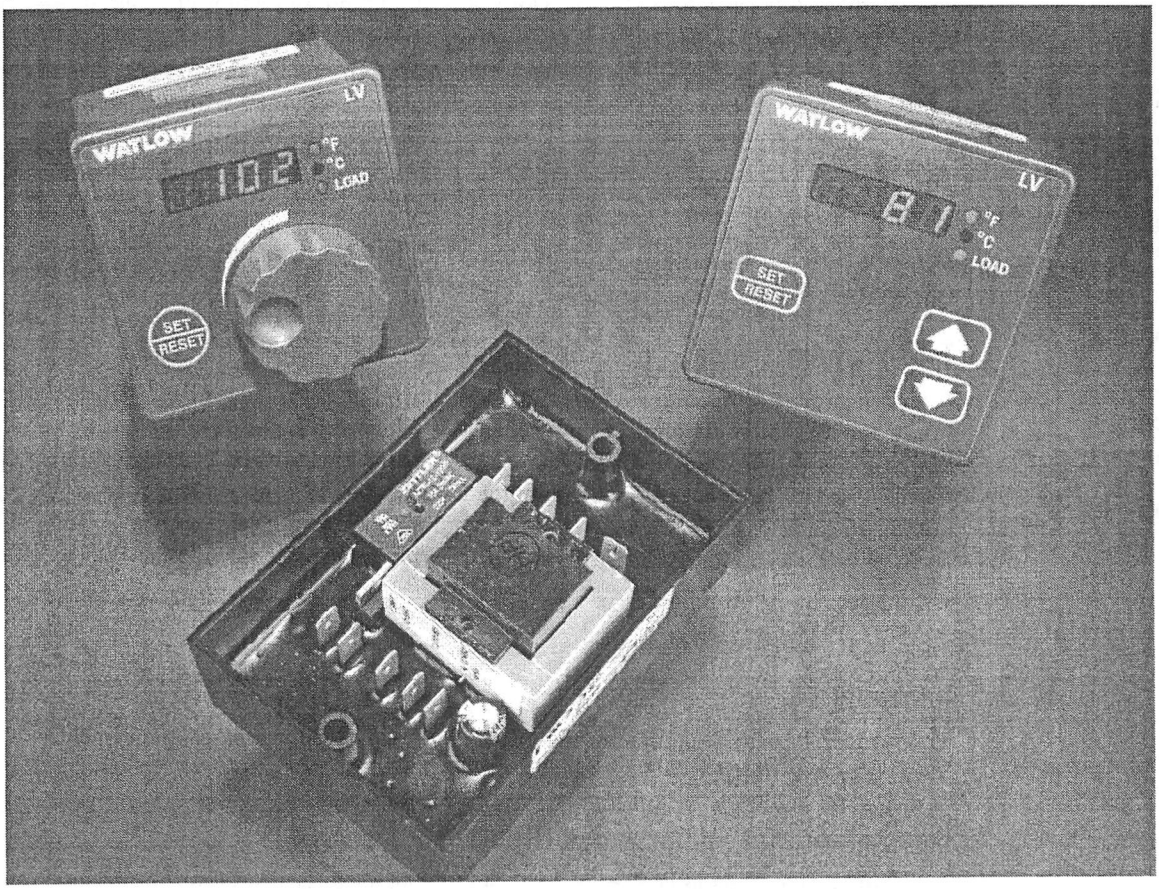
Series L

User's Manual



Series L - Temperature Limit

CE

TOTAL CUSTOMER SATISFACTION
3 Year Warranty

ISO 9001
Registered Company
Winona, Minnesota USA

WATLOW

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Made in the U.S.A.

$5.00

Safety Information

We use note, caution and warning symbols throughout this book to draw your attention to important operational and safety information.

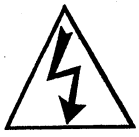
A "NOTE" marks a short message to alert you to an important detail.

A "CAUTION" safety alert appears with information that is important for protecting your equipment and performance. Be especially careful to read and follow all cautions that apply to your application.

CAUTION or WARNING

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

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



Electrical Shock Hazard

CAUTION or WARNING

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

Technical Assistance

If you encounter a problem with your Watlow controller, review your configuration information to verify that your selections are consistent with your application: inputs, outputs, alarms, limits, etc. If the problem persists, you can get technical assistance from your local Watlow representative (see back cover), by e-mailing your questions to wintechsupport@watlow.com or by dialing +1 (507) 494-5656 between 7 a.m. and 5 p.m., Central Standard Time (CST). Ask for for an Applications Engineer. Please have the following information available when calling:

- Complete model number
- System wiring information
- Series L Limit User's Manual

Warranty

These controllers are manufactured by ISO 9001-registered processes and are backed by a three-year warranty.

