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Series 945

User's Manual



TOTAL
CUSTOMER
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3 Year Warranty

1/4 DIN
Microprocessor-Based
Auto-tuning Control

WATLOW
Watlow Controls

1241 Bundy Blvd., P.O. Box 5580, Winona, Minnesota USA 55987-5580, Phone: 507/454-5300, Fax: 507/452-4507

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Contents

Page Item

Chapter 1
3 Starting Out With The Watlow Series 945
3 General Description

Chapter 2
4 How To Install And Wire The Series 945
4 Installation Procedure
4 Dimensional Information
5 Wiring the Series 945
5 Sensor Installation Guidelines
6 Input Wiring
7 Output 1 Wiring
8 Output 2 Wiring
9 Alarm Wiring
10 Retransmit Wiring
11 System Wiring Examples

Chapter 3
12 How To Use The Keys And Displays
12 Series 945 Keys and Displays

Chapter 4
13 How To Setup The Series 945
13 How to Set the DIP Switch
13 Entering Setup Menu
14 Setup Parameters
17 Setup Menu Table
18 Operation Parameters
20 Operation Menu Table

Chapter 5
21 How To Tune And Operate
21 Auto-tuning
22 Manual Tuning
23 Manual and Automatic Operation
24 Changing the Position of an Alarms Jumper
25 Using Alarms
26 Error Code Messages
27 Error Code Actions

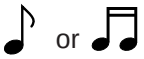
28 Appendix 1
28 Noise Sources
28 Decreasing Noise Sensitivity
29 Eliminating Noise
30 Checking For Ground Loops
30 Noise Suppression Devices Available…
31 Line Filtering Configurations For Controls

32 Appendix 2
32 Entering the Calibration Menu
33 Restoring Factory Calibration
35 Calibration Procedures
39 Glossary
41 Index

42 Specifications
43 Model Number Information
43 Returns
43 Warranty

Notes

Informational notes alert you to important details. When you see a note icon, look for an explanation in the margin.

 or

Safety Information

Boldface safety information protects both you and your equipment. Please be attentive to them. Here are explanations:



The WARNING symbol in the wide text column alerts you to a **"WARNING**," a safety hazard which could affect you and the equipment. A full explanation is in the narrow column on the outside of the page.



The CAUTION symbol in the wide text column alerts you to a "**CAUTION**," a safety or functional hazard which could affect your equipment or its performance. A full explanation is in the narrow column on the outside of the page.

Technical Assistance



If you encounter a problem with your Watlow control, review all of your 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 dialing: 1-507-454-5300

An Application Engineer will discuss your problem with you. Please have the following information available:

- Complete model number
- Serial Number
- All configuration information
- User's Manual

The model and serial numbers can be found on the outside of the case.

Your Feedback

Your comments or suggestions on this manual are welcome, please send them to: Technical Writer, Watlow Controls, 1241 Bundy Blvd., P.O. Box 5580, Winona, MN 55987-5580, or phone 507/454-5300. The Watlow Series 945 User's Manual and integral software are copyrighted by Watlow Winona, Inc., © 1989, with all rights reserved. blr0392

The Watlow Series 945,
A Microprocessor-Based Control

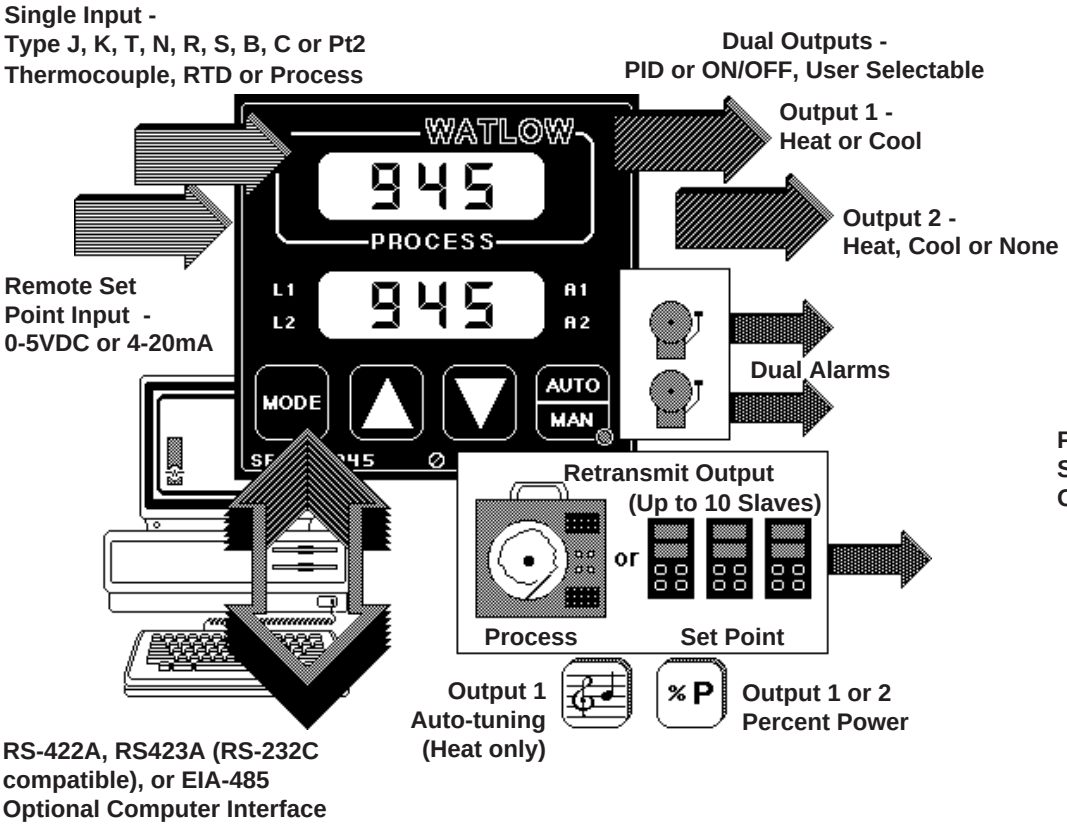


Figure 1 -
Series 945 Input and Output Overview

General Description

Welcome to the Watlow Series 945, a 1/4 DIN microprocessor-based temperature control. It has a single input, remote set point input, dual output, and dual alarm. The 945 is an auto-tuning control when Output 1 is in the heat mode, and features Automatic/Manual capability with bumpless transfer. In the Auto mode, the 945 has closed loop control with sensory feedback, while the Manual mode has open loop control with user defined output power level. The 945 accepts a variety of thermocouples, as shown above, along with RTD, or process input. The primary output is heat or cool, while the secondary output can be heat, cool or none. An optional retransmit output is offered in place of one of the alarms. Selectable as retransmit of set point or process variable. Units with communications feature data logging with user selectable table, chart or SPC (**S**tatistical **P**rocess **C**ontrol) printout of data.

With the Series 945 you can select either PID or ON/OFF for Output 1 or 2. Input a complete set of PID parameters for both outputs, including proportional band, reset/integral and rate/derivative. By setting either output's proportional band to zero, the Series 945 becomes a simple ON/OFF control with the switching differential selectable under the HYS (hysteresis) parameter in the Setup menu.

Operator-friendly features include automatic LED indicators to aid in monitoring and setup, as well as a calibration offset at the front panel. The Watlow Series 945 automatically stores all information in a non-volatile memory.

How to Install and Wire the Series 945

1. Make a panel cutout per the dimensions given below. Your panel thickness can be from 0.06" to 0.25" (1.52 to 6.35 mm).

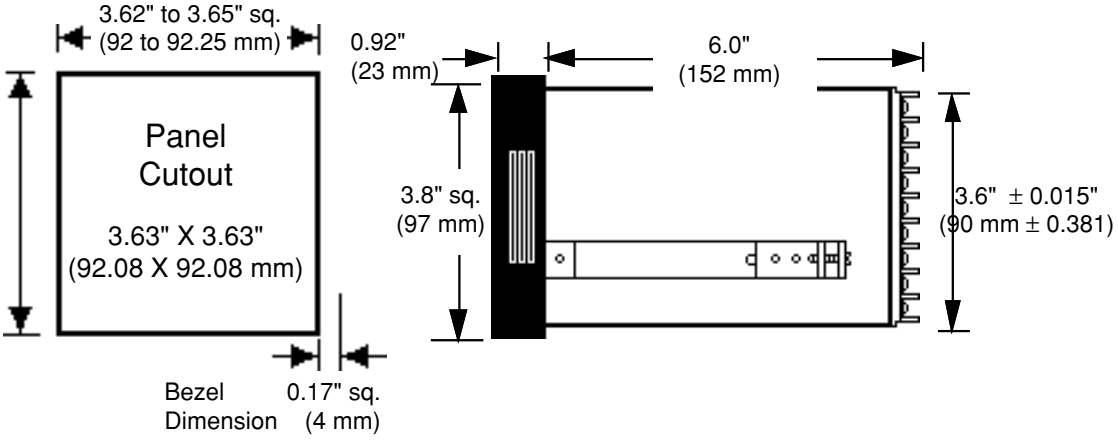


Figure 2 - Series 945 Panel Cutout and Unit Dimensions

2. Remove the 945 from its case by turning the front panel screw 90° counterclockwise (CCW). Grip the bezel firmly and pull the control out of the case.

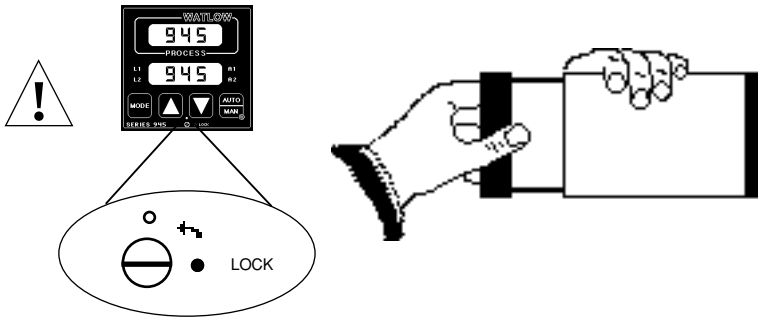


Figure 3 - How to Open the Series 945.

CAUTION:

The front panel screw turns 90° only. Do not apply excessive force or turn the screw more than 90°.

3. Place the case in the cutout you just made. Attach the two mounting brackets, shipped with your unit, either to the top and bottom, or to both sides of the unit. Tighten the brackets securely against your panel.

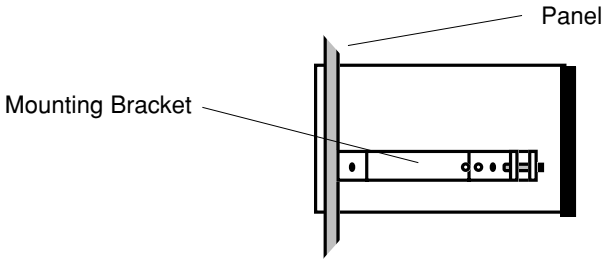


Figure 4 - Mounting the Series 945 Case.

4. Insert the control chassis into its case and press the bezel to seat it. Turn the front panel screw 90° clockwise (CW) to lock the control in place.

How to Wire the Series 945

The Series 945 wiring is illustrated by model number option. **Check the terminal designation sticker** on the control and compare your model number to those shown here and also the model number breakdown on the inside back cover of this manual.

Series 945 internal circuits appear "inside" the line drawing of the 945, while connections and terminal designations appear "outside" the line drawing. All outputs are referenced to a de-energized state. The final wiring figure is a typical system example.

When you apply power without a sensorinput on the terminal strip, the 945 displays "- - - -" in the upper display, and "0" in the lower display. Press AUTO/MAN twice, and ER 7 is displayed for one second. This error indicates an open sensor or A/D error. Remove power to the control and connect the sensor properly, see Page 6. All wiring and fusing must conform to the National Electric Code and to any locally applicable codes as well.

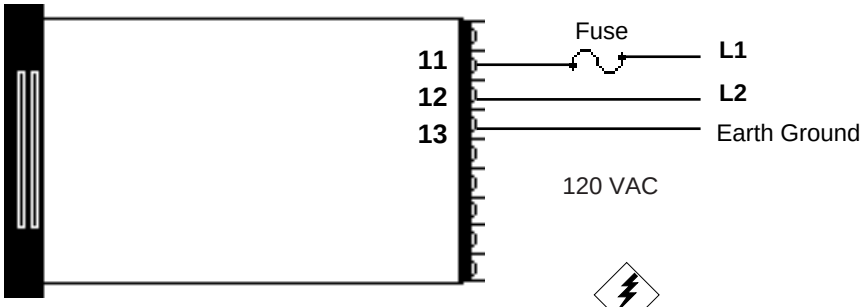


Figure 5 - 120 VAC Power Wiring

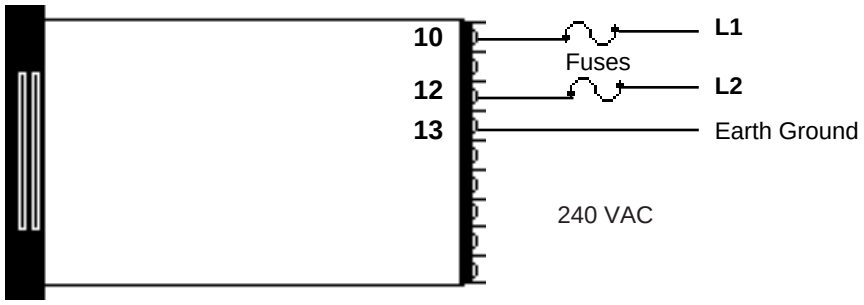


Figure 6 - 240 VAC Power Wiring

WARNING:

To avoid potential electric shock, use National Electric Code (NEC) safety practices when wiring and connecting this unit to a power source and to electrical sensors or peripheral devices.

Sensor Installation Guidelines

We suggest you mount the sensor at a location in your process or system where it reads an average temperature. Choose a point that will adequately represent the process temperature without being overly reactive.

For thermocouple inputs: Use an isolated or ungrounded thermocouple if an external 4-20mA output device with a non-isolated circuit common is connected. Extension wire must be of the same alloy as the thermocouple itself to limit errors.

For RTD inputs: There could be a +2°F input error for every 1 of lead length resistance when using a 2 wire RTD. That resistance, when added to the RTD element resistance, will result in erroneous input to the instrument. To overcome this problem, use a 3 wire RTD sensor, which compensates for lead length resistance. When extension wire is used for a 3-wire RTD, all wires must have the same electrical resistance (i.e. same gauge, copper stranded).

For 0-5VDC or 4-20mA process inputs: The rL and rH settings scale the display to match the measured range of the process signal. For 0-5VDC process input, the impedance is 100KΩ. For 4-20mA process input, the impedance is 249Ω.

