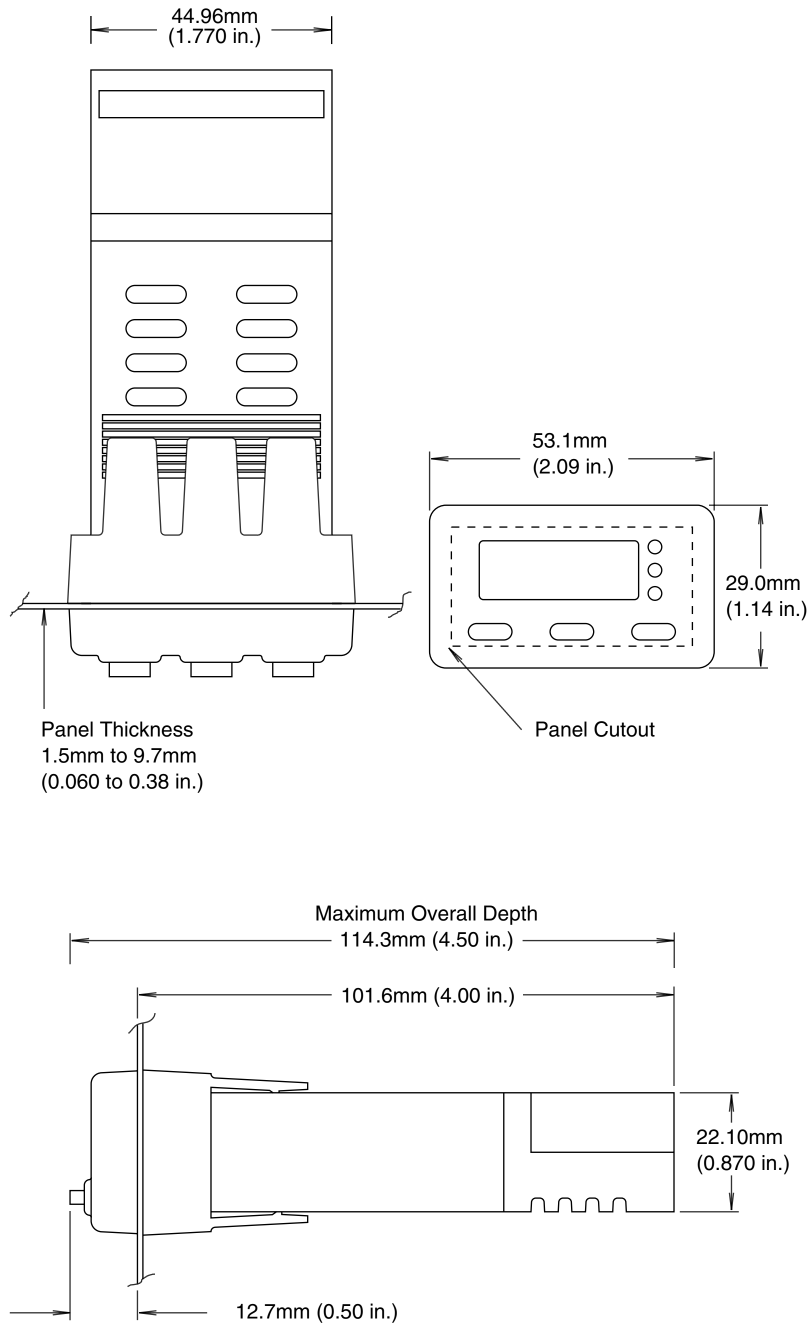


Punch and Die Supplier

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

Dimensions

Figure 11- Series 935A Dimensions



Installation Procedure

1. Make a panel cutout using the dimensions in Figure 9, p. 38.
2. Insert the 935A 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 IP65/NEMA 4X 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 IP65/NEMA 4X 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 0.48 mm (0 to 0.019 in.).