Return Material Authorization (RMA)

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
   - Method of return shipment
   - Your P.O. number
   - Detailed description of the problem
   - Any special instructions
   - Name and phone number of person returning the product.
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 try to verify the reason for the return.
4. In cases of manufacturing defect, we will enter a repair order, replacement order or issue credit for material returned.
5. To return products that are not defective, goods must be be in new condition, in the original boxes and they must be returned within 120 days of receipt. A 20 percent restocking charge is applied for all returned stock controls and accessories.
6. If the unit is unrepairable, it will be returned to you with a letter of explanation.
7. Watlow reserves the right to charge for no trouble found (NTF) returns.

1 Overview

Watlow's Series L family of temperature limit controllers* provide an economical limit controller solution for applications where thermal system protection is needed.

A limit controller is added to applications to prevent over or under temperature conditions. The limit provides safety assurances against instances where a thermal runaway condition occurs as a result of a failed sensor, controller or output device.

The Series L limit controller is recommended for any application where thermal system runaway could result in large product scrap costs, damage to system equipment, potential fire hazard or risk to personnel. All Series L limit controllers are Factory Mutual and CSA approved.

These controllers are available with or without an operator interface and can be ordered in square 1/8th DIN panel mount, din rail mount, open board or potted module design configurations. Push-on, quick connect spade terminal or removable screw clamp style terminal block ordering options provide the electrical connections.

The microprocessor design platform provides improvements in the performance, repeatability, and accuracy offered by Watlow's current line of basic control products.

The Series LV includes an operator interface to allow viewing and selection of the limit set point. A red four character, seven-segment LED displays the limit set point. The limit set point selection is made with a continuous turn, velocity-sensitive rotary encoder. Push-to-Set operation reduces accidental limit set point adjustments. Limit set point operating range temperature values are customer definable in the product configuration part number.

The Series LF offers fixed limit set points. These units are supplied without an operator interface. Limit set point temperature values are customer definable in the product configuration part number.

The features and performance of these products make them ideally suited for a wide range of industrial limit control applications in the food preparation, industrial machinery, packaging and plastic markets.

Watlow's Series L limit controllers include industry-leading service, support and a 3-year warranty.

*Also available, Series C, an on-off temperature controller version.

Features and Benefits

Four-Character LED Display

- Improves limit set point adjustment accuracy.

Fixed or Adjustable Limit Set Points

- Tamper proof operation.
- Control flexibility.

Set Point Adjustment Opetions

- Rotary encoder.
- Tactile increment and decrement keys.

Push to Set

- Reduce accidental limit set point adjustments.

Multiple Mounting Options

- Minimizes installation time.

High or Low Limit Operation

- Application flexibility.

Fahrenheit or Celsius Operation with Indication

- Application flexibility.

Sensor Break Protection

- Provides positive system shutdown.

Agency Approvals

- Meets requirements for agency certification.
- NEMA 4X/IP65 seal panel mount versions available.
- W.E.E.E.; CE; RoHS

Micro Processor Based Technology

- Accurate and repeatable protection.

Stock to Four-Day Delivery

2 Installation

Installing the Open Board Controller

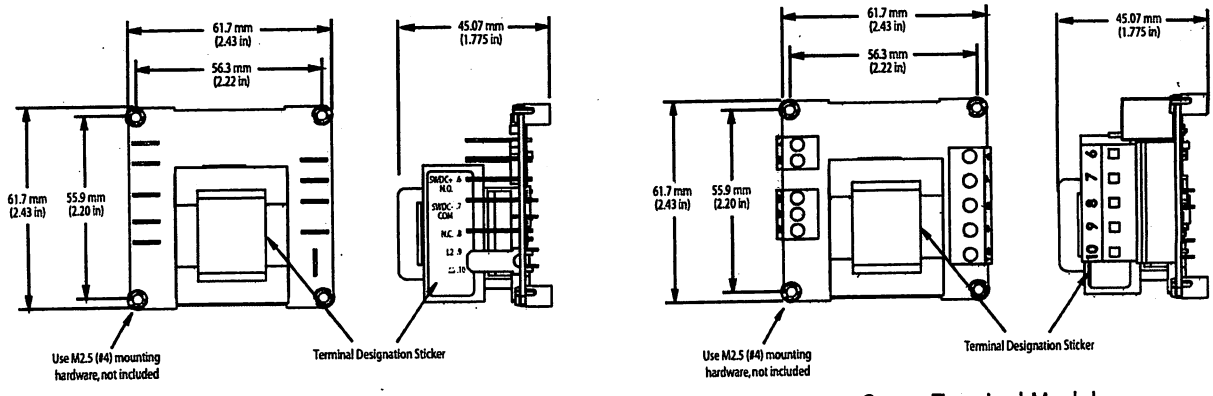


Figure 2a

1. Locate and drill four 3.2 mm (0.125 in) holes in the desired panel location. See Figure 2a for hole locations.
2. Mount the controller using four M2.5 (#4) screws.