Input Wiring

Thermocouple Input

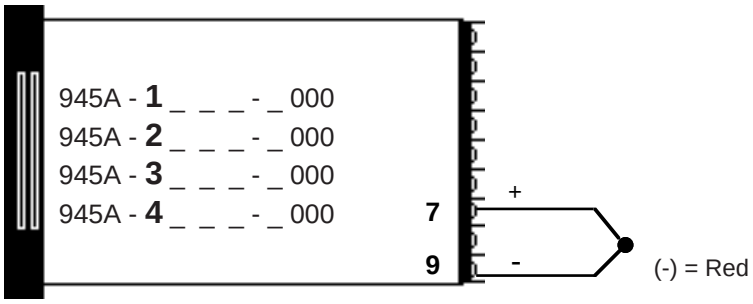


Figure 7 - Thermocouple Input Wiring

RTD, 2 or 3 Wire

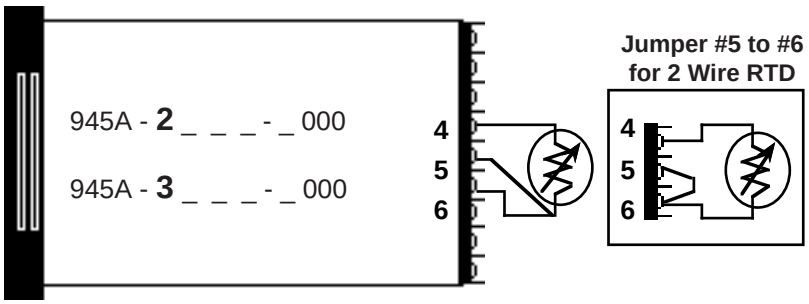
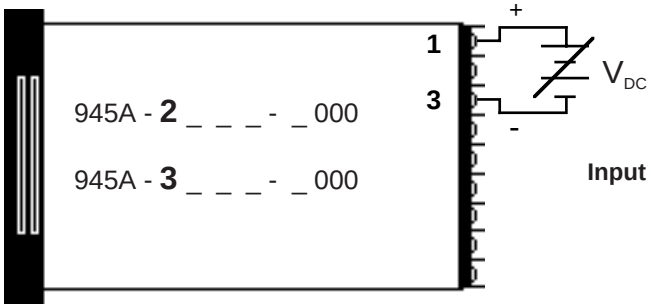


Figure 8 - 2 or 3 wire RTD Input Wiring.

These input connections are also used in conjunction with T/C and RTD sensor types when using the remote set point input.

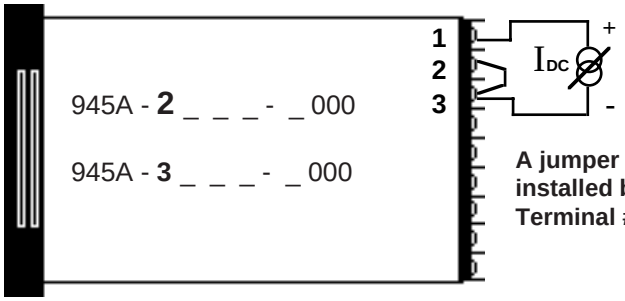
0 - 5VDC Process or Remote Set Point Input



Input impedance: 100KΩ

Figure 9 - 0 - 5 VDC Process Input Wiring.

4 - 20mA Process or Remote Set Point Input

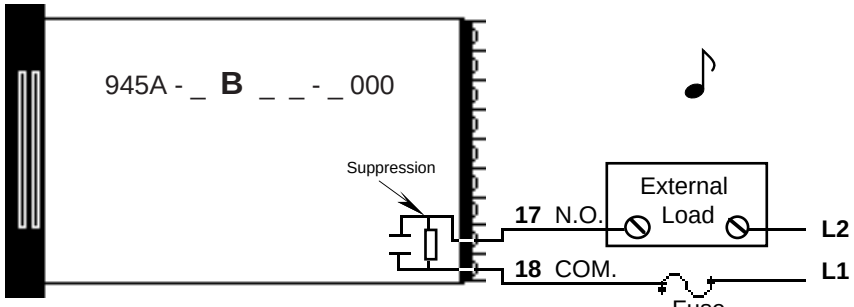


4-20mA process input: 249Ω.

A jumper must be installed between Terminal #2 and 3.

Figure 10 - 4-20mA Process Input Wiring.

Output 1 - Solid State Relay With Contact Suppression



Off state impedance: 20K max.

Figure 11 - Solid State Relay With Contact Suppression

Output 1 - Switched DC Output (Open Collector)

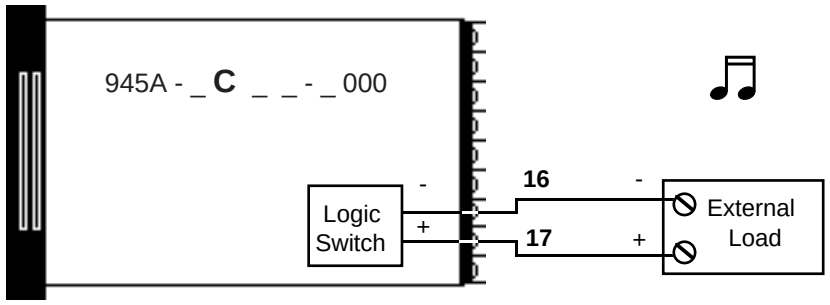
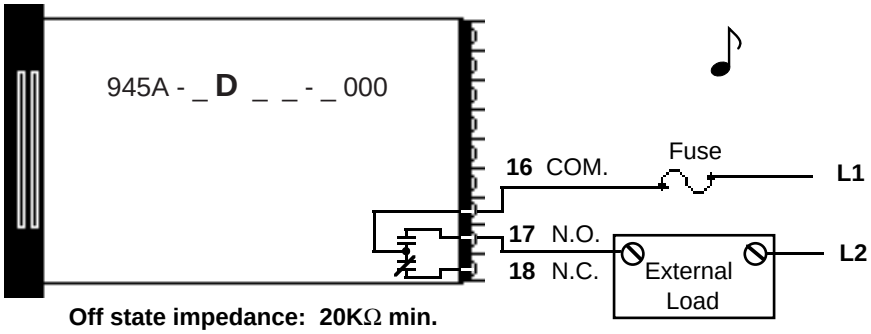


Figure 12 - Switched DC (Open Collector)

NOTE: Minimum load resistance is 500 . Available current is 22mA maximum. Typical voltage drop across a 1K load is 12 to 19 volts.

Output 1 - Mechanical Relay, 6 Amp, Form C

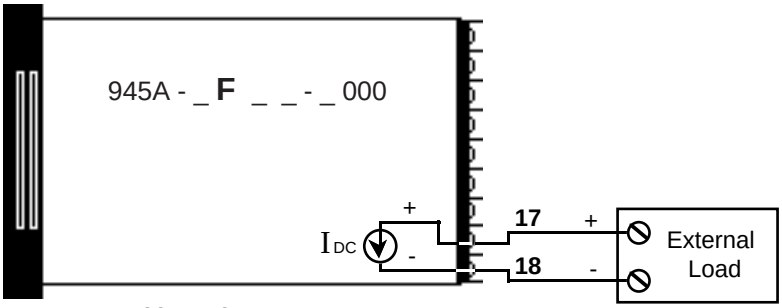


Off state impedance: 20KΩ min.

Figure 13 - 6 Amp Mechanical Relay

NOTE: This output is supplied with an arc suppression snubber across the output terminals. High impedance loads may remain energized even though the output device is turned OFF.

Output 1 - Process, 4 - 20mA

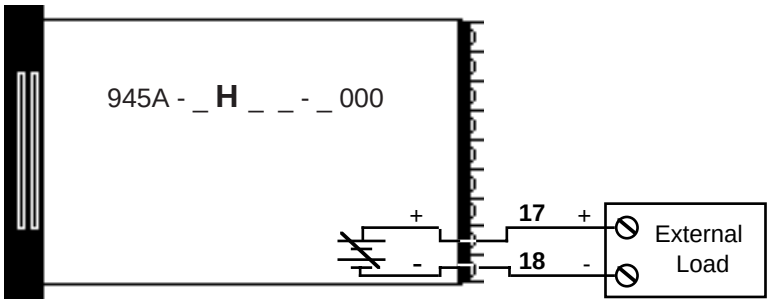


Load impedance: 600Ω max.

Figure 14 - Process, 4-20mA

Output 1 & 2 Wiring

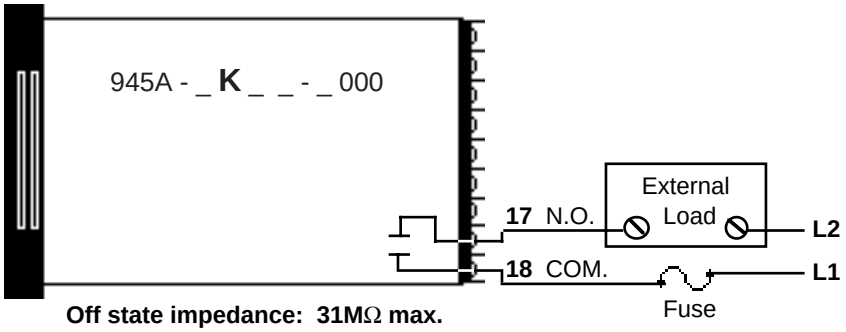
Output 1 - Process, 0 - 5VDC



Load impedance: 10KΩ min.

Figure 15 - Process, 0 - 5VDC

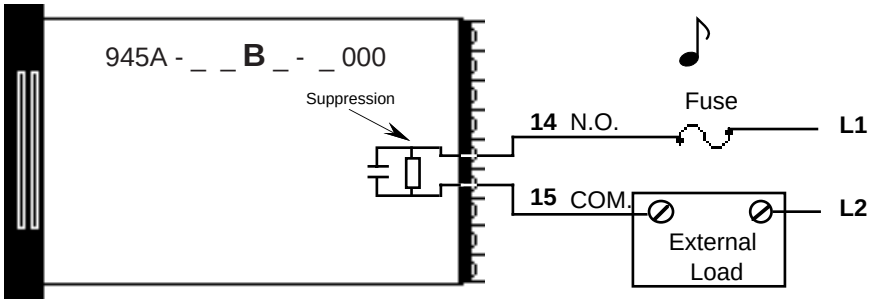
Output 1 - Solid State Relay Without Contact Suppression



Off state impedance: 31MΩ max.

Figure 16 - Solid State Relay Without Contact Suppression

Output 2 - Solid State Relay With Contact Suppression

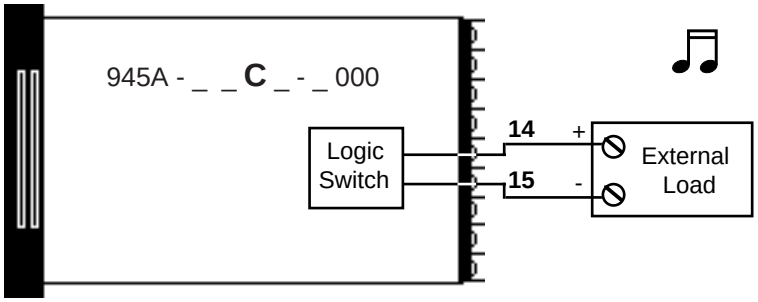


Off state impedance: 20KΩ max.

Figure 17 - Solid State Relay With Contact Suppression

NOTE:
This output is supplied with an arc suppression snubber across the output terminals. High impedance loads may remain energized even though the output device is turned OFF.

Output 2 - Switched DC Output (Open Collector)

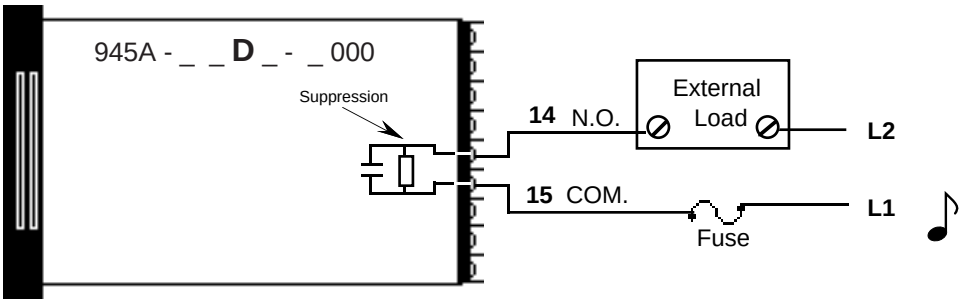


Load impedance: 10KΩ min.

Figure 18 - Switched DC Output (Open Collector)

NOTE:
Minimum load resistance is 500Ω. Available current is 22mA maximum. Typical voltage drop across a 1KΩ load is 12 to 19 volts.

Output 2 - Mechanical Relay, 6 Amp, Form A

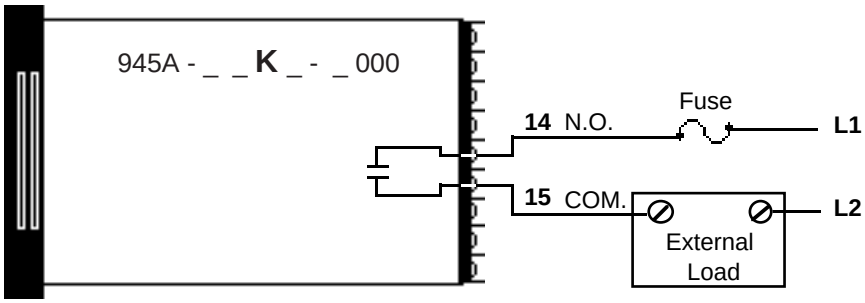


Off state impedance: 20KΩ min.

Figure 19 - 6 Amp Mechanical Relay

NOTE:
This output is supplied with an arc suppression snubber across the output terminals. High impedance loads may remain energized even though the output device is turned OFF.

Output 2 - Solid State Relay Without Contact Suppression

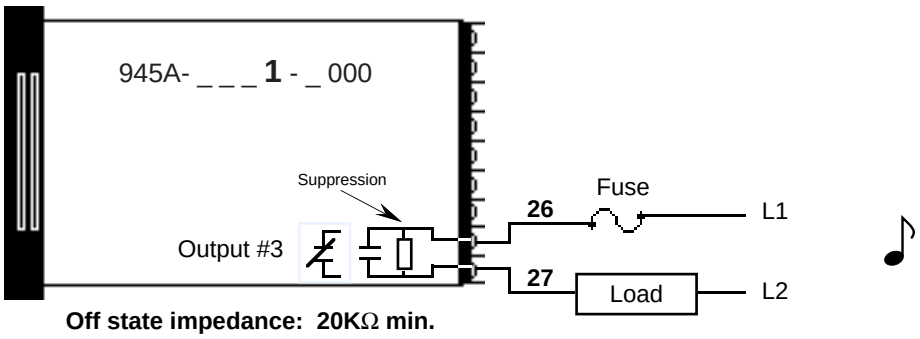


Off state impedance: 31MΩ max.

Figure 20 - Solid State Relay Without Contact Suppression

For more information on alarms and alarm jumper selection, see Chapter 5.

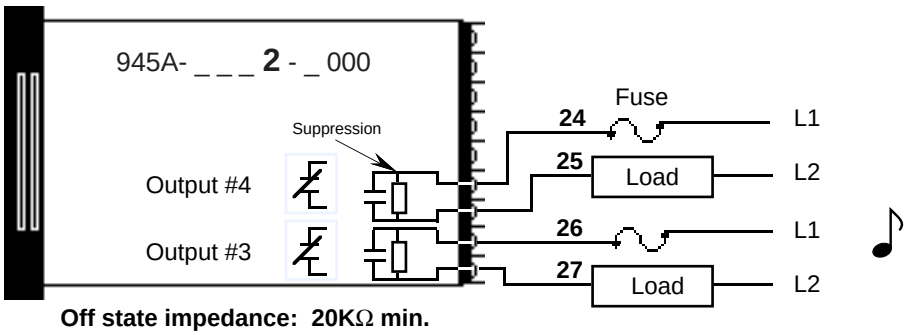
Alarm Output - Mechanical Relay, 6 Amp, Single Form A or B



Off state impedance: 20KΩ min.

Figure 21 - Alarms Option 1 Wiring.