Collar Removal

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

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

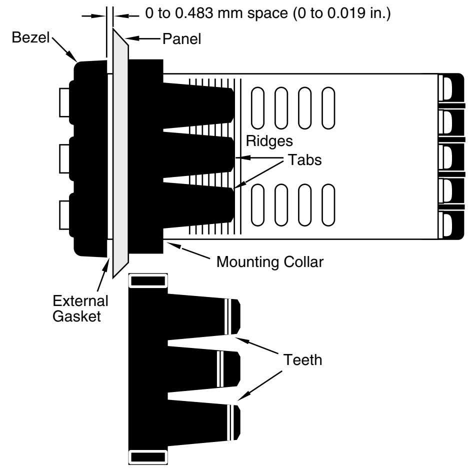
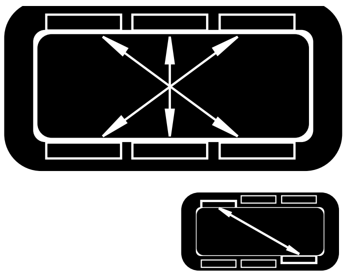


Figure 13- Case Rear View and IP65/NEMA 4X Seal Example



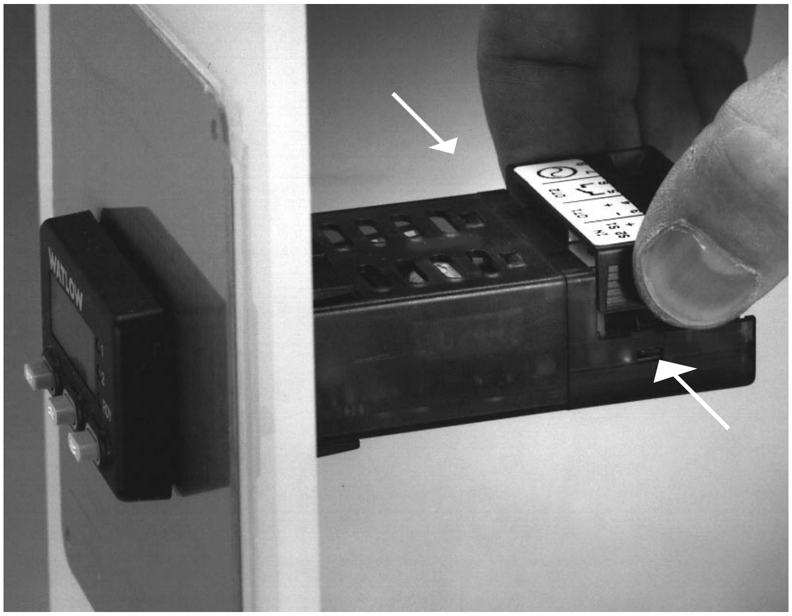
NOTE: To guarantee a proper IP65/NEMA 4X seal, make sure the gasket between the panel and the rim of the case is not twisted and is seated properly. Press firmly.

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.