Installing the Potted Controller

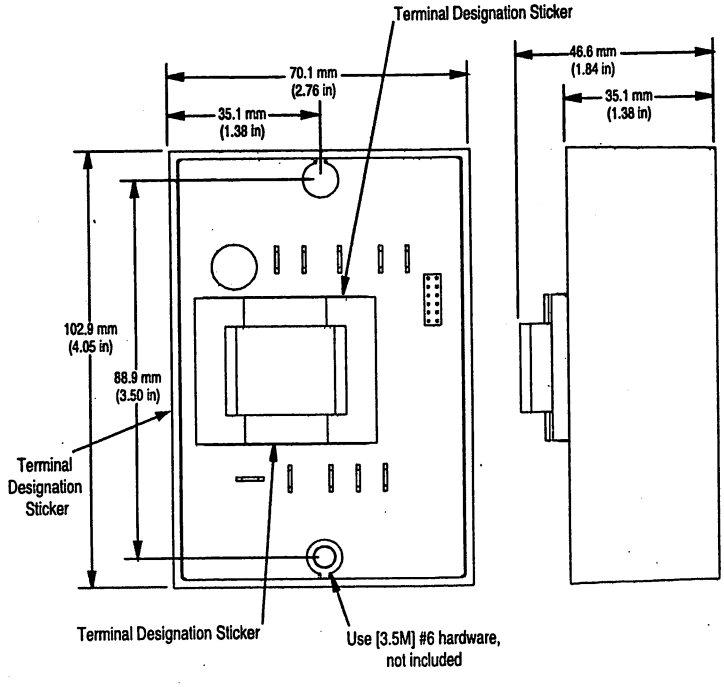


Figure 2b

1. Drill two 5 mm (0.187 in) diameter holes in the desired panel location. See Figure 2b for hole locations.
2. Mount the controller using two M3.5 (#6) screws.

Installing the DIN Rail Mount Controller

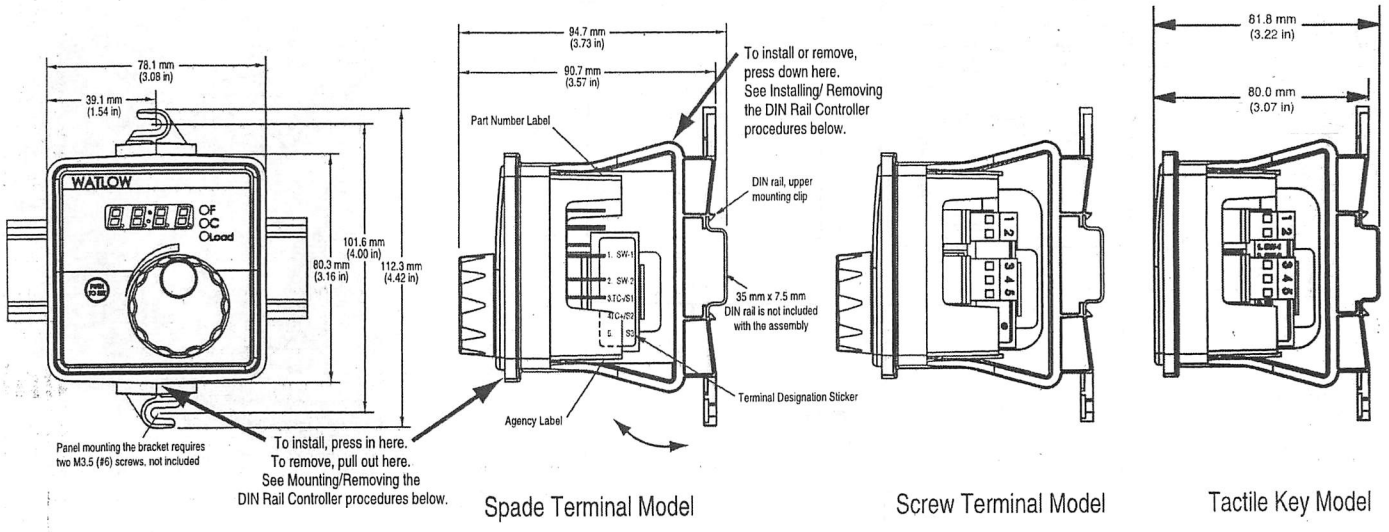


Figure 3a

Sub-Panel Mounting

1. Using the controller as a location template, mark both mounting holes.
2. Drill and tap two 2.7 mm (0.106 in) diameter holes in the desired panel location. See Figure 3a above for hole locations.
3. Mount the controller using two M3.5 (#6) screws.

DIN Rail Mounting

1. Place the DIN rail upper mounting clip on the top edge of the DIN rail. See Figure 3a. DIN rail spec, DIN 50022, 35 mm x 7.5 mm (1.38 in x 0.30 in).
2. Press down firmly on the top back edge of the DIN rail bracket and push in on the bottom, front edge of the bracket. The controller snaps securely onto the rail. See Figure 3a. If the controller does not snap on, check to see if the DIN rail is bent. Minimum clipping distance is 34.8 mm (1.37 in), the maximum is 35.3 mm (1.39 in).