Alarm Output - Mechanical Relay, 6 Amp, Dual Form A or B

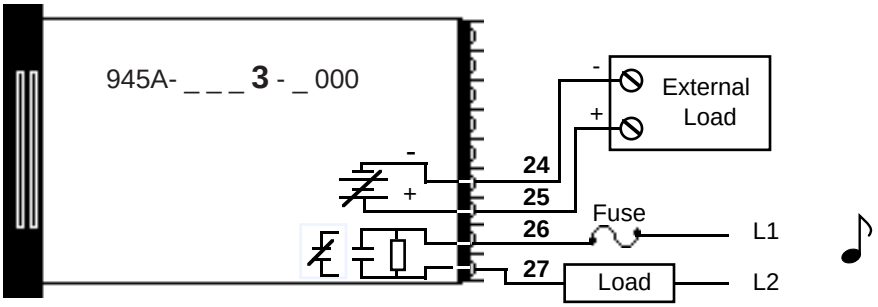


Off state impedance: 20KΩ min.

Figure 22 - Alarms Option 2 Wiring.

Mechanical Relay, 6 Amp, Form A or B/0 - 5VDC Retransmit

Figure 23 - Alarm/Retransmit Option 3 Wiring.

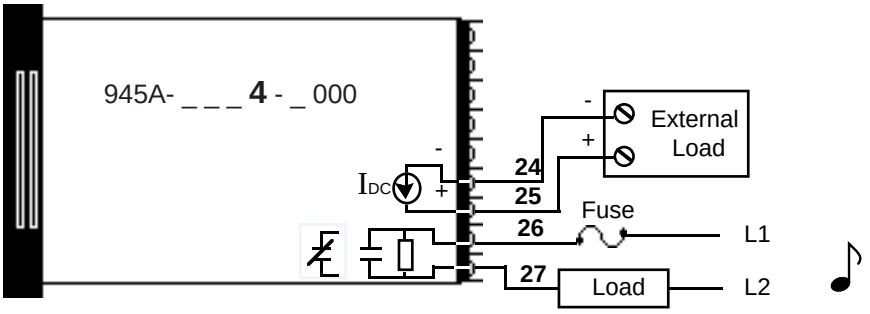


NOTE:
This output is supplied with an arc suppression snubber across the output terminals. High impedance loads may remain energized even though the output device is turned OFF.

Load impedance: 10KΩ min. for 0-5VDC. Relay offstate impedance: 20KΩ.

Mechanical Relay, 6 Amp, Form A or B/4 - 20mA Retransmit

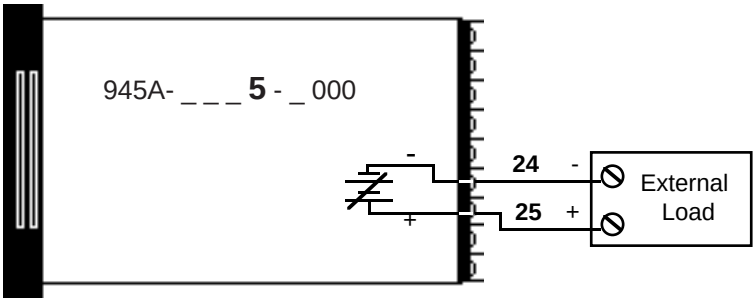
Figure 24 - Alarm/Retransmit Option 4 Wiring.



Load impedance: 10K min. for 4-20mA. Relay offstate impedance: 20K .

0 - 5VDC Retransmit Output

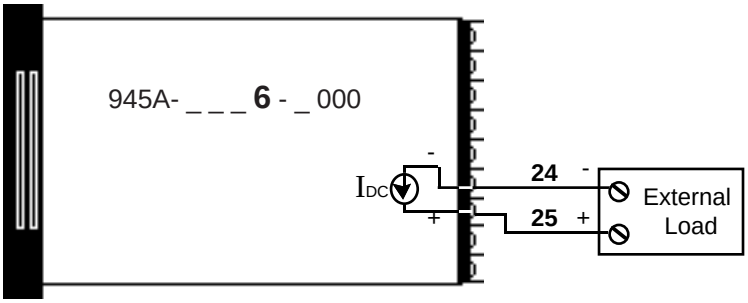
Figure 25 - Retransmit Option 5 Wiring.



Load impedance: 10KΩ min.

4 - 20mA Retransmit Output

Figure 26 - Retransmit Option 6 Wiring.



Load impedance: 600Ω max.

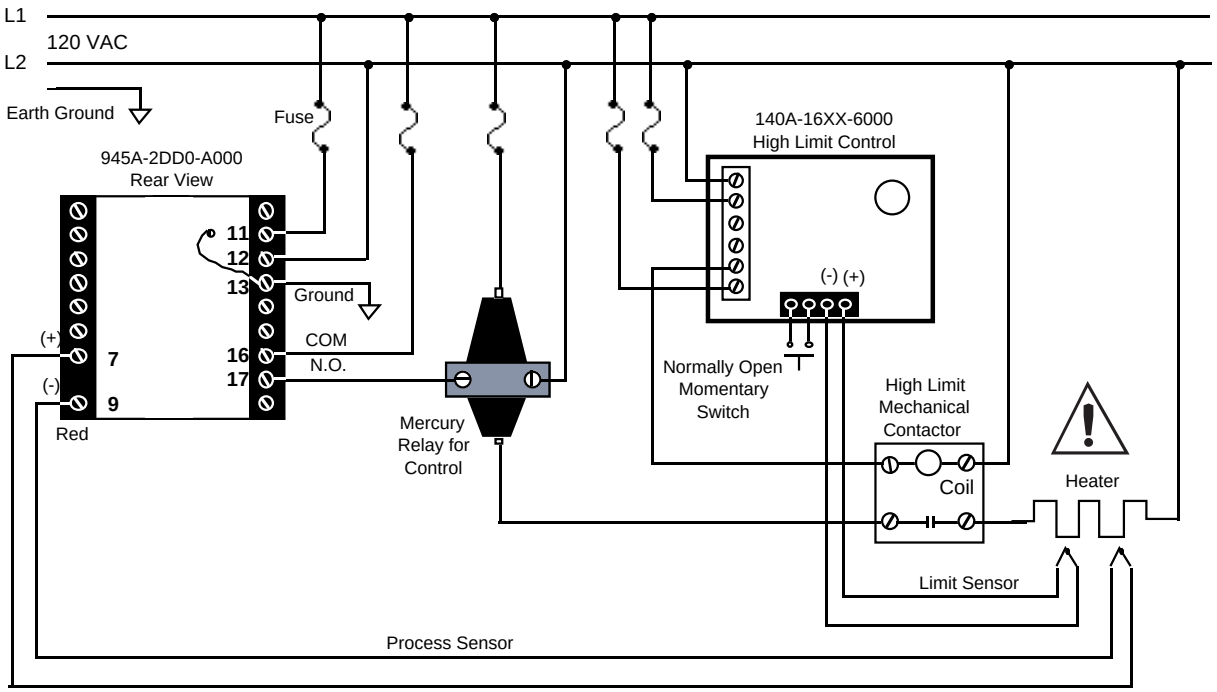
WARNING:

All wiring and fusing must conform to the National Electric Code NFPA70 and to any locally applicable codes. Contact your local board for additional information. Failure to observe NEC safety guidelines could result in injury to personnel.

CAUTION:

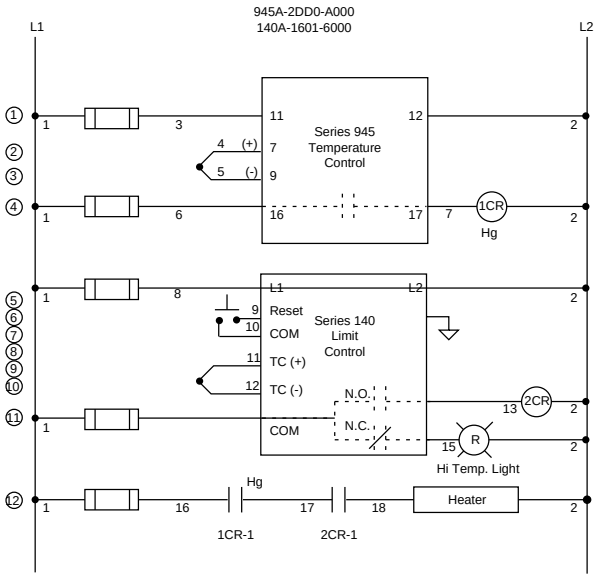
Watlow mercury relays are designed to be used only with resistive loads.

Figure 27 - System Wiring Example



945A-2DD0-A000

Terminal	Function	
1	4-20, 0-5 +	
2	4-20, Jumper to 3	
3	4-20, 0-5 -	
4	S1	
5	S2	
6	S3	
7	T.C. +	
8	Not Used	
9	T.C. -	
10	L1 240V	
11	L1 120V	
12	L2	
13	Earth Ground	
14	N.O.	Output #2
15	Com.	
16	Com.	
17	N.O.	Output #1
18	N.C.	



Chapter 3

How to Use the Keys and Displays

Figure 28 - Series 945 Keys and Displays.

After 1 minute with no key activations, the control reverts to the process value in the upper display and the set point in the lower display.

Upper Display
Red, 0.56" (14 mm) high, seven segment, four digit LED display, indicating either process actual temperature, the operating parameter values, or an open sensor. When powering up, the Process display will be blank for 8 seconds.

Lower Display
Red 0.56" (14 mm) high, seven segment, four digit LED display, indicating the set point, operation parameters, menu parameters, and error or alarm codes.



L 1 & L2
When lit, these LED's tell you when Output 1 or Output 2 is energized. L2 only appears if your unit has the #2 output hardware.

A1 & A2
When lit, these LEDs tell you when Alarms 1 or 2 are active. Only appears on those units with alarms option.

MODE Key
Steps the control through the Operating menu; also, in the Auto mode, enters new data selected.

UP Key
Increases the value of the displayed parameter. A single touch increases the value by one. Hold the key down to increase the value at a rapid rate. New data is self entering in 5 seconds.

DOWN Key
Decreases the value of the displayed parameter. A single touch decreases the value by one. Hold the key down to decrease the value at a rapid rate. New data is self entering in 5 seconds.

AUTO/MAN Key
Pressed once, it clears any latched alarms. If the key is pressed again within 5 seconds, the control toggles between the Auto and Manual mode. While in the Manual mode, percent power is always displayed in the lower display.

Front Panel Locking Screw
Secures or releases the control chassis from its case.

UP/DOWN keys
When pressed simultaneously for 3 seconds, the Setup Menu appears displaying the LOC parameter. At the LOC parameter, continue to press the UP/DOWN keys simultaneously , and the Calibration Menu will appear.

Auto/Manual LED
Lit when the control is in Manual operation. Press the key twice to enter Auto operation. A blinking Auto/Manual LED indicates that pressing the AUTO/MAN key toggles between Auto and Manual. After 5 seconds without pressing the AUTO/MAN key, the LED stops blinking, and returns to its previous state.

Chapter 4

How To Setup The Series 945

Setting up the Series 945 is a simple process. First configure the 945's features to your application in the Setup Menu, and then enter values in the Operating Menu. Use the MODE key to move through the menus and the UP/DOWN keys to select data.

At this point, enter the Calibration menu by pressing the UP/DOWN keys simultaneously for 3 seconds. Selecting US or SI under the dFL parameter determines the following: If selected as US, rate, reset, °F and proportional band in degrees will appear. If selected as SI, integral, derivative, °C and proportional band in % of span will appear. See Appendix II to change this parameter.

How to Set the DIP Switch

The Watlow Series 945 has a Dual In-line Package (DIP) switch inside the control on the A007-1954 circuit board (middle board). The location of the board and switches appear below. The switches are clearly numbered. When Switch #1 is ON, the Setup parameters can be viewed but not changed. Switch #2 is not used. The factory default is OFF.

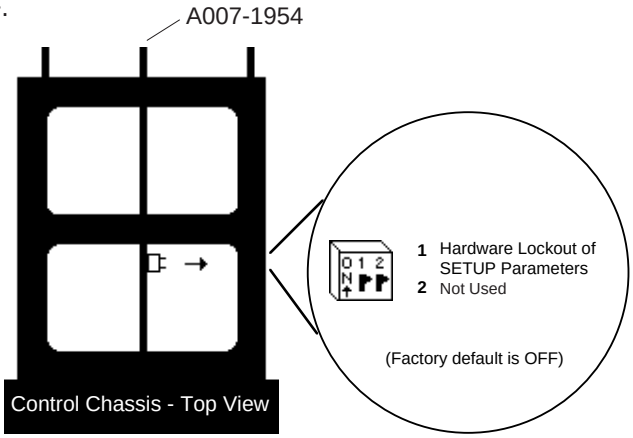


Figure 29 - DIP Switch Location and Orientation

Entering the Setup Menu

Enter the Setup Menu by pressing the UP/DOWN keys simultaneously for 3 seconds. The lower display shows the LOC parameter, and the upper display shows its current level. All keys are inactive until you release both keys. You can reach the LOC parameter from anywhere.

You will not see all parameters in this menu, depending on the unit's configuration and model number. After stepping through the menu it returns to the control set point parameter under the Operation menu.



Figure 30 - Entering the Setup Menu

Setup Menu

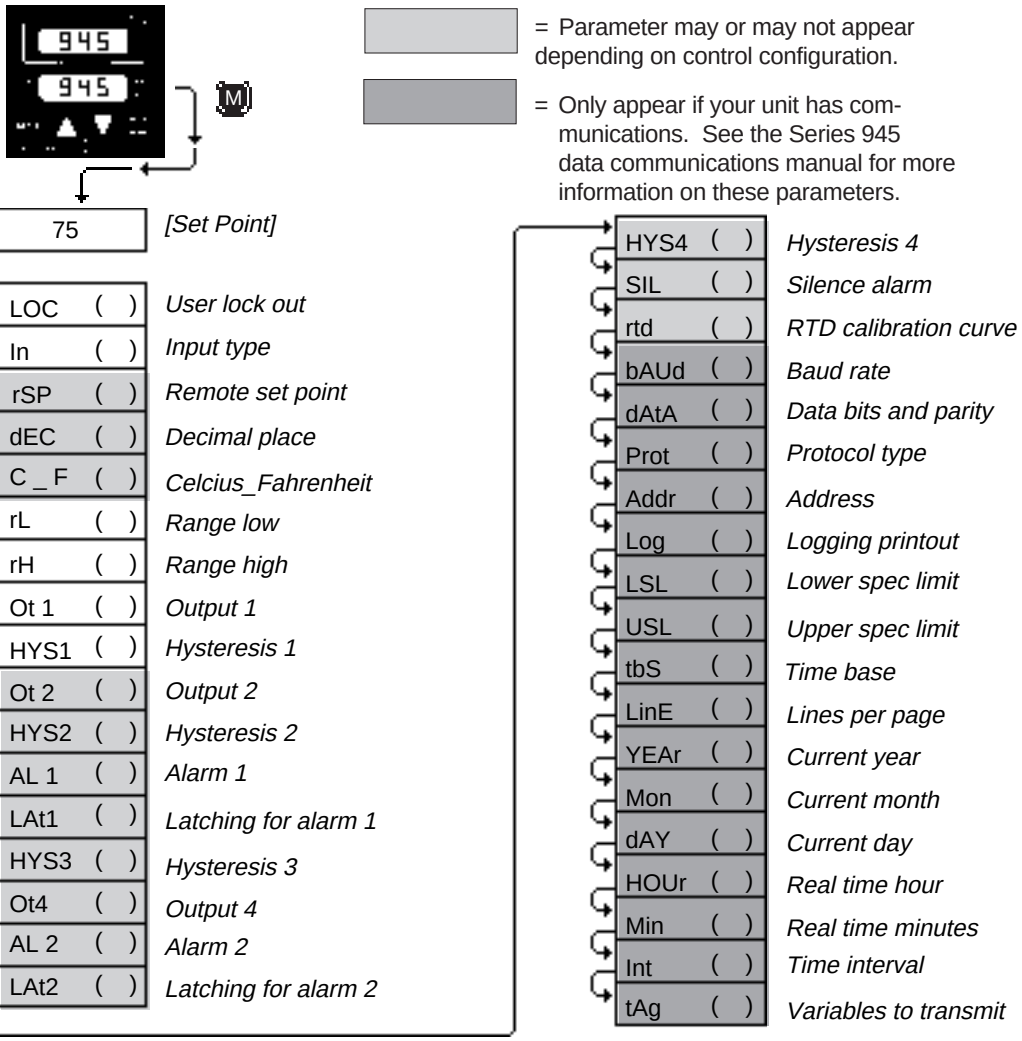


Figure 31 -
The Setup Menu

NOTE:
The rL and rH parameters are used to scale the display for process inputs, and/or will scale the retransmit range for process output. rL and rH also limit the range of the set point.