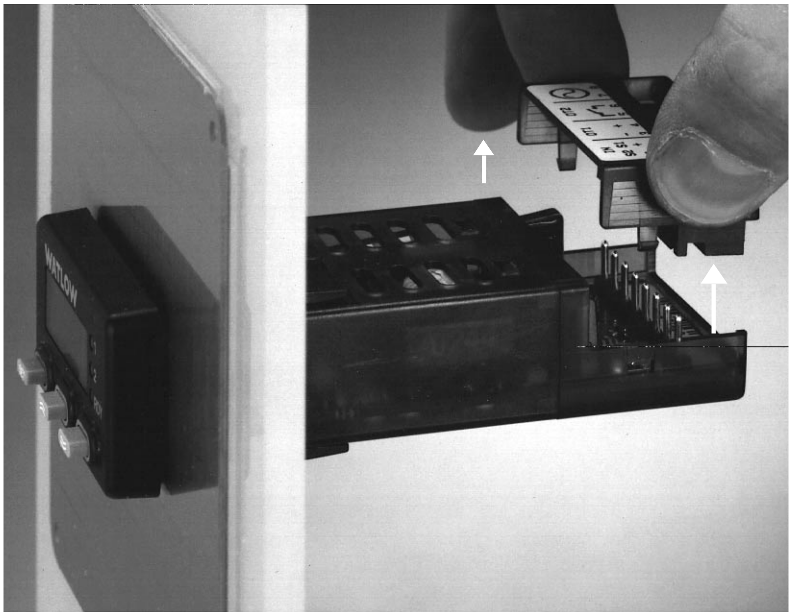
Terminal Block Removal

Figure 14- Terminal Block Removal Procedure

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



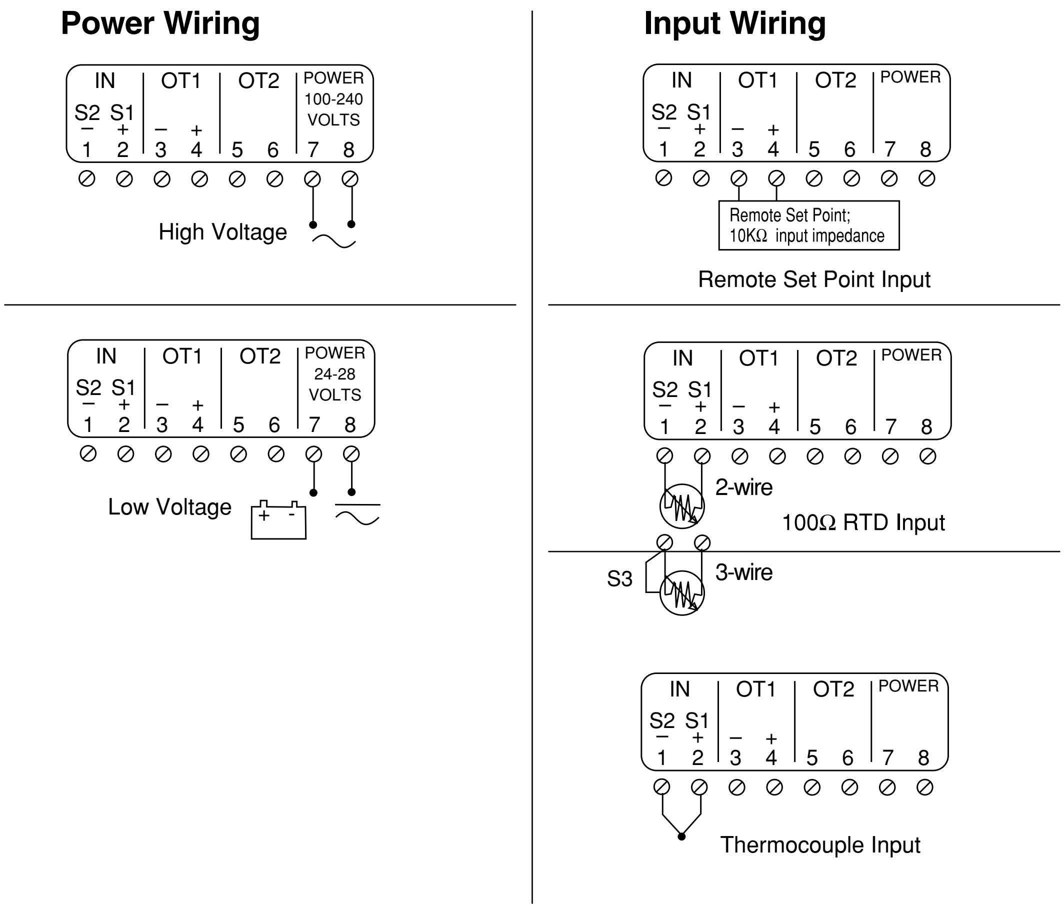
2. Move your grip rearward slightly, then lift the terminal cover straight up.



Wiring a 935A

Figure 15 - Wiring the Series 935A

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.

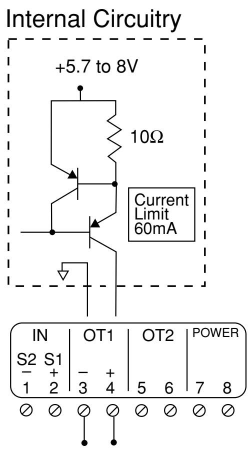


CAUTION: Using grounded thermocouples with non-isolated output switching devices could introduce ground loops into the control system, and possibly damage the controller and product.

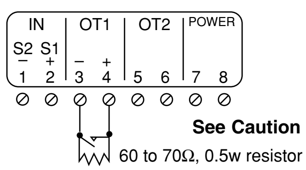
NOTE: Torque terminals to 1.36 Nm (12 in lbs).

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.