Removing the DIN Rail Controller

1. Remove power from the system.
2. Remove all the wiring connections from the back of the controller.
3. While pressing down on the top, back edge of the DIN rail bracket, pull forward on the bottom, front edge of the DIN rail bracket. See Figure 3a.

Removing the Controller from the DIN Rail Bracket

1. Remove power from the system.
2. Remove all the wiring connections from the back of the controller.
3. Remove the DIN rail bracket from the DIN rail.
4. Insert a flat blade screwdriver between the DIN rail bracket and the case. Rotate the screwdriver to release the DIN rail bracket hooks from the ridges on the case, while firmly pushing the controller out the front of the DIN rail bracket. Alternate back and forth between the top and then the bottom. Be sure to support the controller as it comes out of the bracket. See Figure 3b.

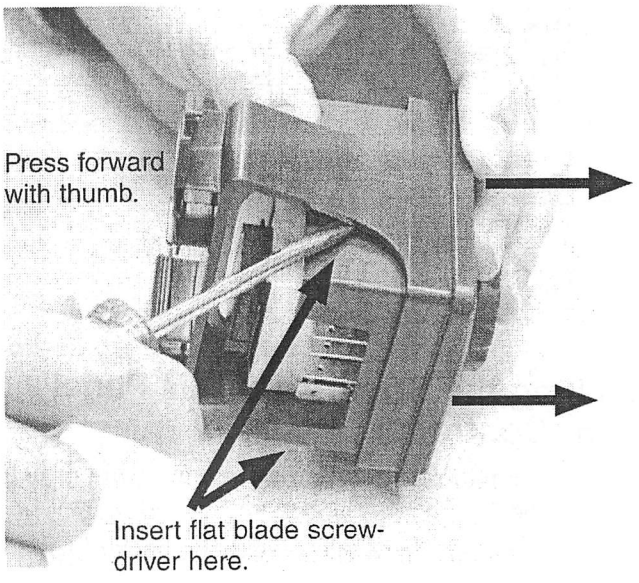


Figure 3b

⚠ **Caution: FM approval requires limit switches to be suitably enclosed to restrict casual user adjustment.**