Setup Parameters

When you are at the top of the menu, the Series 945 displays the user level of operation in the upper display, and the LOC parameter in the lower display.

Press the MODE key and the **value** of the next parameter appears in the upper display, the prompt appears in the lower display. For units with process input, see the L-r parameter on Page 20 for how LOC is affected.

LOC

Lock: Selects the level of operator lockout. **Range:** 0 - 3 **Default:** 0

LOC 0: All operating parameters may be viewed or changed. Manual operation is permitted. Bumpless transfer to manual operation can occur on sensor break.

LOC 1: The set point, actual, and L-r (if rSP is enabled) are the only visible parameters, set point **is** adjustable in this level. Manual operation **is** permitted. Bumpless transfer to manual operation can occur on sensor break.

LOC 2: The set point, actual, and L-r (if rSP is enabled) are the only visible parameters, set point **is** adjustable in this level. Manual operation is **not** permitted. Bumpless transfer is defeated, outputs are disabled on sensor break.

LOC 3: The set point and actual are the only visible parameters, set point is **not** adjustable in this level of lockout. Manual operation is **not** permitted. Bumpless transfer is defeated, outputs are disabled on sensor break.

In

Input: Selects the sensor input type. Only those input types which are compatible with your unit will appear. See the model number information for your type.
Range: J, K (appears as H), t, n, c, r, S, b, Pt2, rtd, rt.d, 0-5, 420 **Default:** J **or** r

rSP

Remote Set Point: Enables models with process input capability to accept a remote set point signal from another device. This parameter only appears if In = Thermocouple or RTD. **Range:** OFF, 0-5, 420 **Default:** OFF

dEC

Decimal: Selects the location of the decimal point for all process related data. This parameter only appears if the In parameter is 0-5 or 420.
Range: 0, 0.0, 0.00 **Default:** 0

C _ F

Celsius _ Fahrenheit: Selects the units of temperature measurement. This parameter only appears if the In parameter is a thermocouple or RTD input. Dependent on the dFL parameter. See Appendix II. **Range:** C or F
If dFL = US: **Default:** C If dFL = SI: **Default:** F

rL

Range Low: Selects the low end of the set point range. See the model number and specification information on the inside back cover, and Table 1 on Page 16 for sensor range values. Also used to set the low end of the process or remote set point input and/or the low end of the range for the retransmit output. 0.0VDC and 4mA represent Range Low (rL) for process inputs and outputs. The process input and retransmit output are linearly scaled between rL and rH.
Range: Sensor range low to rH **Default:** Low limit of sensor type

rH

Range High: Selects the high end of the set point range. See the model number and specification information on the inside back cover, and Table 1 on Page 16 for your sensor range values. Also used to set the high end of the process or remote set point input and/or the high end of the range for the retransmit output. 5.0 VDC and 20mA represent Range High (rH) for process input and output. The process input and retransmit output are linearly scaled between rL and rH.
Range: Sensor range high to rL **Default:** High limit of sensor type

Ot1

Output 1: Selects the output action for the primary output. Action is in response to the difference between set point and process variable. Select ht (heat) for reverse acting or select CL (cool) for direct acting. **Range:** ht, CL **Default:** ht

HYS1

Hysteresis 1: Selects the switching hysteresis for Output 1 when Pb1 = 0 (ON/OFF). See Page 18 for the Pb1 parameter.

Range:	1°F - 99°F	0.1°F - 9.9°F	**Default:** 3°F/0.3°F
	1°C - 55°C	0.1°C - 5.5°C	
	1 Unit - 99 Units	0.1 Units - 9.9 Units	

Ot2

Output 2: Selects the output action for the secondary output. Action in response to the difference between set point and process variable. Select ht (heat) for reverse acting or select CL (cool) for direct acting. This parameter only appears if you have a secondary output. **Range:** CL, ht, no **Default:** CL

HYS2

Hysteresis 2: Selects the switching hysteresis for Output 2 when Pb2 = 0 (ON/OFF). See Page 18 for the Pb2 parameter. This parameter only appears if you have a secondary output; it will not appear if Ot2 = no.

Range:	1°F - 99°F	0.1°F - 9.9°F	**Default:** 3°F/0.3°F
	1°C - 55°C	0.1°C - 5.5°C	
	1 Unit - 99 Units	0.1 Units - 9.9 Units	

AL1

Alarm 1: Determines whether the alarm type for Alarm 1 is process, deviation, or none. A process alarm is set at an absolute temperature. A deviation alarm follows or tracks the set point. This parameter only appears if your unit has alarms.
Range: Pr, dE, no **Default:** Pr

LAt1

Latching 1: Selects whether Alarm 1 is latching or non-latching. Latching alarms must be cleared before the alarm output will reset. Non-latching automatically resets the alarm output when the condition clears. This parameter will not appear if AL 1 = no, or your unit does not have alarms. **Range:** LAt or nLA **Default:** nLA

HYS3

Hysteresis 3: Selects the switching hysteresis for Alarm 1. Appears if your unit has alarms and AL 1 = Pr or dE.

Range:	1°F - 99°F	0.1°F - 9.9°F	**Default:** 3°F
	1°C - 55°C	0.1°C - 5.5°C	
	1 Unit - 99 Units	0.1 Unit - 9.9 Units	

Ot4

Output 4: Selects Output 4 as retransmit of Process (PrOC) or Set Point (StPt). Hardware must be present. Scaling of the retransmit output is determined by rL and rH. **Range:** PrOC, StPt, no **Default:** PrOC

AL2

Alarm 2: Determines whether Alarm 2 type is process, deviation, or none. A process alarm is set at an absolute temperature. A deviation alarm follows or tracks the set point. This only appears if your unit has alarms.
Range: Pr, dE, no **Default:** Pr

LAt2

Latching 2: Selects whether Alarm 2 is latching or non-latching. Latching alarms must be cleared before the alarm output will reset. Non-latching automatically resets the alarm output when the condition clears. Will not appear if your unit does not have alarms or AL2 = no. **Range:** LAt or nLA **Default:** nLA

HYS4

Hysteresis 4: Selects the switching hysteresis for Alarm 2. Appears if your unit has alarms and AL 2 = Pr or dE.

Range:	1°F - 99°F	0.1°F - 9.9°F	**Default:** 3°F
	1°C - 55°C	0.1°C - 5.5°C	
	1 Unit - 99 Units	0.1 Unit - 9.9 Units	

SIL

Silencing: Selects alarm silencing (inhibit) for Alarm 1. This parameter only appears when AL1 = dE. For more information see Chapter 5.
Range: On or OFF **Default:** OFF

rtd

RTD: Selects the RTD calibration curve for RTD inputs. Appears if In = rtd or rt.d. JIS = 0.003916Ω/Ω°C, DIN = 0.003850Ω/Ω°C.
Range: din or JIS **Default:** din

Any parameters that appear after RTD are related to data communications. See *How to Use Data Communications with the Watlow Series 945* for more information.

Table 1 - Input Ranges.

Input Type	Sensor Range Low	Sensor Range High
J	32°F/0°C	1382°F/750°C
K (appears as H)	-328°F/-200°C	2282°F/1250°C
t	-328°F/-200°C	662°F/350°C
n	32°F/0°C	2282°F/1250°C
c	797°F/425°C	4200°F/2315°C
Pt2	32°F/0°C	2543°F/1395°C
r	32°F/0°C	2642°F/1450°C
S	32°F/0°C	2642°F/1450°C
b	1598°F/870°C	3092°F/1700°C
rtd (1°)	-328°F/-200°C	1112°F/600°C
rt.d (0.1°)	-99.9°F/-99.9°C	392.0°F/200.0°C
0-5 (VDC)	-5.00/-50.0/-500	35.00/350.0/3500
420 (mA)	-5.00/-50.0/-500	35.00/350.0/3500

Setup Menu

Use this page as a master copy for configuring your Series 945.
Do not enter any values here; make photocopies instead.

Table 2 -
Setup Menu Prompts
and Descriptions.

Parameter	Value	Range	Factory Default	Appears If:
LOC		0 - 3	0	
In		J, K (appears as H), t, n, c, Pt2, r, S, b, rtd, rt.d, 0-5, 420	J **or** r	
rSP		OFF, 0-5, 420	OFF	In = T/C or RTD
dEC		0, 0.0, or 0.00	0	In = 0-5 or 420
C _ F		C or F	F	In = T/C or RTD
rL		rL to rH	Input dependent.	
rH		rH to rL	Input dependent.	
Ot1		ht or CL	ht	
HYS1		1°F - 99°F, 1°C - 55°C, 1U - 99U 0.1°F - 9.9°F, 0.1°C - 5.5°C, 0.1U - 9.9U	3°F	
Ot2		ht, CL or no	CL	Unit has secondary output
HYS2		1°F - 99°F, 1°C - 55°C, 1U - 99U 0.1°F - 9.9°F, 0.1°C - 5.5°C, 0.1U - 9.9U	3°F	Unit has secondary output Ot2 = ht or CL
AL1		Pr, dE or no	Pr	Unit has alarms
LAt 1		LAt or nLA	nLA	Unit has alarms and AL1 = Pr or dE
HYS3		1°F - 99°F, 1°C - 55°C, 1U - 99U 0.1°F - 9.9°F, 0.1°C - 5.5°C, 0.1U - 9.9U	3°F	Unit has alarms and AL1 = Pr or dE
Ot4		no, PrOC, StPt	PrOC	Hardware is present
AL 2		Pr, dE or no	Pr	Unit has alarms
LAt 2		LAt or nLA	nLA	Unit has alarms and AL2 = Pr or dE
HYS4		1°F - 99°F, 1°C - 55°C, 1U - 99U 0.1°F - 9.9°F, 0.1°C - 5.5°C, 0.1U - 9.9U	3°F	Unit has alarms and AL2 = Pr or dE
SIL		On or OFF	OFF	Unit has alarms & AL1 = dE
rtd		JIS or din	din	In = rtd or rt.d

Operation Menu

In the Operation menu, the 945 operates as a digital set point control. All outputs are turned OFF when set point is set to OFF.

= Parameter may not appear depending on control configuration

= Only appears if your unit has communications. See the Series 945 data communications manual for more information.

NOTE:
The upper display will always return to the process value after 1 minute without key strokes.

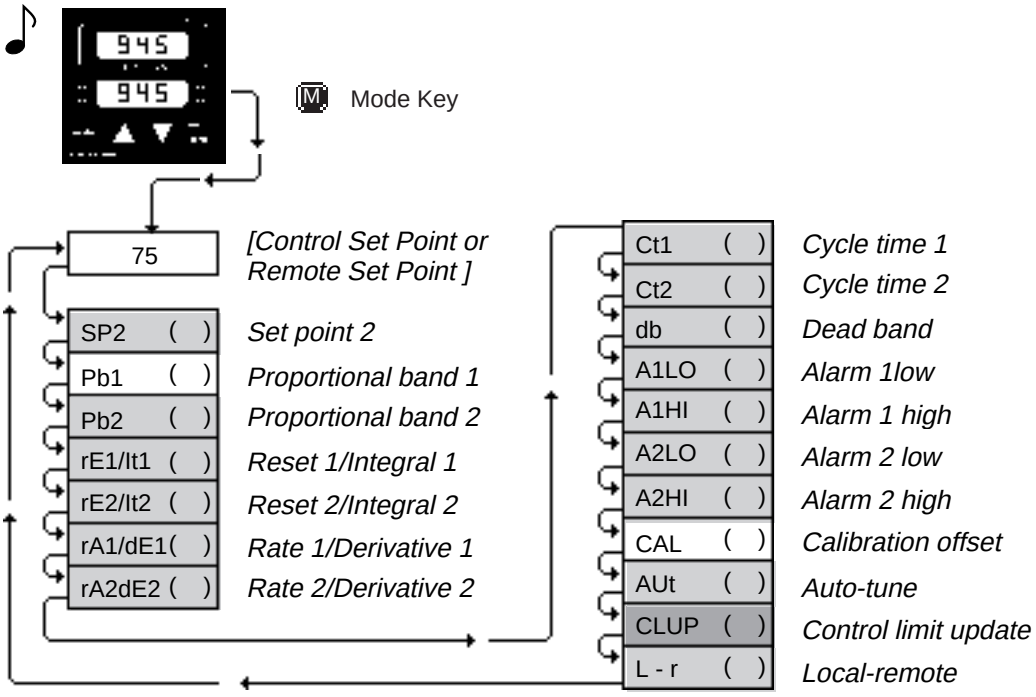


Figure 32 -
The Operation Menu

Operation Parameters

75

Set Point 1 or Remote Set Point 1: Sets the operating set point for the control outputs. Appears if L-r = L, see Page 20. If L-r = R, this parameter represents the remote set point. **Range:** OFF / rL to rH **Default:** Dependent on input range

SP2

Set Point 2: Sets the operating set point for Output 2 when control mode is ht/ht or CL/CL. Appears when Ot1 and Ot2 are the same, and functions as an ON/OFF control**. Range:** rL to rH **Default:** Same as primary set point.