Output 1 Wiring

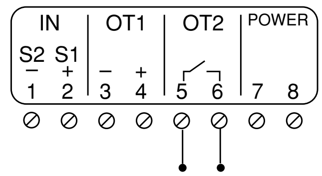


Output 1; Switched DC; "C"

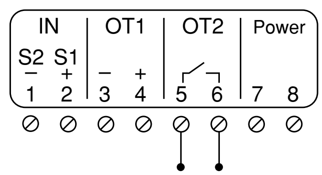


Output 1; Front Panel Lock

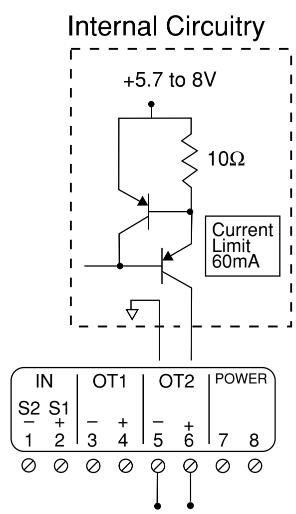
Output 2 Wiring



Output 2; Solid State Relay; "K"



Output 2; Electromechanical Relay; "D"



Output 2; Switched DC; "C"

CAUTION: Failure to install a 60 to 70Ω, 0.5w resistor across the customer-supplied Front Panel Lock switch will cause the panel to lock out even when the switch is open. Injury to personnel, or damage to equipment or property could result.

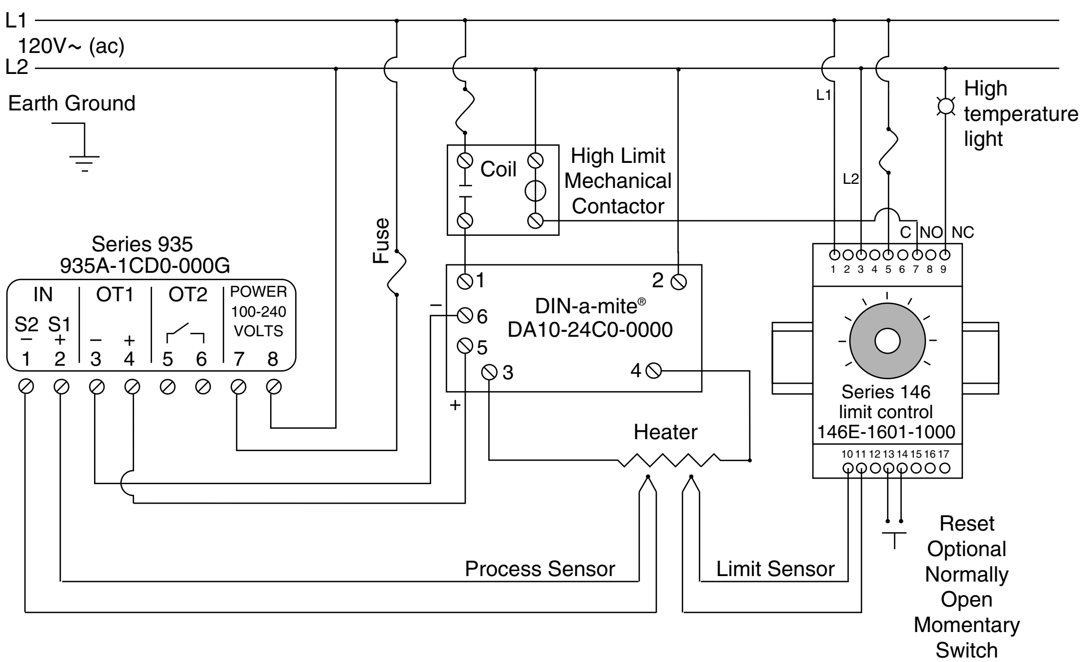
WARNING: When Output 1 is a Front Panel Lock OT1 = FPL, the output is energized! Do not connect a power switching device to Output 1; injury or death, or damage to equipment or property could result.

NOTE:
Switching inductive loads (relay coils, solenoids, etc.) with the mechanical relay or solid-state relay output options requires using an R.C. suppressor. Watlow carries the R.C. suppressor Quencharc brand name, which is a trademark of ITW Pakron. Watlow Part No. 0804-0147-0000.