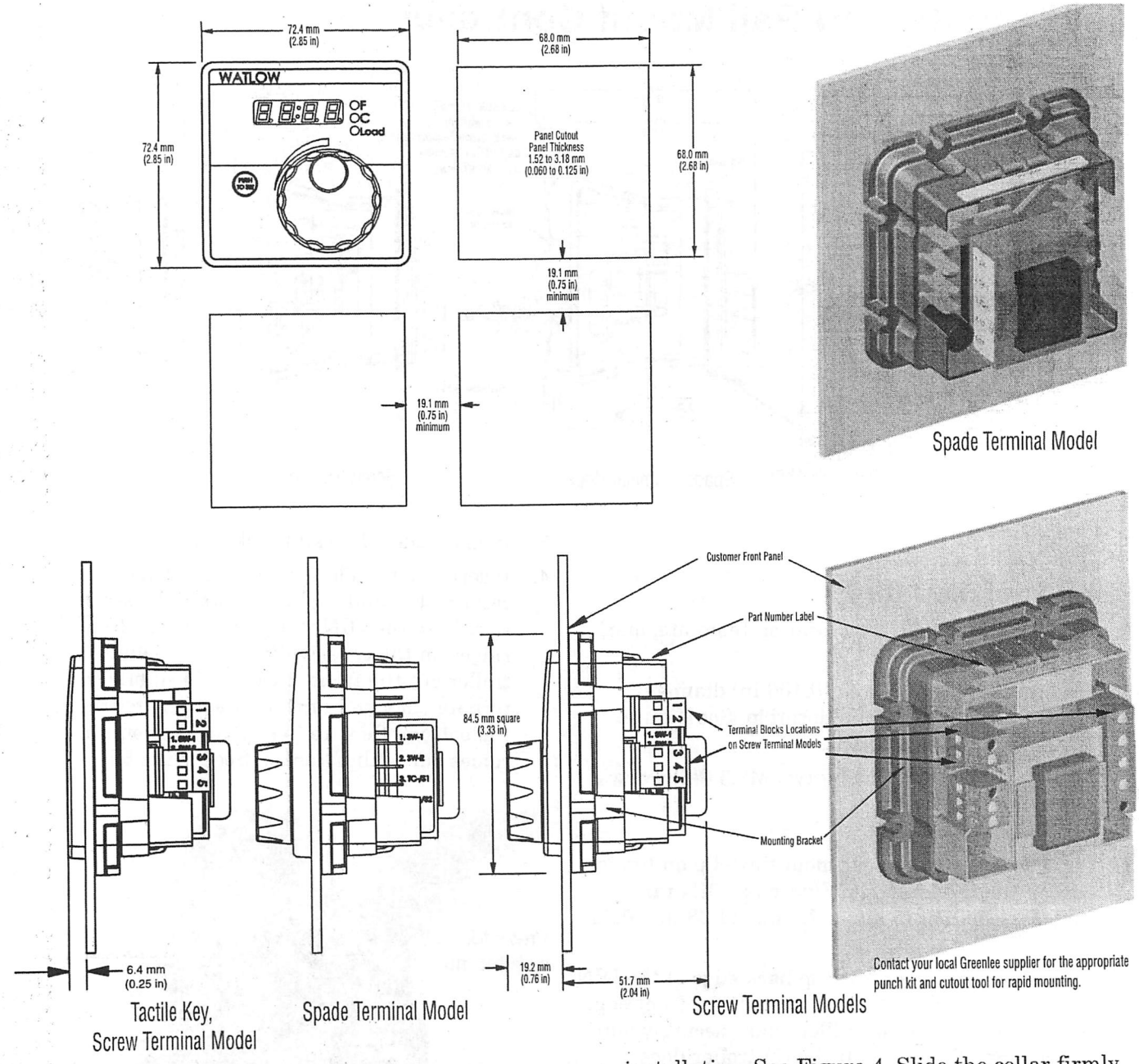


Figure 4

Installing the Square 1/8 DIN Panel Mount Controller

1. Make the panel cutout using the mounting dimensions above.
2. Remove mounting bracket from the back of the controller.
3. If your controller has a gasket, check to see that the gasket is not twisted, and is seated within the case bezel flush with the panel. Place the case in the cutout. Make sure the gasket is between the panel cutout and the case bezel.
4. While pressing the front of the case firmly against the panel, slide the mounting collar over the back of the control. The tabs on the collar must line up with the mounting ridges on the case for secure installation. See Figure 4. Slide the collar firmly against the back of the panel, getting it as tight as possible. To ensure a tight seal, use your thumb to lock the tabs into place while pressing the case from side to side. Don't be afraid to apply enough pressure to install the controller. The tabs on each side of the collar have teeth that latch into the ridges. Each tooth is staggered at a different height, so only one of the tabs on each side are ever locked into the ridges at a time. Confirm that the tabs on one side of the collar correspond with those on the opposite side. Make sure the two corresponding tabs are the only ones locked in the ridges at the same time. If the corresponding tabs are not supporting the case at the same time, you will not have a NEMA 4X seal.
5. Insert the control chassis into its case and press the bezel to seat it. Make sure the inside gasket

is also seated properly and not twisted. The hardware installation is complete. Proceed to the wiring section.

2. Insert the controller into the panel cutout.
3. While pressing the bezel firmly against the panel, slide the mounting bracket over the back of the controller. Be sure the levers on the mounting bracket line up with the teeth on the case.
4. Press the bracket up to the back of the panel. The controller should fit tightly in the panel cutout.

Removing the Panel Mount Square 1/8 DIN Controller

1. Remove power from the system.
2. Remove all the wiring connections from the back of the controller.
3. Slide a thin, wide tool (putty knife) under all three mounting tabs, top then bottom, while pushing forward on the back of the case. Be ready to support the controller as it slides out of the panel cutout.

⚠ Caution: FM approval requires limit switches to be suitably enclosed to restrict casual user adjustment.

3 Wiring

Warning:
Use National Electric (NEC) or other country-specific standard wiring and safety practices when wiring and connecting this controller to a power source and to electrical sensors or peripheral devices. Failure to do so may result in damage to equipment and property, and/or injury or loss of life.

Note:
Insulated terminals required for quick connect style terminals.

For quick connect terminals 1, 2, 6, 7, 8, 9, and 10, AMP P/N 3-520406-2 or equivalent recommended. Use Amp crimp tool P/N 58078-3, insert 90391-3.

For quick connect terminals 3, 4, and 5, AMP P/N 2-520405-2 or equivalent recommended. Amp crimp tool P/N 58078-3, insert 58079-3.

Caution:
FM approval requires limit switches to be suitably enclosed to restrict casual user adjustment.

The terminals on the back of the Series L limits are the same for all of the package styles. They are 6.3 mm (0.25 in) quick connect, push on style terminals or removable screw terminal block. The terminal style is an ordering option.

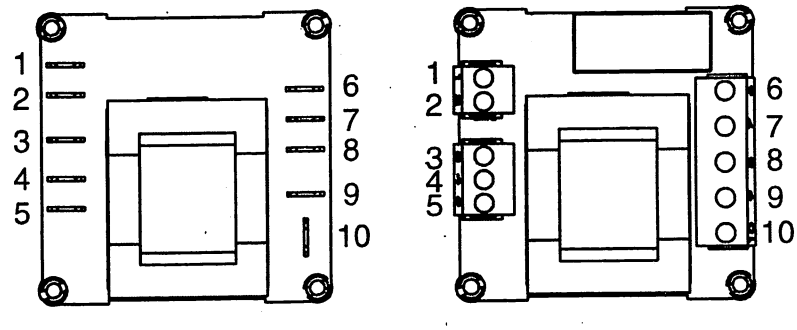
Check the part number to determine your hardware configuration. Refer to the wiring diagrams appropriate for your controller's configuration.