Pb1
Pb2

Proportional Band: Expressed in degrees, process units or % of span, within which a controller proportioning function is active for Output 1 or 2. When PbX = 0, it functions as an ON/OFF control. The switching differential is then determined by the corresponding HYSX parameter. Pb1 is always visible. Pb2 will not appear if your unit does not have Output 2, Ot2 = no, or Ot2 is the same value as Ot1. Also dependant on the dFL parameter in the Calibration menu.
If dFL = US: **Range:** 0 to 999°F/0 to 555°C/0 to 999 Units; 0.0 to 9.9°F/0.0 to 5.5°C/ 0.0 to 9.9 Units **Defaults:** *Pb1* = 25°F/2.5°F *Pb2* = 0
If dFL = SI: **Range:** 0 to 999.9% of span **Defaults:** *Pb1* = 3.0% *Pb2* = 0.0%

rE1/It1
rE2/It2

Reset/Integral1: A reset (integral) control action for Output 1 or Output 2 automatically eliminating offset, or "droop," between set point and actual process temperature. Will not appear if your unit does not have a secondary output. rE1/It1: Will not appear if Pb1 = 0. rE2/It2: Will not appear if Pb2 = 0, Ot2 = no, or Ot2 is the same configuration as Ot1. Either reset (rE) or integral (It) will appear depending on how the dFL parameter is set in the Calibration menu.
See Appendix II.
If dFL = US: **Range:** 0.00 to 9.99 repeats/minute **Default:** 0.00
If dFL = SI: **Range:** 00.1 to 99.9 minutes per repeat **Default:** 0.00

rA1/dE1
rA2/dE2

Rate/Derivative 1: The rate (derivative) function for Output 1 or Output 2. Rate or derivative is used to eliminate over shoot on start up, or after the set point changes. *rA1/dE1:* Will not appear if Pb 1 = 0. *rA2/dE2:* Will not appear if your unit does not have a secondary output, Pb2 = 0, Ot2 = no, or Ot2 is the same value as Ot1. Either rate (rA) or derivative (dE) will appear depending on how dFL is set in the Calibration menu. If dFL = US or SI: **Range:** 0.00 to 9.99 minutes **Default:** 0.00

Ct1
Ct2

Cycle Time 1 & 2: Time for a controller to complete one ON/OFF cycle for Output 1or Output 2; expressed in seconds. *Ct1:* Will not appear if Pb 1 = 0, or Output 1 is 4-20mA. Ct2: Will not appear if your unit does not have a secondary output, Pb2 = 0, Ot2 = no, or Ot2 is the same value as Ot1.
Range: 1 to 60 seconds **Default:** 5

db

Dead Band: The area between Output 1 and 2 where no heating or cooling takes place in a heat/cool proportional control. Only appears if your unit is set up as a ht/CL or CL/ht unit. **Range:** ±0 to 99°F/0 to 55°C/0 to 99 Units; or ±0.0 to 9.9°F/0.0 to 5.5°C/0.0 to 9.9 Units **Default:** 0

A1LO

Alarm 1 Low: Represents the low process alarm or low deviation alarm for Alarm 1. Will not appear if your unit does not have alarms and AL 1 = no.
If AL 1 = dE: **Range:** 0 to -999°F/0 to -999°C/0 to -999 Units **Default:** -999°F
If AL 1 = Pr: **Range:** rL to A1HI **Default:** rL

A1HI

Alarm 1 High: Represents the high process alarm or high deviation alarm for Alarm 1. Will not appear if your unit does not have alarms and AL 1 = no.
If AL 1 = dE: **Range:** 0 to 999°F/0 to 999°C/0 to 999 Units **Default:** 999°F
If AL 1 = Pr: **Range:** A1LO to rH **Default:** rH

A2LO

Alarm 2 Low: Represents the low process alarm or low deviation alarm for Alarm 2. Will not appear if your unit does not have Alarm 2 and AL 2 = no.
If AL 2 = dE: **Range:** 0 to -999°F/0 to -999°C/0 to -999 Units **Default:** -999°F
If AL 2 = Pr: **Range:** rL to A2HI **Default:** rL

A2HI

Alarm 2 High: Represents the high process alarm or high deviation alarm for Alarm 2. Will not appear if your unit does not have Alarm 2 and AL 2 = no .
If AL 2 = dE: **Range:** 0 to 999°F/0 to 999°C/0 to 999 Units **Default:** 999°F
If AL 2 = Pr: **Range:** A2LO to rH **Default:** rH

CAL

Calibration Offset: Adds or subtracts degrees from the input signal.
Range: -180°F to 180°F/-100°C to 100°C/-180Units to 180 Units; or -180.0°F to 180.0°F/-100.0°C to 100.0°C **Default:** 0

AUt

Auto-Tune: Initiates auto-tune for Output 1. This parameter appears if Ot 1 =ht.
Range: 0 = off, 1 = slow, 2 = medium, 3 = fast **Default:** 0

L-r

Local-Remote: Selects a local or remote set point for the Series 945. This parameter only appears if the LOC parameter = 0, 1 or 2, and rSP = 0-5 or 420. If L-r = r, the remote set point will be displayed in place of the internal set point.
Range: L = Local operation r = remote operation **Default:** L

Operation Menu

Table 3 - Operation Menu Prompts and Descriptions.

Use this page as a master copy for your Series 945 Operation parameters. Do not enter any values here; make photocopies instead.

Parameters	Value	Range	Factory Default	Appears If:
Set Point 1 or Remote Set Point 1			rL to rH	75°F
SP2		rL to rH	Primary set point.	Ot1 = Ot2, Pb1 = 0
Pb1		If dFL = US: 0 - 999°F/0 - 555°C/0 - 999U 0 - 99.9°F/0 - 55.5°C/0 - 99.9U 0=ON/OFF control. HYS1 =swtch. diff. If dFL = SI: 0 to 999.9% of span	25°F/2.5°F 3%/.3%	
Pb2		Same as Pb1.	0°F	Ot2 = ht or CL Ot2 ≠ Ot1
rE1/It1		If dFL = US: 0.00 to 9.99 repeats/min. 0.00 = No Reset. If dFL = SI: 00.1 to 99.9 min./repeat	0.00 rpt/min. 0.00	Pb1 ≠ 0
rE2/It2		Same as rE1/It1.	0.00 rpt/min.	Pb2 ≠ 0, Ot2 ≠ Ot1 Ot2 = ht or CL
rA1/dE1		0.00 to 9.99 min. 0.00 = No Rate.	0.00 min.	Pb1 ≠ 0
rA2/dE2		Same as rA1/dE1.	0.00 min.	Pb2 ≠ 0, Ot2 ≠ Ot1 Ot2 = ht or CL
Ct1		1 to 60 seconds	5 seconds	Pb1 ≠ 0, Output1 ≠ 420
Ct2		1 to 60 seconds	5 seconds	Pb2 ≠ 0, Ot2 ≠ Ot1, Ot2 = ht or CL
db		±0 - 99°F/±0 - 55°C/0 - 99U. ±0.0 - 9.9°F/0.0 - 5.5°C/0.0 - 9.9U	0	Ht/CL or CL/Ht
A1LO Deviation **dE** Process **Pr**		-999° to 0° rL to A1HI	-999° rL	AL1 = Pr, dE Unit has alarms
A1HI Deviation **dE** Process **Pr**		0° to 999° A1LO to rH	999° rH	AL1 = Pr, dE Unit has alarms
A2LO Deviation **dE** Process **Pr**		-999° to 0° rL to A2HI	-999 rL	AL2 = Pr, dE Unit has Alarm 2
A2HI Deviation **dE** Process **Pr**		0° to 999° A2LO to rH	999° rH	AL2 = Pr, dE Unit has Alarm 2
CAL		±180°F/±100°C/±180U	0	
AUt		0-3	0	Ot1 = ht, L-r = L
L-r		L or r	L	rsP = 0-5 or 420

Chapter 5

How to Tune and Operate

Auto-tuning

Auto-tuning applies to Output 1, heating only.

The auto-tuning procedure operates on a thermal response value — slow, medium, or fast. Use the slow thermal response when your process does not reach set point too rapidly, or if it usually does not exceed set point a lot. A fast thermal response produces a rapid temperature change over a short period of time.

Once the auto-tune sequence has begun, the Output 1 heat proportional band is set to 0 and the control goes into an ON/OFF mode of control at 90% of the established set point. The displayed set point remains unchanged.

The cool output remains off for the tuning duration. Once the control learns the thermal system response, it returns to a standard PID control using the PID values automatically set as a result of auto-tuning. Output 2 cool PID values are unaffected by auto-tuning, and remain at their factory default settings. See Manual tuning on the next page to set cool PID parameters. Any change of the set point, while in auto-tune, re-initiates the auto-tune procedure.

The Series 945 will **not** Auto-tune while in remote set point. Transferring from local to remote set point takes the 945 out of auto-tune.

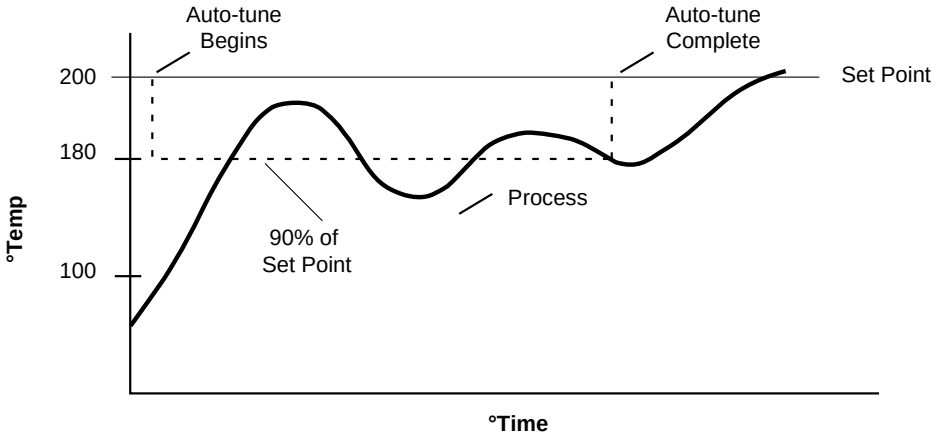


Figure 33 - Auto-tuning at a Set Point of 200°F.

In order for the 945 to successfully complete auto-tune, the process must cross set point four times within 80 minutes after auto-tune has started. If this does not happen within the 80 minute time limit, the Pb remains at 0 and the control functions in an ON/OFF mode.

To start auto-tuning:

1. **Press the MODE key** until the **AUt** parameter appears in the data display.
2. **Select a thermal response value** using the UP/DOWN keys, 1=slow, 2=medium, and 3=fast. A thermal response value of 2 satisfactorily tunes most thermal systems.
3. **Press the MODE key.** While the control is in the tuning mode, the lower display alternately displays the normal information and the prompt **At**. The time between alternations is 1 second.
4. **When tuning is complete,** the displays return to their previous state and **AUt** reverts to 0. The 945 installed appropriate PID tuning parameters and saved them in the non-volatile memory. I**f a mechanical relay or contactor is switching power to the load, a longer cycle time may be desirable to minimize wear on the mechanical components. Typical life of a mechanical relay is 100,000 cycles.**

To abort auto-tuning, the operator must reset the **AUt** parameter to 0, press AUTO/MAN twice, or cycle power off and on. In all cases, aborting auto-tune restores all values to those previous to auto-tuning.

Manual Tuning

For optimum control performance, tune the Series 945 to your thermal system. The tuning settings here are for a broad spectrum of applications; your system may have somewhat different requirements. **NOTE: This is a slow procedure, taking from minutes to hours to obtain optimum value.**

NOTE:

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

1. **Apply power to the Series 945** and enter a set point. Begin with these Operation parameters: **Pb** = 1, **rE/It** = 0.00, **rA/dE** = 0.00, **Ct** = 5, **CAL** = 0, **AUt**= 0.
2. **Proportional Band Adjustment** : Gradually increase **Pb** until the upper display temperature stabilizes to a constant value. The process temperature may not be right on set point because the initial reset value is 0.00 repeats per minute.
3. **Reset/Integral Adjustment**: Gradually increase **rE/It** until the upper display temperature begins to oscillate or "hunt." Then slowly decrease **rE/It** until the upper display stabilizes again near set point.
4. **Cycle Time Adjustment**: Set **Ct** 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 may be desirable to minimize wear on the mechanical components. Experiment until the cycle time is consistent with the quality of control you want. Ct will not appear on units with a process output.

5. **Rate/Derivative Adjustment**: Increase **rA/dE** to 1.00 minute. Raise set point by 20° to 30°F, or 11° to 17°C, observe the system's approach to set point. If the load temperature overshoots set point, increase **rA/dE** to 2.00 minutes.

   Next raise set point by 20 to 30°F, or 11 to 17°C and watch the approach to the new set point. If you increase **rA/dE** too much, approach to set point will be very sluggish. Repeat as necessary until the system rises to the new set point without overshooting or approaching the set point too slowly.

6. **Calibration Offset Adjustment:** You may want your system to control to a temperature other than the value coming from the input sensor. If so, measure the difference between that temperature (perhaps at another point in the system) and the process value showing in the upper display. Then enter the **CAL** offset value you want. Calibration offset adds or subtracts degrees from the value of the input signal.

Manual and Automatic Operation

To change from manual to auto operation, press AUTO/MAN twice.
Manual operation provides open loop control of the outputs from a range of -100% (full cooling) to 100% (full heating) power. The 945 allows a negative output value only with a Cl (Cool) selection on either Ot1 or Ot2. Automatic operation provides closed loop ON/OFF or PID control. When the operator transfers from a closed loop to an open loop, the 945 retains the power level from the closed loop control, referred to as bumpless transfer. When the 945 returns to closed loop control, it restores the previous set point temperature.

The LED on the AUTO/MAN key indicates auto or manual operation. When the LED is ON, the control is in manual operation. When the LED is OFF, it is in Automatic operation. When the LED flashes, press the key again within five seconds to complete the change in operation.

When a sensor opens the 945 will switch from automatic to manual operation.

- If LOC = 0 or 1 and the conditions for bumpless transfer are met, process stabilizes within ± 5% of set point within the last two minutes and less than 75% power. The 945 switches to manual operation at the last automatic power level.

- If LOC = 2 or 3, or the conditions of bumpless transfer have not been met, the 945 switches into manual operation at 0% power (outputs disabled).

When transferring from auto to manual operation, the control output(s) remains stable ("bumpless," smooth transition). When transferring from manual to automatic operation, the control output(s) may change significantly. In manual operation, the output value appears in the lower display; in automatic operation, the set point appears.

Changing the Position of an Alarm Jumper

1. Remove power from the control. Turn the front panel screw 90° counterclockwise.
2. Grip the front panel bezel and pull it straight out from the control case. The control chassis will come out of the case as you pull the bezel.
3. Set the jumper to the position you want. See below for jumper location.
4. Return the control chassis to the case. Be sure you have it oriented correctly. Press firmly, but gently, to seat the chassis.

NOTE:

Depending on the unit you order, your control may have 0, 1, or 2 alarm jumpers.

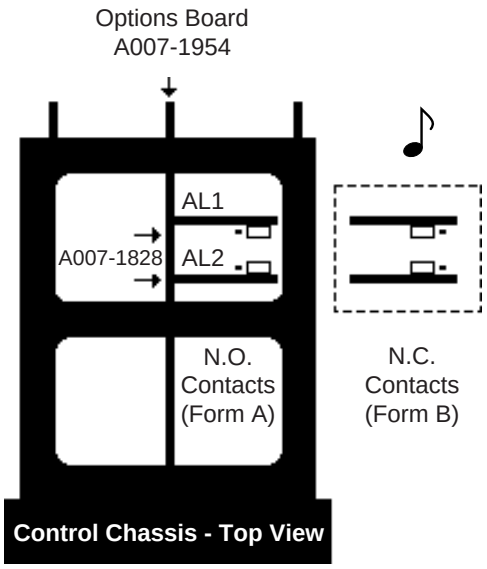


Figure 34 - Alarms Jumper Location.

The alarm output de-energizes upon an alarm or power interruption to the 945's power supply. When you select **N.O. Contacts**, the contact is open when an alarm occurs. When selecting **N.C. Contacts**, the contact closes when an alarm occurs.

Using Alarms

The Series 945 has two alarm types, Process or Deviation. A **Process alarm** sets an absolute temperature. When the process exceeds that absolute temperature limit an alarm occurs. The Process alarm set points may be independently set high and low.

A **Deviation alarm** alerts the operator when the process strays too far from set point. The operator can enter independent high and low alarm settings. The reference for the deviation alarm is the set point. Any change in set point causes a corresponding shift in the deviation alarm. **Example:** If your set point is 100°F, and a deviation alarm set at +7°F as the high limit, and -5°F as the low limit, the high alarm trips at 107°F, and the low alarm at 95°F. If you change the set point to 130°F, the alarms follow the set point and trip at 137°F and 125°F.

Both process and deviation alarms can be latching or non-latching. When the alarm condition is removed a **non-latching alarm automatically** clears the alarm output. You must **manually clear** a **latching alarm** before it will disappear.

Flashing 'LO" or "HI" in the lower display indicates an alarm. The lower display alternately shows information from the current parameter and the "LO" or "HI" alarm message at one second intervals. The alarm output is de-energized and the A1 or A2 LED is lit.

To clear an alarm…

- **First correct the alarm condition, then…**
  - **If the alarm is latching…**
    Clear it manually; press AUTO/MAN once as soon as the process temperature is inside the alarm limit according to the HYSX parameter.
  - **If the alarm is non-latching…**
    The alarm will clear itself automatically as soon as the process temperature is inside the alarm limit according to the HYSX parameter.