System Wiring Examples

Figure 16 - Series 935A System Wiring Examples

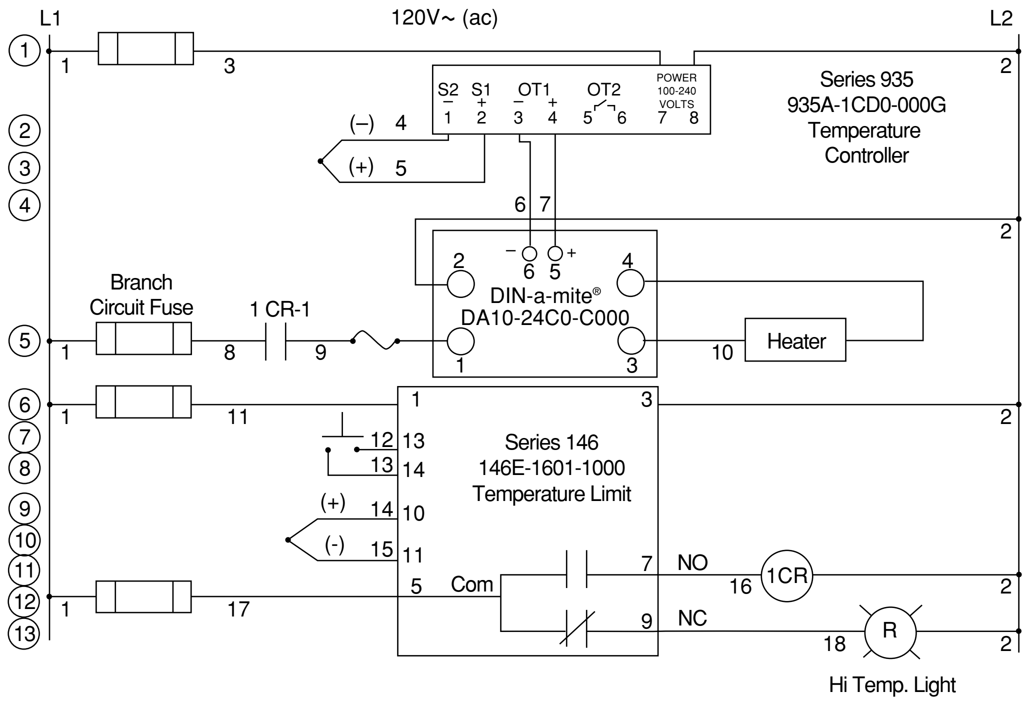
WARNING: All electrical wiring and fusing must conform to local and national electric codes. Contact local authorities for further information. Failure to comply with electric codes could result in injury or death, or damage to property.



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 935A Ladder Diagram Wiring Example

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.



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

Delay ON
A Series 935A 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 935A 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 935A 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 935A 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

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.

Remote Set Point
A 0-5V⎓ (dc) input from another controller or other source.

RTD
Resistive Temperature Detector. A sensor whose resistance increases with increasing temperature.Set Point
The desired process value programmed into a control.

Signal
Any electrical transmittance that conveys information.

Signal OFF
A Series 935 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 935 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

Specifications

Specifications (2191)

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 Listed, File #E102269.
- IP65/NEMA 4X[2] rated front panel.
- CE approved:
  •89/336/EEC Electromagnetic Compatibility Directive:
  EN61326 Industrial Immunity, Class A Emissions
  •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, 100Ω platinum two-wire , DIN curve
- Remote set point input, field-selectable,
  0-5V⎓ (dc), scalable, 10kΩ input impedance. (Remote Input Option A only.)
- Remote timer start dry contact closure initiates timer start. (Remote Input Option B only.)

Input Range

Specified temperature ranges represent the controller's operational span.

Thermocouple

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

RTD Resolution Platinum 0.00385 Curve

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

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

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

2 Output
- Switched dc logic signal, 6V⎓ (dc) @ 60mA nominal, short circuit protected, non-isolated (Watlow DIN-a-mite® power controller compatible).
- Electromechanical[1] relay, Form A, 2A @ 30V⎓ (dc) or, 240V~ (ac), without contact suppression[3]. (Remote Input Option A only.)
- Solid-state relay, Form A, 0.5A, 24 to 264V~ (ac), without contact suppression[3]. Off-state output impedance 31MΩ. (Remote Input Option A only.)

Output Cycle Time
- Switched dc and solid-state relay; 5.0 second default, 0.1 second minimum.
- Electromechanical relay; 30.0 second default, 5.0 second minimum.

Line Voltage/Power
- 100-240V~ (ac) +10%, -15%; (85-264V~ [ac]) 50/60Hz, ±5%.
- 24-28V≂ (ac/dc) +10%, -15%; (20-31V≂ [ac/dc]) 50/60Hz, ±5%. (Remote Input Option A only.)
- Fused internally (factory replaceable only) time-lag type, 2A, 250V.
- Power consumption 6VA maximum.
- Data retention upon power failure via non-volatile memory.
- Switching supply speed 45kHz, ±5kHz.