All outputs are referenced to a de-energized state.

Wiring Guidelines

1. Use the correct thermocouple type per the model number on the case sticker of the unit. See dimension drawings for sticker locations.
   - Use correct thermocouple polarity. Red is usually negative.
   - If you must extend thermocouple leads, use thermocouple extension wire to minimize errors.
   - Be sure you have good crimp connections on all wire connections.
   - Insulate the thermocouple mounting from the mounting surface to prevent heat migration input errors.
   - Thermocouple leads should be routed separately from any high voltage lines.
   - Long lead lengths create electrical resistance. When using a two-wire RTD, there will be an additional 2.6° C (4.7° F) error for every 1Ω of lead length resistance. That resistance when added to the resistance of the RTD element, can result in erroneous input to the temperature controller.
2. In electrically-noisy environments (heavy switching contactors, motors, solenoids, etc.), use shielded thermocouple lead wire with the shield connected at the sensor end only.
3. Use a separate thermocouple to maintain the limit function of this controller; do not parallel thermocouple input from the primary controller.
4. All wiring and fusing must conform to the National Electric Code (NEC) NFPA70 and any other locally applicable codes.
5. Fuse the independent load voltage on the L1 (hot) side and connect it to the common (C) side of the relay.

Note: The model number determines the connection terminal style. See below for terminal locations.



Warning:
Use National Electric (NEC) or other country-specific standard wiring and safety practices when wiring and connecting this controller to a power source and to electrical sensors or peripheral devices. Failure to do so may result in damage to equipment and property, and/or injury or loss of life.

WARNING:
If high voltage is applied to a low-voltage controller, irreversible damage will occur.

Note:
Insulated terminals required for quick connect style terminals.

For quick connect terminals 1, 2, 6, 7, 8, 9, and 10, AMP P/N 3-520406-2 or equivalent recommended. Use Amp crimp tool P/N 58078-3, insert 90391-3.

For quick connect terminals 3, 4, and 5, AMP P/N 2-520405-2 or equivalent recommended. Amp crimp tool P/N 58078-3, insert 58079-3.

Figure 7a — **AC Power Wiring**

- Nominal voltage options:
- 24V~ (ac)
- 120V~ (ac)
- 230 to 240V~ (ac)

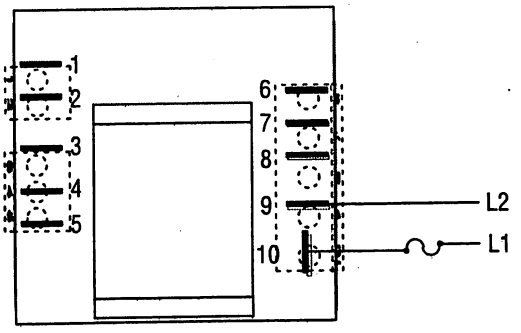


Figure 7b — Thermocouple Input

Thermocouples are polarity sensitive. The negative lead (usually red) must be connected to the negative thermocouple terminal.

- Input impedance: >10 MΩ

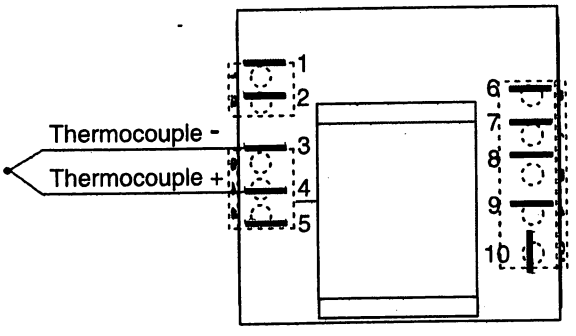
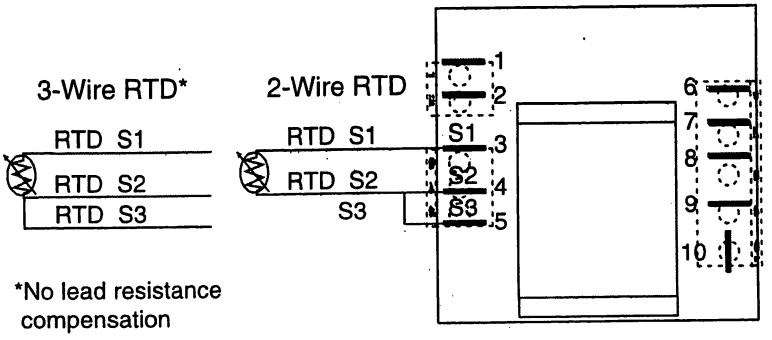


Figure 7c — RTD Input

(100 Ω Platinum DIN curve 0.00385 Ω/Ω/°C)

- Terminals S2 and S3 must be shorted for a two-wire RTD
- Nominal excitation current: 125 µA



*No lead resistance compensation

Warning:
Use National Electric (NEC) or other country-specific standard wiring and safety practices when wiring and connecting this controller to a power source and to electrical sensors or peripheral devices. Failure to do so may result in damage to equipment and property, and/or injury or loss of life.