Figure 35 - Alarm Display Examples

Alarm Silencing for alarm output A1 is available with the deviation alarm. This overrides alarm A1 during power up. The **non-latching** mode automatically enables alarm output A1 on initial power up. In the **latching** mode, manually disable the alarm by pressing AUTO/MAN once. In both cases alarm silencing disables the A1 alarm output relay, but the A1 LED displays the alarm condition until the process value is within the "safe" region of the deviation alarm band. Once the process value crosses into the "safe" region, both a latching or a non-latching alarm is ready. Any future deviation outside this safe band triggers an alarm.

Error Code Messages

Four dashes, "- - - -", in the upper display indicate a Series 945 error. The error code is visible in the lower display.

NOTE:

An alarm display will be masked by an error condition or when the control is in the Calibration or Setup Menus.



WARNING:

Electrical noise or a noise event, vibration or excess environmental moisture or temperature may cause Series 945 errors to occur. If the cause of an error is not otherwise apparent, check for these.

Er 1 - Sensor overrange error
The sensor input generated a value higher than that allowed for the range of the sensor, or the A/D circuitry malfunctioned. Enter a valid input. The A/D value is above the range limits, but within the A/D conversion limits. Make sure the In parameter matches your sensor.

Er 2 - Sensor underrange error
The sensor input generated a value lower than that allowed for the range of the sensor, or the A/D circuitry malfunctioned. Enter a valid input. The A/D value is below the range limits, but within the A/D conversion limits. Make sure the In parameter matches your sensor.

Er 3 - Ambient error
Check the specification for the ambient temperature range.

Er 4 - Configuration error
The unit's microprocessor is faulty; call the factory.

Er 5 - Non volatile checksum error
The nonvolatile memory checksum discovered a checksum error. Unless a momentary power interruption occurred while the unit was storing data, the nonvolatile memory is bad. Call the factory.

Er 6 - A/D underflow error
The A/D circuit is underrange. An open or reversed polarity sensor is the most likely cause. Check the sensor; if the connection is good, and functions properly, call the factory. The A/D underrange voltage is too low to convert an A/D signal. Make sure the In parameter matches your sensor.

Er 7 - A/D overflow error
The A/D circuit is overrange. An open or reversed polarity sensor is the most likely cause. Check the sensor; if the connection is good, and functions properly, call the factory. The A/D overrange voltage is too high to convert an A/D signal. Make sure the In parameter matches your sensor.

Error Code Actions

- **Error codes Er 1, Er 2, Er 3, Er 6, or Er 7 will result in these conditions:**
  - **If operator access is LOC 0 or 1…**

  …and the control was in AUTO operation when the error occurred, it goes into manual (% power) operation. If the output power is less than 75% power, and a <5% change in power occurred within the last two minutes, the 945 switches into manual operation at the last automatic power level (bumpless transfer). If the control was in manual operation, it remains there. (Press AUTO/MAN twice to see the error code.) The alarm output (if present) is in its alarm state (LED lit). The upper display reads "- - - -". The lower display indicates the error code.

  If the control was operating with stable output values when the error occurred, it continues to operate at those levels on a % power basis. If output values were not stable, the control outputs go to 0% power (OFF).

  - **If operator access is LOC 2 or 3…**

  The control remains in AUTO operation and the outputs go OFF. AUTO/MAN and MODE are inactive. The UP/DOWN keys may be used simultaneously to enter the Setup Menu. The alarm output (if present) is in its alarm state (LED lit). The Upper display reads "- - - -". The Lower display indicates the error code.

  - **To clear a corrected error…**
    - Cycle power or MODE through Setup until you return to the set point.

- **Error codes Er 4 or Er 5 will result in these conditons:**
  - The control is in AUTO operation with both outputs OFF.
  - The alarm outputs are in their alarm state (de-energized with the LED lit).
  - The upper display indicates the process value.
  - The lower display indicates the error code.
  - All keys are inactive.
  - All Setup Menu parameters return to default values.
  - The above conditions occur regardless of the LOC value, or the presence of the Setup or Calibration Menus.

- **To clear a corrected error…**
  - Cycle power to the control.

Appendix 1

Noise and Installation Guidelines

For wiring guidelines, refer to the IEEE Standard No. 518-1982, available from IEEE, Inc. 345 East 47th Street, New York, NY 10017.

Noise Sources

- Switches and relay contacts operating inductive loads such as motors, coils, solenoids, and relays, etc.
- Thyristors or other semiconductor devices which are not zero crossover-fired (randomly-fired or phase angle-fired devices).
- All welding machinery and heavy current carrying conductors.
- Fluorescent and neon lights.

Decreasing Noise Sensitivity

- Physical separation and wire routing must be given careful consideration in planning the system layout. For example, A.C. power supply lines should be bundled together and physically kept separate from input signal lines (sensor lines). A 12" (305 mm) minimum separation is usually effective. Keep all switched output signal lines (high power level) separate from input signal lines (sensor lines). Cross other wiring at 90° angles whenever crossing is unavoidable.

- Look at the system layout; identify and locate electrical noise sources such as solenoids, relay contacts, motors, etc. Route the wire bundles and cables as far away as possible from these noise sources. Don't mount relays or switching devices close to a microprocessor control. Don't have phase angle-fired devices in the same electrical enclosure or on the same power line with the control.

- Shielded cables should be used for all low power signal lines to protect from magnetic and electrostatic coupling of noise. Some simple pointers are:

  ◊ Run low level signal lines unbroken from signal source to the control circuit.
  ◊ Connect a shield to the control circuit common at the control end only. Never leave shields unconnected at both ends or connect both shield ends to a common ground.
  ◊ Maintain shield continuity at daisy chain connection points by reconnecting the broken shield.
  ◊ Assume no electrostatic shielding when using the shield as a signal return. If you must, use triaxial cable (electrostatically shielded coaxial cable).

- Twisted pair wire should be used any time control circuit signals must travel over two feet, or when they are bundled in parallel with other wires.
- Select the size or gauge of wire by calculating the maximum circuit current and choose the gauge meeting that requirement. Using larger wire sizes than required generally increases the likelihood of electrostatic (capacitance) coupling of noise.
- Eliminate ground loops in the entire control system. You can spot the obvious loops by studying the "as-built" wiring diagram. There are also not-so-obvious ground loops resulting from connecting internal circuit commons in the manufacturer's equipment.
- Do not daisy chain A.C. power (or return) lines, or output signal (or return) lines to multiple control circuits. Use a direct line from the power source to each input requiring A.C. power. Avoid paralleling L1 (power lead) and L2 (return lead) to load power solenoids, contactors, and control circuits. If an application uses L1 (power lead) to switch a load, L2 (return lead) has the same switched signal and could couple unwanted noise into a control circuit.
- Tie all ground terminals together with one lead (usually green wire) tied to ground at one point. Don't connect ground to the control case if the control is in a grounded enclosure (preventing ground loops).
- Do not confuse chassis grounds (safety ground) with control circuit commons or with A.C. supply L2 (return or neutral line). Each return system wiring must be separate. Absolutely never use chassis ground (safety) as a conductor to return circuit current.

Eliminating Noise

- Use "snubbers" ("QUENCHARC™") to filter out noise generated by relays, relay contacts, solenoids, motors, etc. A snubber is a simple filter device using a 0.1µf, 600 volt, non-polarized capacitor in series with a 100 , 1/2 watt resistor. The device can be used on A.C. or D.C. circuits to effectively dampen noise at its source.
- The general purpose Watlow snubber, described above, is 0804-0147-0000. For other "QUENCHARC" sizes contact: PAKTRON
  P.O. Box 5439
  Lynchburg, VA 24502
  Phone: 804/239-6941
- A Metal Oxide Varistor (MOV) can be used to limit voltage "spikes" that occur on the A.C. supply lines as a result of lightning strikes, switching large motors, etc. The MOV is available in several varieties and for 115 or 230 volt lines. The device dissipates the voltage "spikes" to ground and in doing so repeatedly, deteriorates its ability to function. MOVs have a limited life. See Table 4.

- "Islatrols" and other similar power line filters are designed to carry the power for the control circuit and "buffer" the control circuit from A.C. line noise. Devices like the Islatrol use media (electromagnetic filtering) other than electric circuits to filter out electrical noise. Take care in matching the power capabilities of the filter with power demands of the circuit. Keep line filters as close to the control as possible to minimize the area for interference pick up.

- Islatrols are available from: Control Concepts Corporation
  328 Water Street
  P.O. Box 1380
  Binghamton, NY 13902-1380
  Phone: 607/724-2484

I - 101 (1A, 120VAC) I - 105 (5A, 120VAC) I - 115 (15A, 120VAC)
I - 202 (2.5A, 208/240VAC) I - 207 (7.5A, 208/240VAC)

- The ultimate protection is an "uninterruptable" power supply. This "senses" the A.C. power line; when the line fluctuates, a battery powered 60Hz inverted circuit takes over, supplying power within one-half to one cycle of the A.C. line; very expensive.

Checking for Ground Loops

To check for ground loops, disconnect the ground wire at the ground termination. Measure the resistance from the wire to the point where it was connected. The ohmmeter should read a high ohm value. If you have a low ohm value across this gap, there is at least one ground loop present in your system.

Or check for continuity; your reading should be "open." If you do find continuity, begin looking for the ground loops. Begin disconnecting ground in the system one at a time, checking for continuity after each disconnection. When continuity reads "open" you have eliminated the ground loop(s). Also, as you reconnect grounds, keep making the continuity test. It is possible to reconnect a ground loop.

Noise Suppression Devices Available From Watlow

Watlow Controls stocks a few key noise suppression parts. You may order these by calling your local Watlow distributor.

Table 4 - Noise Suppression Device Ratings

Item	Electrical Ratings	Part Number
Common Mode Line Filter	250V, 3 Amp	0804-0196-0000
Differential Mode Line Filter	Refer to the Islatrol listing above.	
Metal Oxide Varistor	150V, 80 Joule	0802-0273-0000
MOV	130V, 38 Joule	0802-0304-0000
MOV	275V, 75 Joule	0802-0266-0000
MOV	275V, 140 Joule	0802-0405-0000
Quencharc	0.01µf, 100 , 600VAC	0804-0147-0000

Line Filtering Configurations For Controls

These three diagrams show filter configurations for removing input power noise. Choose the one best suited for your system. For very dirty or critical applications - use a microcomputer-regulated power supply or Uninterruptable Power Supply (U.P.S.). Don't fasten common mode line filters or filters with metal cases to metal at ground potential. This prevents ground loops and maintains filter effectiveness.

1 NOTE:
Keep filters 12" (305 mm) or less from the control. Minimize the line distance where noise can be reintroduced to the control.

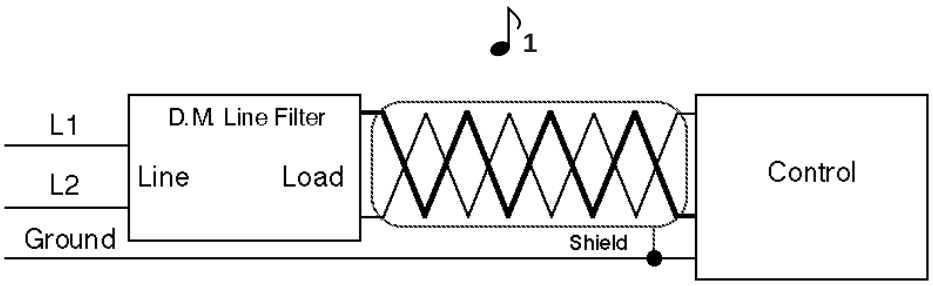


Figure 37 - Differential Mode Filter Wiring

2 NOTE:
To prevent ground loops do not fasten common mode line filters or filters with metal that is at ground potential. Doing so will reduce filter effectiveness.

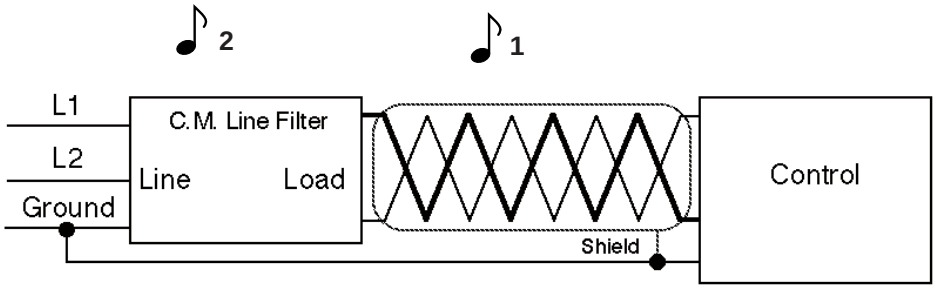


Figure 38 - Common Mode Filter Wiring

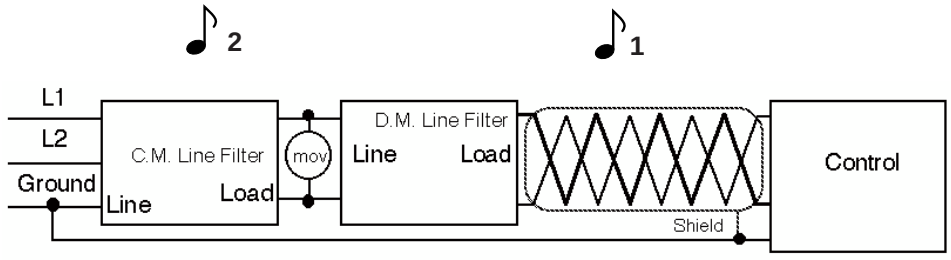


Figure 39 - Combination Differential/Common Mode Filter Wiring

Appendix 2

Calibration

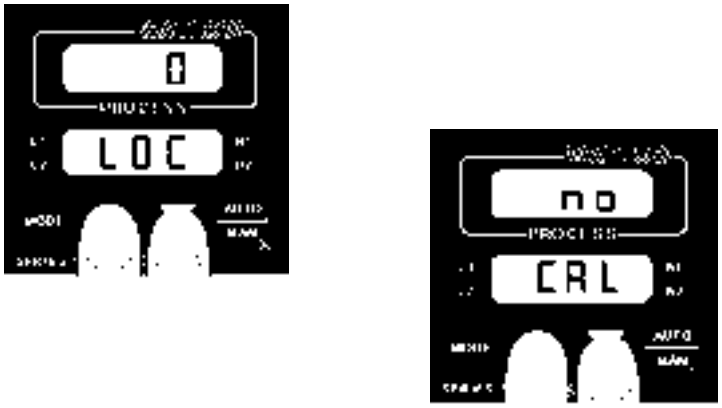
Before attempting to calibrate, make sure you have the proper equipment called for in each procedure.

Entering the Calibration Menu

Enter the Calibration Menu to change the configuration of the dFL (default language) parameter. Several parameters are dependent on the dFL parameter, they are listed below. It is a good idea to change this parameter, if necessary, before entering the Setup menu. The factory configures your unit to your preference, but can be changed at any time.

In the Calibration menu, various input signals must also be supplied in order for the control to go through its auto calibration. The calibration menu can only be entered from the LOC parameter in the Setup menu. Press the UP/DOWN keys simultaneously for 3 seconds (± 1 second). The CAL parameter appears in the lower display with "no" in the upper display.

Figure 40 - Entering the Calibration Menu.



NOTE:

Calibration values are not retained unless you are in the MANUAL mode. Do not enter the MANUAL mode until you are at the correct input parameters.

Any inadvertent change in the displayed data, when pressing the UP/DOWN keys, is ignored. Calibration values are not retained unless you are in the MANUAL mode. Press the UP/DOWN keys to change the upper display to “YES.” Press the MODE key to enter the calibration sequence.