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

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

Terminals
- Touch-safe set screw type, accepts 0.5 to 4mm^2 (22 to 12 AWG wire). Torque to 0.1 Nm (4.5 in lbs).

Controller Weight
- 113 g (4.0 oz).

Shipping Weight
- 207 g (7.3 oz).

These specifications are subject to change without prior notice.

Ordering a 935A

Ordering Information (2192)

935_-1C__-__0__

Single thermocouple or RTD (DIN) input, dual output, singlie display temperature control with time function and four digit display

Remote Inputs

A = Remote set point input, or front panel lock input in place of output #1
B = Separate input for remote timer start, or front panel lock

Output 1/Remote Input

C = Switched dc, logic signal, non-isolated; (Watlow *DIN-a-mite*® power controller compatible)
(Optionally used for remote set point input; or front panel lock input for Remote Input A option only.)

Output 2

C = Switched dc, logic signal, non-isolated (Watlow *DIN-a-mite*® power controller compatible)
D = Electromechanical relay [1], Form A, 2A, 240V~ (ac), without contact suppression [3] *(Remote Input A option only.)*
K = Solid-state relay, 0.5A, 24-264V~ (ac), without contact suppression [3] *(Remote Input A option only.)*

Power Supply

0 = 100 to 240V~ (ac) nominal (high voltage)
1 = 24 to 28V≂ (ac/dc) nominal (low voltage)*(Remote Input A option only.)*

Custom Options

00 = None
AA = No Watlow logo
XX = Custom label or parameters

Display

R = Red displays
G = Green displays

Table 15 - Input Range Information

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

[1] Electromechanical relays are warranted for 100,000 closures only. Solid-state switching devices are recommended for applications requiring fast cycle times or extended service life.

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

[3] When using this output to drive a solenoid, MDR or electromechanical relay (contactor), protect output with a Quencharc®. Order code number 0804-0147-0000. Refer to owner's manual for wiring information. Quencharc® is a registered trademark of ITW Paktron.

Declaration of Conformity
Series 935 CE

WATLOW Winona, Inc.
1241 Bundy Boulevard
Winona, Minnesota 55987 USA

Declares that the following product: **English**

Designation:	Series 935
Model Numbers:	935(A or B) – 1C(C, D or K)(0 or 1) – (Any four letters or numbers)
Classification:	Temperature control, Installation Category II, Pollution degree II
Rated Voltage:	100 to 240 V~ (ac) or 24 to 28 V ≂ (ac or dc)
Rated Frequency:	50 or 60 Hz
Rated Power Consumption:	6 VA maximum

Meets the essential requirements of the following European Union Directives by using the relevant standards show below to indicate compliance.

89/336/EEC Electromagnetic Compatibility Directive

EN 61326:1997 With A1:1998 – Electrical equipment for measurement, control and laboratory use – EMC requirements (Industrial Immunity, Class A Emissions).

EN 61000-4-2:1996 With A1, 1998 – Electrostatic Discharge Immunity
EN 61000-4-3:1997 – Radiated Field Immunity
EN 61000-4-4:1995 – Electrical Fast-Transient / Burst Immunity
EN 61000-4-5:1995 With A1, 1996 – Surge Immunity
EN 61000-4-6:1996 – Conducted Immunity
EN 61000-4-11:1994 Voltage Dips, Short Interruptions and Voltage Variations Immunity
EN 61000-3-2:1995 With A1-3:1999 – Harmonic Current Emissions
EN 61000-3-3:1995 With A1:1998 – Voltage Fluctuations and Flicker

73/23/EEC Low-Voltage Directive

EN 61010-1:1993 With A1:1995 Safety Requirements of electrical equipment for measurement, control and laboratory use. Part 1: General requirements

déclare que le produit suivant : ***Français***

Désignation :	Série 935
Numéros de modèle :	935(A ou B) – 1C(C, D ou K)(0 ou 1) – (N'importe quelle combinaison de quatre lettres ou chiffres)
Classification :	Régulation de température, Catégorie d'installation II, Degré de pollution II
Tension nominale :	100 à 240 V~ (c.a) ou 24 à 28 V ≂ (c.a ou c.c)
Fréquence nominale :	50 ou 60 Hz

Consommation d'alimentation nominale: 6 VA maximum

Répond aux normes essentielles des directives suivantes de l'Union européenne en utilisant les standards normalisés ci-dessous qui expliquent les normes auxquelles répondre :

Directive 89/336/CEE sur la compatibilité électromagnétique

EN 61326:1997 avec A1 :1998 – Matériel électrique destiné à l'étalonnage, au contrôle et à l'utilisation en laboratoire – Exigences CEM (Immunité industrielle, Émissions de catégorie A).