Note:
Use of an external reset switch may affect FM approval. Only the use of a momentary N.O. switch is valid for approval.

Note:
Insulated terminals required for quick connect style terminals.

For quick connect terminals 1, 2, 6, 7, 8, 9, and 10, AMP P/N 3-520406-2 or equivalent recommended. Use Amp crimp tool P/N 58078-3, insert 90391-3.

For quick connect terminals 3, 4, and 5, AMP P/N 2-520405-2 or equivalent recommended. Amp crimp tool P/N 58078-3, insert 58079-3.

Quencharc Note:
Switching pilot duty loads (relay coils, solenoids, etc.) with the mechanical relay output option requires use of an R.C. suppressor.

Watlow carries the R.C. suppressor Quencharc brand name, which is a trademark of ITW Paktron. Watlow Part No. 0804-0147-0000.

Figure 8a — External Reset Switch

- Momentary normally open (N.O.), dry contact closure

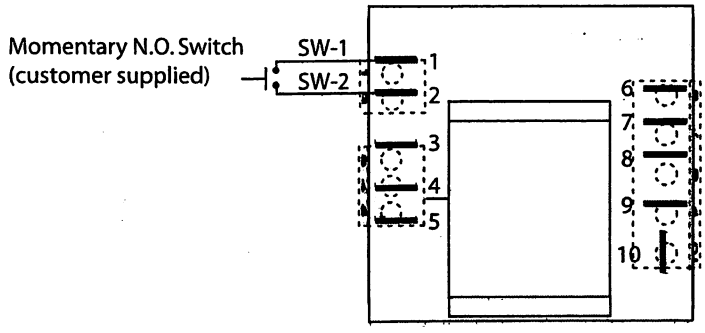
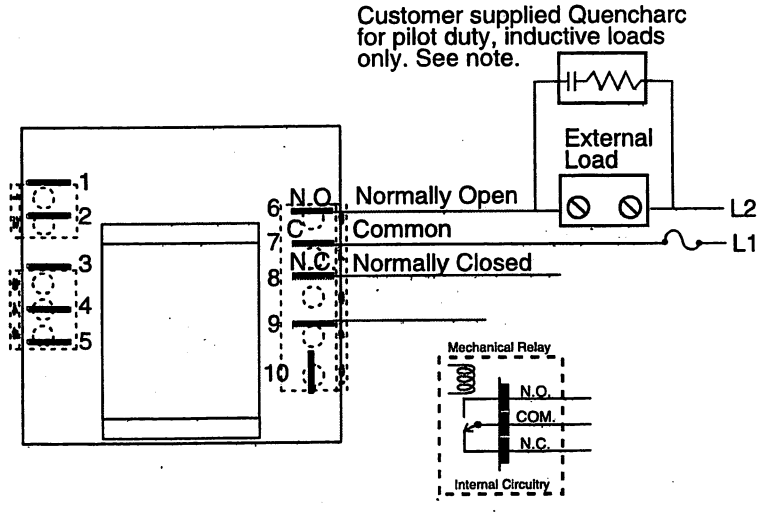
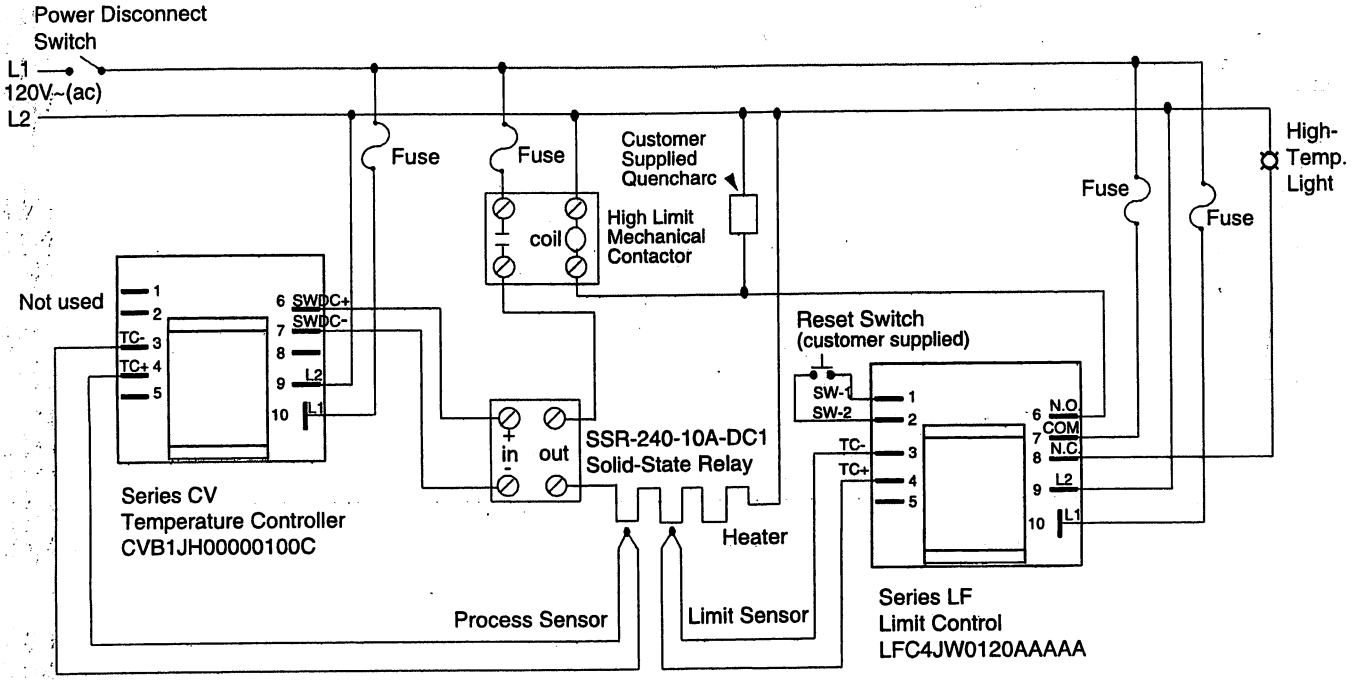