NOTE:

While in the Calibration Menu, all outputs are OFF, except the 4-20mA output.

Upon entering the calibration menu, the top display window indicates CAL. The upper display continues to indicate CAL (with the exception of calibration of the 4-20mA output) while the operator walks through the entire calibration parameter list. While calibrating the 4-20mA output, the upper display contains a numeric value to be slewed up or down until the output value is correct. The control uses the lower display to prompt the user as to what the input should be.

The dFL parameter allows you to select either U.S. parameters which include displaying rate, reset, °F, and proportional band in degrees or units, or select SI (System International). The parameters displayed here are integral, derivative, °C, and proportional band in % of span.

Once the information has been properly established and maintained for 5 to 10 seconds, the MODE key may then be used to display the next parameter. After the final input is established, press the MODE key twice to return the unit to the configuration menu at the top of the parameter list.

Restoring Factory Calibration

The rSt parameter restores the factory calibration values to the Series 945. If you calibrate your control incorrectly, you have the option to default to the original values. Once you leave the CAL menu, the values are entered.

1. Press the UP/DOWN keys simultaneously for three seconds. The LOC parameter appears in the lower display. Continue holding the UP/DOWN keys until the lower display reads CAL.

2. Press the UP key until YES appears in the upper display.

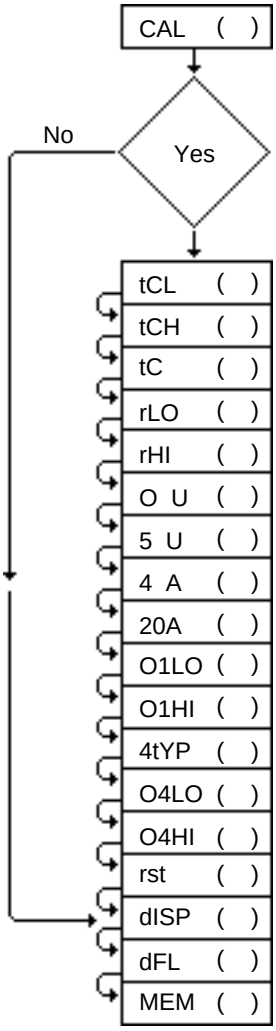
3. MODE through the calibration menu until rSt appears in the lower display.

4. Press the UP key until YES appears in the upper display.

5. Press the MODE key and the 945 advances to test the displays.

This procedure is used only to restore calibration, it is not meant to clear values.

Calibration Menu



YES to calibrate, No skips to display test.

Input 0.00mV for low thermocouple input.

Input 50.00mV (16.035 for r, S or b units) for high thermocouple input.

Connect a "J" T/C compensator, with inputs shorted. T/C units only.

Connect the JIS RTD low resistance per model number.

Connect the JIS RTD high resistance per model number.

Set the voltage source to 0.000 volts.

Set the voltage source to 5.000 volts.

Set the current source to 4.00mA.

Set the current source to 20.00mA.

Press the UP/DOWN keys until Output 1 reads process low.

Press the UP/DOWN keys until Output 1 reads process high.

Factory select for Output 4 type.

Press the UP/DOWN keys until Output 4 reads process low.

Press the UP/DOWN keys until Output 4 reads process high.

Restores factory calibration values.

Factory use only.

Select US (rate, reset, proportional band in degrees or units, °F) or SI (integral, derivative, proportional band in % of span, °C).

Factory use only.

Figure 41 - Calibration Menu

Before attempting to calibrate, make sure you have the proper equipment called for in each procedure.

The Series 945 is calibrated and tested before leaving the factory.

Thermocouple Field Calibration Procedure

Equipment Required:

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

Setup And Calibration

1. Connect the AC line voltage L1, L2, and ground to the proper terminals.
2. Connect the millivolt source to Terminal #9 (-) and Terminal #7 (+) on the Series 945 terminal strip. Use regular 20 - 24 gauge wire.
3. Apply power to the unit and allow it to warm up for 15 minutes. **After warm-up** put the unit in the CAL menu. See Page 32.
4. Press AUTO/MAN twice to enter the MANUAL mode. The unit is calibrating when the MANUAL LED is ON. Make sure the unit is in MANUAL mode **only** when you are in the correct parameters. See Figure 41. Press MODE.
5. At **tcL**, enter 0.00mV from the millivolt source to the control. Allow 10 seconds to stabilize. Press MODE.
6. At **tcH**, enter 50.00mV for type "J" units or 16.035mV for type "R" units from the millivolt source to the 945. Allow at least 10 seconds to stabilize. Press MODE.
7. At **tc**, disconnect the millivolt source, and connect the reference compensator or T/C calibrator to Terminal #9 (-), and Terminal #7 (+) on the 945 terminal strip. Allow 10 seconds to stabilize. The unit leaves CAL if 1 minute passes between key activations. Press AUTO/MAN twice to exit the MANUAL mode. To conclude, advance to the next prompt or exit the CAL menu.

NOTE

Before calibration on an installed control, make sure all data and parameters are documented. See Setup, and Operation Tables, Pages 18 and 20.

RTD Field Calibration Procedure

Equipment Required:

- 1KΩ precision decade resistance box with 0.01 ohms resolution.

Setup And Calibration

1. Connect the AC line voltage L1, L2, and ground to the proper terminals.
2. Connect the decade resistance box to Terminal #4, 5 and 6 on the terminal strip. Use regular 20 - 24 gauge wire of the same length and type.
3. Apply power to the unit and allow warm up for 15 minutes. **After warm-up** put the unit in the CAL menu. See Page 32. Press MODE until **rLO** s displayed.
4. Press AUTO/MAN twice to enter the MANUAL mode. The unit is calibrating when the MANUAL LED is ON. Make sure the unit is in MANUAL mode **only** when you are in the correct parameters. See Figure 41.
5. At **rLO** set the decade resistance box to the correct low setting below. This can be calibrated to JIS or DIN. Allow 10 seconds to stabilize. Press MODE.

	Calibration	Low	High
945A-2XX0-0000	1°	17.31	317.33
945A-3XX0-0000	0.1°	59.59	177.13

Table 5 - RTD Settings.

6. At **rHI**, set the decade resistance box to the correct high setting. Allow at least 10 seconds to stabilize. The unit leaves the CAL mode if 1 minute passes between key activations. Press AUTO/MAN twice to exit the MANUAL mode. To conclude, advance the MODE key to the next prompt or exit the CAL menu.

IMPORTANT:

When the MANUAL LED is ON the unit is automatically calibrating. Your sequence is VERY important. Always move to the next parameter before changing the calibration equipment.

0 - 5 Volt Input Field Calibration Procedure

Equipment Required:

- Precision voltage source 0-5 volt minimum range with 0.001 volt resolution.

Setup And Calibration

1. Connect the AC line voltage L1, L2, and ground to the proper terminals on the 945.
2. Connect the voltage/current source to Terminal #1 and #3 on the Series 945 terminal strip. Use regular 20 - 24 gauge wire.
3. Apply power to the unit and allow it to warm up for 15 minutes. **After warm-up** put the unit in the CAL menu. See Page 32. Press the MODE key until **OU** is displayed.
4. Press AUTO/MAN twice to enter the MANUAL mode. The unit is calibrating when the MANUAL LED is ON. Make sure the unit is in the MANUAL mode **only** when you are in the correct parameters. See Figure 41.
5. At the **OU** parameter, set the voltage/current source to 0.000volts. Allow at least 10 seconds to stabilize. Press the MODE key.
6. At the **5U** parameter, set the voltage/current source to 5.000 volts. Allow at least 10 seconds to stabilize. The unit leaves the CAL mode if 1 minute passes between key activations. Press AUTO/MAN twice to exit the MANUAL mode. To conclude the 0-5 Volt calibration, advance the MODE key to the next prompt or exit the CAL menu.

NOTE:

Before calibration on an installed control, make sure all data and parameters are documented. See Setup and Operation Tables, Pages 18 and 20.

4-20mA Input Field Calibration Procedure

Equipment Required:

- Precision current source 0-20mA minimum range with 0.01 mA resolution.

Setup And Calibration

1. Connect the AC line voltage L1, L2, and ground to the proper terminals on the Series 945. Jumper for correct line voltage. See Chapter 2.
2. Connect the voltage/current source to Terminal #1 and #3. Jumper Terminal #2 to #3 on the Series 945 terminal strip. Use regular 20 - 24 gauge wire.
3. Apply power to the unit and allow it to warm up for 15 minutes. **After warm-up** put the unit in the CAL menu. See Page 32. Press the MODE key until **4A** is displayed.
4. Press the AUTO/MAN key twice to enter the MANUAL mode. The unit is calibrating when the MANUAL LED is ON. Make sure the unit is in the MANUAL mode **only** when you are in the correct parameters. See Figure 41.
5. At the **4A** parameter, set the mA source to 4.00mA. Allow at least 10 seconds to stabilize. Press the MODE key.
6. At the **20A** parameter, set the voltage/current source to 20.00mA. Allow at least 10 seconds to stabilize. The unit leaves the CAL mode if 1 minute passes between key activations. Press AUTO/MAN twice to exit the MANUAL mode. To conclude, advance the MODE key to the next prompt or exit the CAL menu.

IMPORTANT:

When the MANUAL LED is ON the unit is automatically calibrating. Your sequence is VERY important. Always move to the next prompt before changing the calibration equipment.

0 - 5 or 0-10 Volt Output Field Calibration Procedure

Equipment Needed: • 20KΩ, 1/4 watt, 10% resistor • 4 1/2 digit digital multimeter.

Setup and Calibration

1. Connect the AC line voltage L1, L2, and ground to the proper terminals.
2. Connect the multimeter across the 20KΩ resistor to Terminal #17 (+) and #16 (-) for 0-5Volt and 0-10Volt units on the Series 945 terminal strip. Use regular 20-24 gauge wire.
3. Apply power and allow warm up for 15 minutes. **After warm-up** put the unit in the CAL menu. See Page 32. Press the MODE key until **O1LO** is displayed.
4. Press AUTO/MAN twice to enter the MANUAL mode. The unit is calibrating when the MANUAL LED is ON. Make sure the unit is in the MANUAL mode **only** when you are in the correct parameters. See Figure 41.
5. At the **O1LO** parameter, the multimeter should read approximately 0V. Allow at least 10 seconds to stabilize.
6. Use the UP/DOWN keys (reverse acting) to adjust the reading on the multimeter for 0.00V ±0.05V. To achieve this, you will need to press and hold the UP or DOWN key until the reading on the multimeter comes above 0V, then with the opposite key, adjust the multimeter for 0.00V ±0.05V.
7. At **O1HI**, the multimeter should read approx. 5V. Allow 10 seconds to stabilize. The unit leaves the CAL mode if 1 minute passes between key activations.
8. Use the UP/DOWN keys (reverse acting) to adjust the reading on the multimeter for **5.00V ± 0.05V for 0-5Volt units** and **10.00V ± 0.05V for 0-10Volt units**.
9. Press the AUTO/MAN key twice to exit the MANUAL mode. To conclude, advance the MODE key to the next prompt or exit the CAL menu.

NOTE

Before calibration on an installed control, make sure all data and parameters are documented. See Setup and Operation Tables, Pages 18 and 20.

0-20 or 4-20mA Output Field Calibration Procedure

Equipment Required: • 470Ω, 1/2 watt 10% resistor. • 4 1/2 digit digital multimeter.

Setup and Calibration

1. Connect the AC line voltage L1, L2, and ground to the proper terminals.
2. Connect the multimeter in series with the 470Ω resistor to Terminals #17 (+) and #16 (-) for 0-20mA units and 4-20mA units on the 945 terminal strip. Use regular 20 - 24 gauge wire.
3. Apply power to the unit and allow warm up for 15 minutes. **After warm-up** put the unit in the CAL menu. See Page 32. Press MODE until **O1LO** is displayed.
4. Press the AUTO/MAN key twice to enter the MANUAL mode. The unit is calibrating when the MANUAL LED is ON. Make sure the unit is in the MANUAL mode **only** when you are in the correct parameters. See Figure 41.
5. At the **O1LO** parameter, the multimeter should read approximately **0mA for 0-20mA units**, and **4mA for 4-20mA units**. Allow at least 10 seconds to stabilize.
6. Use the UP/DOWN keys (reverse acting) to adjust the reading on the multimeter for **0mA ± 0.10mA on 0-20mA units**, and **3.85mA ± 0.10mA on 4-20mA units**. Press the MODE key.
7. At **O1HI**, the multimeter should read approx. 20mA. Allow 10 seconds to stabilize. The unit leaves the CAL mode if 1 minute passes between key activations.
8. Use the UP/DOWN keys (reverse acting) to adjust the reading on the multimeter for **20.15mA ± 0.10mA on 0-20mA units and 4-20mA units**.
9. Press the AUTO/MAN key twice to exit the MANUAL mode. To conclude, advance the MODE key to the next prompt or exit the CAL menu.

IMPORTANT:

When the MANUAL LED is ON the unit is automatically calibrating. Your sequence is VERY important. Always move to the next prompt before changing the calibration equipment.

0 - 5 Volt Retransmit Field Calibration Procedure

Equipment Required:

- 20KΩ, 1/4 watt, 10% resistor.
- 4 1/2 digit Digital Multimeter.

Setup and Calibration

1. Connect the AC line voltage L1, L2, and ground to the proper terminals of the 945.
2. Connect the multimeter across the 20KΩ resistor to Terminal #25 Positive and #24 Negative on the Series 945 terminal strip. Use regular 20 - 24 gauge wire.
3. Apply power to the unit and allow it to warm up for 15 minutes. **After warm-up** put the unit in the CAL menu. See Page 32. Press MODE until the **O4LO** prompt is displayed.
4. Press the AUTO/MAN key twice to enter the MANUAL mode. The unit is calibrating when the MANUAL LED is ON. Make sure the unit is in the MANUAL mode **only** when you are in the correct parameters. See Figure 41.
5. At the **O4LO** parameter, the multimeter should read approximately 0.00V. Allow at least 10 seconds to stabilize.
6. Use the UP/DOWN keys (reverse acting) to adjust the reading on the multimeter for 0.0 volts. Press the MODE key.
7. At **O4HI**, the multimeter should read approximately 5.00V. Allow at least 10 seconds to stabilize. The unit leaves the CAL mode if 1 minute passes between key activations.
8. Use the AUTO/MAN key twice to exit the MANUAL mode. To conclude the 0-5 volt output calibration, advance the MODE key to the next prompt or exit the CAL menu.

NOTE:

Before calibration on an installed control, make sure all data and parameters are documented. See Setup and Operation Tables, Pages 18 and 20.

4-20mA Retransmit Field Calibration Procedure

Equipment Required:

- 470Ω, 1/2 watt 10% resistor.
- 4 1/2 digit Digital Multimeter.

Setup and Calibration

1. Connect the AC line voltage L1, L2, and ground to the proper terminals of the 945.
2. Connect the multimeter in series with the 470Ω resistor to Terminal #25 Positive and #24 Negative on the Series 945 terminal strip. Use regular 20 - 24 gauge wire.
3. Apply power to the unit and allow it to warm up for 15 minutes. After **warm-up** put the unit in the CAL menu. See Page 32. Press MODE until the **O4LO** prompt is displayed.
4. Press the AUTO/MAN key twice to enter the MANUAL mode. The unit is calibrating when the MANUAL LED is ON. Make sure the unit is in the MANUAL mode **only** when you are in the correct parameters. See Figure 41.
5. At the **O4LO** parameter, the multimeter should read approximately 4mA. Allow at least 10 seconds to stabilize.
6. Use the UP/DOWN keys (reverse acting) to adjust the reading on the multimeter for 4.00mA. Press the MODE key.
7. At **O4HI**, the multimeter should read approximately 20mA. Allow at least 10 seconds to stabilize. The unit leaves the CAL mode if 1 minute passes between key activations.
8. Use the UP/DOWN keys (reverse acting) to adjust the reading on the multimeter for 20.00mA.
9. Press AUTO/MAN twice to exit the MANUAL mode. To conclude, advance the MODE key to the next prompt or exit the CAL menu.