EN 61000-4-2:1996 Avec A1, 1998 – Immunité aux décharges électrostatiques
EN 61000-4-3:1997 – Immunité aux champs de radiation
EN 61000-4-4:1995 – Immunité contre les surtensions électriques rapides/ Rafale
EN 61000-4-5:1995 avec A1, 1996 – Immunité contre les surtensions
EN 61000-4-6:1996 – Immunité conduite
EN 61000-4-11:1994 Immunité contre les écarts de tension, interruptions courtes et variations de tension
EN 61000-3-2:1995 avec A1-3 :1999 – Emissions de courant harmoniques
EN 61000-3-3:1995 avec A1 :1998 – Fluctuations et vacillements de tension

Directive 73/23/CEE sur les basses tensions

EN 61010-1:1993 avec A1 :1995 Normes de sécurité du matériel électrique pour la mesure, le contrôle et l'utilisation en laboratoire. 1ère partie : Conditions générales

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

Bezeichnung:	Serie 935
Modell-Nummern:	935(A oder B) – 1C(C, D oder K)(0 oder 1) – (Beliebige vier Ziffern oder Buchstaben)
Klassifikation:	Temperaturregler, Installationskategorie II, Verschmutzungsgrad II
Nennspannung:	100 bis 240 V~ (ac) oder 24 bis 28 V ≂ (AC oder DC)
Nennfrequenz:	50/60 Hz.
Nennstromverbrauch:	6 VA max.

Erfüllt die wichtigsten Normen der folgenden Anweisung(en) der Europäischen Union unter Verwendung des wichtigsten Abschnitts bzw. der wichtigsten Abschnitte die unten zur Befolgung aufgezeigt werden.

89/336/EEC Elektromagnetische Kompatibilitätsrichtlinie

EN 61326:1997 mit A1:1998 – Elektrisches Gerät für Messung, Kontrolle und Laborgebrauch – EMV-Anforderungen (Störfestigkeit Industriebereich, Klasse A Emissionen)

EN 61000-4-2:1996 mit A1, 1998 – Störfestigkeit gegen elektronische Entladung
EN 61000-4-3:1997 – Störfestigkeit gegen Strahlungsfelder
EN 61000-4-4:1995 – Störfestigkeit gegen schnelle Stöße/Burst
EN 61000-4-5:1995 mit A1, 1996 – Störfestigkeit gegen Überspannung
EN 61000-4-6:1996 – Geleitete Störfestigkeit
EN 61000-4-11:1994 Störfestigkeit gegen Spannungsabfall, kurze Unterbrechungen und Spannungsschwankungen
EN 61000-3-2:1995 mit A1-3:1999 – Harmonische Stromemissionen
EN 61000-3-3:1995 mit A1:1998 – Spannungsfluktationen und Flimmern

73/23/EEC Niederspannungsrichtlinie

EN 61010-1:1993 mit A1:1995 Sicherheitsanforderungen für elektrische Geräte für Messungen, Kontrolle und Laborgebrauch. Teil 1: Allgemeine Anforderungen

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

Designación:	Serie 935
Números de modelo:	935(A o B) – 1C(C, D o K)(0 o 1) – (Cualesquiera cuatro letras o números)
Clasificación:	Control de temperatura, Categoría de instalación II, Grado de contaminación II
Voltaje nominal	100 a 240 V~ (CA) o 24 a 28 V ≂(CA o CD)
Frecuencia nominal:	50 o 60 Hz

Consumo de energía nominal: 6 VA máximo

Cumple con los requisitos esenciales de las siguientes Directrices de la Unión Europea mediante el uso de las normas aplicables que se muestran a continuación para indicar su conformidad.

89/336/EEC Directriz de compatibilidad electromagnética

EN 61326:1997 CON A1:1998.– Equipo eléctrico para medición, control y uso en laboratorio – Requisitos EMC (Inmunidad industrial, Emisiones Clase A).

EN 61000-4-2:1996 con A1, 1988 – Inmunidad a descarga electrostática
EN 61000-4-3:1997 – Inmunidad a campo radiado
EN 61000-4-4:1995 – Inmunidad a incremento repentino/rápidas fluctuaciones eléctricas transitorias
EN 61000-4-5:1995 con A1, 1996 – Inmunidad a picos de voltaje o corriente
EN 61000-4-6:1996 – Inmunidad por conducción
EN 61000-4-11:1994 Inmunidad a caídas de voltaje, variaciones y pequeñas interrupciones de voltaje
EN 61000-3-2:1995 con A1-3:1999 – Emisiones de corriente armónica
EN 61000-3-3:1995 con A1:1998 – Fluctuaciones de voltaje y centelleo.

73/23/EEC Directriz de bajo voltaje

EN 61010-1:1993 con A1:1995 Requisitos de seguridad de equipo eléctric para medición, control y uso en laboratorio. Parte 1: Requisitos generales

Jim Boigenzahn	Winona, Minnesota, USA
Name of Authorized Representative	Place of Issue
General Manager	August, 2001
Title of Authorized Representative	Date of Issue

J.F. Boigenzahn

Signature of Authorized Representative

(2193)

Notes

Notes

935A Software Map

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	
ALO Alarm Low	Ah1 Select a value, adjustable between Range Low and Alarm High.	Type J Range Low	tAg = 0; or if Ot1 and Ot2 ≠ ALM	
Ah1 Alarm High	rLO Select a value, adjustable between Alarm Low and Range High.	Type J Range High	tAg = 0; or if Ot1 and Ot2 ≠ ALM	
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 ≠ thM or tMS	
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 ≠ thM or tMS	

*NOTE:
All prompts, except SP and tAg, are hidden if Ot1 = FPL.

Operations Menu

Prompt	Range	Default	Hidden if *	Your Settings
L-r Local/Remote Set Point	L r Choose Local or Remote Set Point.	L	tAG = 0; or if Ot 1 ≠ rSP	
P id 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

Prompt	Range	Default	Hidden if *	Your Settings
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 Ot 1 and/or Ot 2 ≠ 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

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	oF oC 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	
Ot 1 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 ALrM thrM trMS nonE Choose Heat, Cool, Alarm, Timer (Hrs:Min), Timer (Min:Sec) or No output action.	none	tAg = C	
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	Prnc Prno 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 ≠ ALrM	
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 ≠ ALrM	

Prompt	Range	Default	Hidden if *	Your Settings
LAt Alarm Latch	no YES Choose YES for a Latching Alarm.	no	tAg = C; or if Ot1 and/or Ot2 ≠ ALM	
SIL Alarm Silencing	no YES Choose YES for a Silenced Alarm on start-up or silencing during operation.	no	tAg = C; or if Ot1 and/or Ot2 ≠ ALM	
FAIL Input Failure Mode	bPLS -100 100 Choose Bumpless Transfer or Percent Power.	Bumpless	tAg = C; or if Ot1 and Ot2 ≠ hEAt or cooL	
tIM Timer Output Function	dLon dLoF Sgon SgoF Choose Delay ON, Delay OFF, Signal ON, or Signal OFF.	Delay OFF	tAg = C; or if Ot2 ≠ thM or tMS	
Strt Start Timer Function	IMd rdy rdyA PWr Choose Immediate, Ready Band, Ready Band Acknowledge, or Power.	Immediate	tAg = C; or if Ot2 ≠ thM or tMS	
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	tAg = C; or if Ot2 ≠ thM or tMS	

Prompt	Range	Default	Hidden if *	Your Settings
St Signal Time	1 99. 9 If tIM = SGon or SGoF, then select a value between 00:01 and 99:59 min:sec.	00:01	tAG = C; or if tIM ≠ SGon or SGoF	
SLOC Set Point Lockout	no YES Choose YES to Lock the Primary Set Point.	no	tAG = C	
tAG 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 CnFG) A = Auto-tune	P	Always appears	

Notes

Notes

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:

Watlow Winona will be the world's best supplier of superior measurement and control products, services, and systems, by exceeding the expectations of our customers, shareholders, and employees.

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