IMPORTANT:

When the MANUAL LED is ON the unit is automatically calibrating. Your sequence is VERY important. Always move to the next prompt before changing the calibration equipment.

Alarm: A condition, generated by a controller, indicating that the process has exceeded or dropped below a predetermined alarm set point.

Alarm Silence: Disables the alarm relay output.

Anti-reset: Control feature that inhibits automatic reset action outside the proportional band. Also known as "reset windup inhibit."

Automatic prompts: Data entry points where a microprocessor-based control "prompts" or asks the operator/programmer for information input.

Auto-tune: Automatically tunes the Series 945 PID parameters to fit the characteristics of your particular thermal system.

Bumpless transfer: When transferring from auto to manual operation, the control output(s) will not change ("bumpless," smooth transition).

Closed loop: Control system that has a sensing device for process variable feedback.

Cold junction: Point of connection between thermocouple metals and the electronic instrument.

Cold junction compensation: Electronic means to compensate for the ambient temperature at the cold junction.

Cycle time: The time necessary to complete a full ON-through-OFF period in a time proportioning control system.

Data Logging: A convenient replacement for chart recorders. Information is sent from the 945 to a serial printer. Provides a handy reference to review process performance.

Dead band: A temperature band between heating and cooling functions.

Derivative: Anticipatory action that senses the rate of change of the process, and compensates to minimize overshoot and undershoot. Also "rate."

Deviation alarm: An alarm referenced at a fixed number of degrees, plus or minus, from set point.

Default parameters: The parameters permanently stored in memory to provide a data base.

DIN: Deutsche Industrial Norms, a widely-recognized German standard for engineering units.

Droop: Difference in temperature between set point and stabilized process temperature.

Duty cycle: Percentage of "load ON time" relative to total cycle time.

Form A: Single Pole Single Throw relay that only utilizes the N.O. and Common contacts. These contacts close when the relay coil is energized. The contacts open when power is removed from the control.

Form B: Single Pole Single Throw relay that only utilizes the N.C. and Common contacts. These contacts will open when the relay coil is energized. The contacts will close when power is removed from the control.

Form C: Single Pole Double Throw. Utilizes the N.O., N.C. and Common contacts. The user has the option of wiring for a Form A or Form B contact. Refer to Form A & Form B above for more information.

Hysteresis: In ON/OFF control, the temperature change necessary to change the output from full OFF to full ON again.

Hunting: Oscillation or fluctuation of process temperature about the set point.

Input: Process variable information being supplied to the instrument.

Integral: Control action that automatically eliminates offset, or “droop,” between set point and actual process temperature. Also "reset."

I**solation:** Electrical separation of sensor from high voltage circuitry. Allows for application of grounded or ungrounded sensing element.

JIS Japanese Industrial Standards. Also Japanese Industrial Standards Committee (JISC). Establishes standards on equipment and components.

Glossary, O-Z

ON/OFF control: Control of temperature about a set point by turning the output full ON below set point and full OFF above set point in the heat mode.

Open loop: System with no sensory feedback.

Output: Action in response to difference between set point and process variable.

Overshoot: Condition where temperature exceeds set point due to initial power up or process changes.

Parameter: A physical property whose value determines the response of an electronic control to given inputs.

PID control: Proportioning control with auto-reset and rate. Also known as 3 mode control.

Process variable: Thermal system element to be regulated, such as time, temperature, relative humidity, etc.

Proportional band: Span of temperature about the set point where time proportional control action takes place.

Rate: Anticipatory action that senses the rate of change of temperature and compensates to minimize overshoot. Also "derivative."

Reset: Control action that automatically eliminates offset, or "droop," between set point and actual process temperature. Also "integral."

RTD: Resistance Temperature Detector. Resistive sensing device displaying resistance versus temperature characteristics. Displays positive temperature coefficient.

Set point: Intended value of the process variable.

Switching sensitivity: In ON/OFF control, the temperature change necessary to change the output from full ON to full OFF.

Thermal system: A regulated environment consisting of a heat source, heat transfer medium, sensing device and a process variable control instrument.

Thermocouple: Temperature sensing device that is constructed of two dissimilar metals wherein a measurable, predictable voltage is generated corresponding to temperature.

Thermocouple break protection: Fail-safe operation that assures output shutdown upon an open thermocouple condition.

Time Proportioning Control: Action which varies the amount of ON time when "close" to the set point, i.e., in the proportional band. This variance is proportional to the difference between the set point and the actual process temperature. In other words, the amount of time the output relay is energized depends on the system temperature.

Warm Start: Start-up condition where all program information is remembered by the instrument's memory back-up protection.

Zero switching: Action that provides output switching only at the zero voltage crossing points of the AC line.

Index

A
Alarms, 25
  Jumper Selection, 24
  Parameter, 19
Wiring, 9
Appendix, 26
AUTO/MAN key, 12
Automatic Operation, 12, 23
Auto-tuning, 21

B
Bumpless transfer, 23, 27

C
Calibration, 32 - 38
Combination Differential Filter, 31
Common Mode Filter Wiring, 31

D
DC Output 1, 7
DC Output 2, 8
Default Parameters,
  Operation, 20, Table 3
  Setup, 17, Table 2
DIP Switch, How to Set, 13
Differential Mode Filter Wiring, 31
Dimensions, 4
Displays, 12
DOWN key, 12

E
Error Codes, 26

F, G
General Description, 3
Glossary, 40
Ground Loops, 30

H, I
Hysteresis, 15 & 16
Input Wiring, 6
Installation, 4

J
Jumper Selection, Alarms, 24

K
Keys, 12

L
Line Filtering Configurations, 31
Line Voltage, 5
LOC Parameter, 14
Lower Display, 12

M
Manual Operation, 12, 22, 23
Mechanical Relay, 6 Amp,
  Output 1 Wiring, 7
  Output 2 Wiring, 9
  Alarm Wiring, 9
MODE key, 12
Model Number, 43
Mounting, 4

N
Noise,
  How To Eliminate, 29
  Sources, 28
  Suppression Device & Ratings, 30
  Sensitivity, How To Decrease, 28

O
Opening the 945, 4
Operating Menu & Parameters, 18
Output 1 Wiring, 7
Output 2 Wiring, 8

P
Panel Cutout, 4
Power Wiring, 5
Process,
  Calibration, 36
  Input Wiring, 6
  Output 1, 7
  Output 2, 8
Proportional Band, 18

Q, R
Remote Set Point,
  Parameter, 15
  Input Wiring, 6
Retransmit, 3
  Calibration, 38
  Output Wiring, 10
Returns, 43
RTD,
  Calibration, 35
  Input Wiring, 6

S
Sensor
  Calibration, 35
  Guidelines, 5
  Wiring, 6
Setup
  Chart, 17
  Entering, 13
  Menu & Parameters, 14 - 16
Specifications, 42
SS Relay, with & without contact suppression,
  Output 1 Wiring, 7 & 8
  Output 2 Wiring, 8 & 9
Switched DC,
  Output 1 Wiring, 7
  Output 2 Wiring, 8
System Wiring Example, 11

T
Thermocouple
  Calibration, 35
  Input Wiring, 6
Tuning, 21

U, V, W
UP key, 12
Upper Display, 12
Warranty, 43
Wiring, 5

Specifications (1359)

Control Mode
- Single or dual set point, non-ramping.
- Single input, dual outputs, dual alarms.
- Optional retransmit of set point or process variable.
- Control outputs: User selectable as: Heat, Heat/Heat, Heat/Cool, Cool, Cool/Cool, Cool/Heat.
  - Outputs independent, or related via deadband for Heat/Cool.
  - ON/OFF: Determined by the HYSX parameter for Outputs 1 and 2.
  - Proportional band: 0 to 999°F/0 to 555°C/0 to 999 U or 0 to 999.9% of span.
    Reset: 0.00 to 9.99 repeats per minute.
    Integral: 0 and 00.1 to 99.9 minutes per repeat.
    Rate/Derivative: 0.00 to 9.99 minutes.
    Cycle time: 1 to 60 seconds.
  - Dead band: ±99°F, ±99 units or ±55°C (±9.9°F, ±9.9 units or ±5.5°C for rtd.1 and process units)

Operator Interface
- Membrane front panel.
- Dual, four digit 0.56" (14 mm) LED displays.
- MODE, AUTO/MANUAL, UP, and DOWN keys.

Input
- Automatic cold junction compensation for thermocouple.
- RTD input 2 or 3 wire, platinum, 100 ohm @ 0°C software selectable, JIS curve #3916 (0.003916 Ω/Ω/°C) or DIN curve #3850 (0.003850 Ω/Ω/°C).
- Sensor break protection de-energizes control outputs to protect system or selectable bumpless transfer to manual operation.
- Grounded or ungrounded sensors.
- °F,°C, or process variable units are user selectable.
- Operating ranges user selectable.

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
C t/c:	797	to	4200°F	or	425	to	2315 °C
PT 2 (Platinel 2)	32	to	2543°F	or	0	to	1395°C
R t/c:	32	to	2642°F	or	0	to	1450°C
S t/c:	32	to	2642°F	or	0	to	1450°C
B t/c:	1598	to	3092°F	or	870	to	1700°C
1° RTD:	-328	to	1112°F	or	-200	to	600°C
0.1° RTD:	-99.9	to	392.0°F	or	-99.9	to	200.0°C
0-5VDC:	-500	to	3500 units				
4-20mA:	-500	to	3500 units				

Primary Output (Heating or Cooling)
- Solid state relay, 0.5A @ 24VAC min., 264VAC max. opto-isolated, zero cross switching. Off state impedance is 20KΩ min. for 952A-XBXX-X000 units, and 31MΩ for 945A-XKXX-X000 units.
- Electromechanical relay, Form C, 6A @ 120/240VAC, 6A @ 28VDC, 1/8 hp. @ 120VAC, 125VA @ 120VAC. Off state impedance is 20KΩ minimum. Typical relay life of 100,000 cycles.
- Switched DC (Open collector), 500Ω min. load resis tance, 1KΩ load,9mA min., 22mA max., non-isolated.
- 4-20mA reverse or direct acting into a 600Ω maximum load impedance,non-isolated.
- 0-5 VDC reverse or direct into a 1KΩ minimum load impedance, non-isolated.

Secondary Output (Heat, Cool or None)
- Solid state relay, Form A, 0.5A @ 24VAC min., 264VAC maximum, opto-isolated, zero cross switching. Off state impedance is 20KΩ minimum for 945A-XBXX-X000 units, and 31MΩ for 945A-XKXX-X000 units.
- Electromechanical relay, Form A, 6A @ 120/240VAC, 6A @ 28VDC, 1/8 hp. @ 120VAC, 125VA @ 120VAC. Off state impedance is 20KΩ min. Typical relay life is 100,000 cycles.
- Switched DC (Open collector), 500Ω min. load resis- tance, 1KΩ load, 9mA min., 22mA max., non-isolated.

Alarms
- Electromechanical relay, Form A (N.O.) or B (N.C.), 6A @ 120/240VAC, 6A @ 28VDC, 1/8 hp. @ 120VAC, 125VA @ 120VAC. Off state impedance is 20KΩ min. Typical relay life is 100,000 cycles.
- Latching or non-latching.
- Process or deviation.
- Separate high and low values.
- Alarm silencing (inhibit) on power up for Alarm 1.

Retransmit Output
- 4-20mA into a 600Ω maximum load, non-isolated.
- 0-5VDC into a 10KΩ minimum load, non-isolated.
- Retransmit of process or set point. User selectable range.

Accuracy
- Calibration Accuracy & Sensor Conformity: ± 0.1% of span, ± 1LSD, 77°F ± 5°F(25°C ±3°C) ambient & rated line voltage ±10%.
- Accuracy Span: 1000°F or 540°C minimum.
- Temperature Stability: 0.1°F/°F (0.1°C/°C) change in ambient.
- Voltage Stability: ± 0.01% of span / % of rated line voltage.

Communications
- Serial data communications.
- RS-422A or RS-423A (RS-232C compatible) or EIA-485.
- ANSI X3.28 protocol, or XON/XOFF protocol.
- Isolated.
- Data logging.
- #6 compression type screw terminals.

Agency Approvals
- UL recognized, File #E43684, UL873.
- CSA recognized, File # LR30586.

Terminals
- #6 compression type screw terminals.

Power
- 120/240VAC +10%, -15%, 50/60Hz, ± 5%.
- 16VA maximum.
- Data retention upon power failure via nonvolatile memory.

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

Dimensions

• Height:	3.8 in	97 mm
• Width:	3.8 in	97 mm
• Overall depth:	7.0 in	178 mm
• Behind panel depth:	6.0 in	153 mm
• Weight:	2.5 lb max.	0.4 kg

(1360)

Model No.

9 4 5 A – _ _ _ _ – 0 0 0

1/4 DIN, single input, dual output
dual alarms, dual digital displays.

Inputs Type

1 = Type J, K, T, N, C, PT 2 thermocouple
2 = Type J, K, T, N, C, PT 2 thermocouple, RTD 1°, 4-20mA, 0-5VDC
3 = Type J, K, T, N, C, PT 2 thermocouple, RTD 0.1°, 4-20mA, 0-5VDC
4 = Type R, S, B thermocouple

#1 Output Type

B = Solid State Relay, Form A, 0.5A
C = Switched DC, (Open Collector), non-isolated
D = Mechanical Relay, Form C, 6A*
F = Process 4-20mA, non-isolated
H = Process 0-5VDC, non-isolated
K = Solid State Relay without contact suppression, Form A, 0.5A

#2 Output Type

A = None
B = Solid State Relay, Form A, 0.5A
C = Switched DC, (Open Collector), non-isolated
D = Mechanical Relay, Form A, 6A*
K = Solid State Relay without contact suppression, Form A, 0.5A

Alarms

0 = None
1 = Single, Mechanical Relay, 6A, Form A or B
2 = Dual, Mechanical Relay, 6A, Form A or B
3 = Single, Mechanical Relay, 6A/0-5VDC Retransmit
4 = Single, Mechanical Relay, 6A/4-20mA Retransmit
5 = No Alarm Output/0-5VDC Retransmit
6 = No Alarm Output/ 4-20mA Retransmit

Communications

A = None
B = Isolated RS-423/RS-422
D = Isolated EIA-485

*See warranty statement

Returns

1. Call Watlow Customer Service, 507/454-5300, for a Return Material Authorization (RMA) number before returning any item for repair. We need this information:
   - Ship to address
   - Bill to address
   - Contact name
   - Phone number
   - Ship via
   - Your P.O. number
   - Symptoms and/or special instructions
   - Name and phone number of person returning the material.

2. Prior approval and an RMA number, from the Customer Service Department, is needed when returning any unused product for credit. Make sure the RMA number is on the outside of the carton, and on all paperwork returned. Ship on a Freight Prepaid basis.

3. After we receive your return, we will examine it and determine the cause for your action.

4. In cases of manufacturing defect, we will enter a repair order, replacement order, or issue credit for material. A 20 percent restocking charge is applied for all returned stock controls and accessories.

5. If the unit is unrepairable, it will be returned to you with a letter of explanation. Repair costs will not exceed 50 percent of the original cost.

Warranty

The Watlow Series 945 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. This excludes mechanical relays which are warrantied for 100,000 cycles.

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. (1190)

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