Figure 8b — Mechanical Relay Output

- Form C contacts
- 8 A, resistive
- 250 VA pilot duty, 120/240V~ (ac), inductive
- 240V~ (ac) maximum
- 30V⎓ (dc) maximum
- See Quencharc note
- For use with ac or dc
- Minimum load current 100 mA
- Output does not supply power



System Wiring Examples



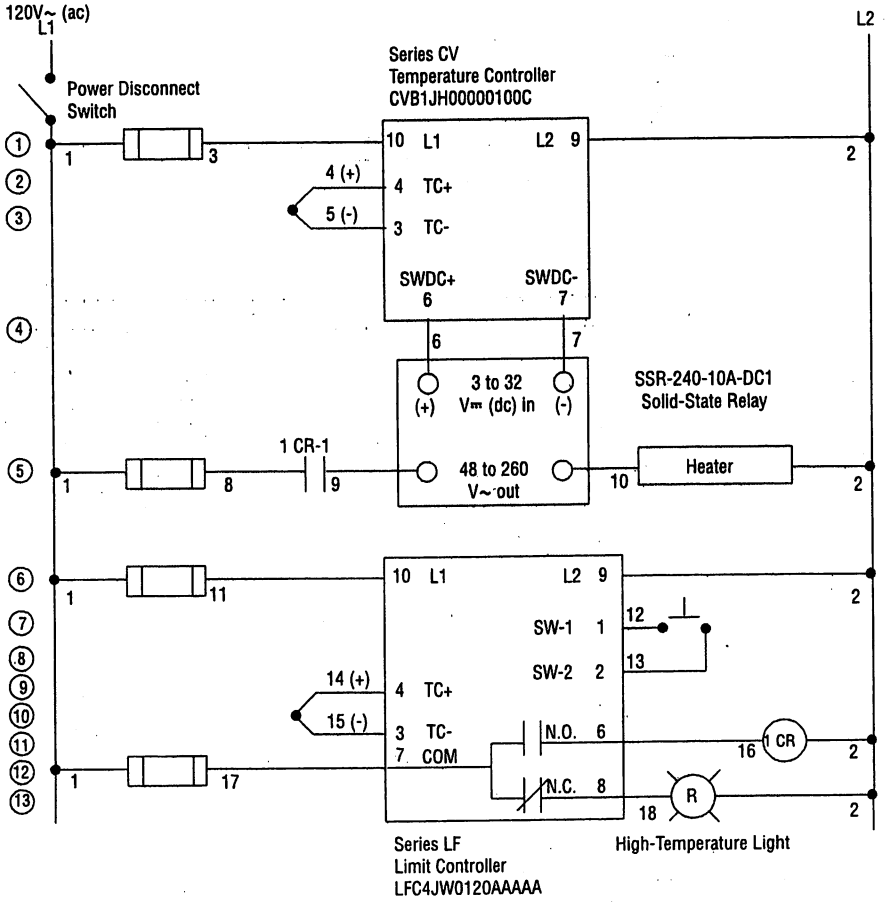


Figure 9 — System Wiring Examples

4 User Interface

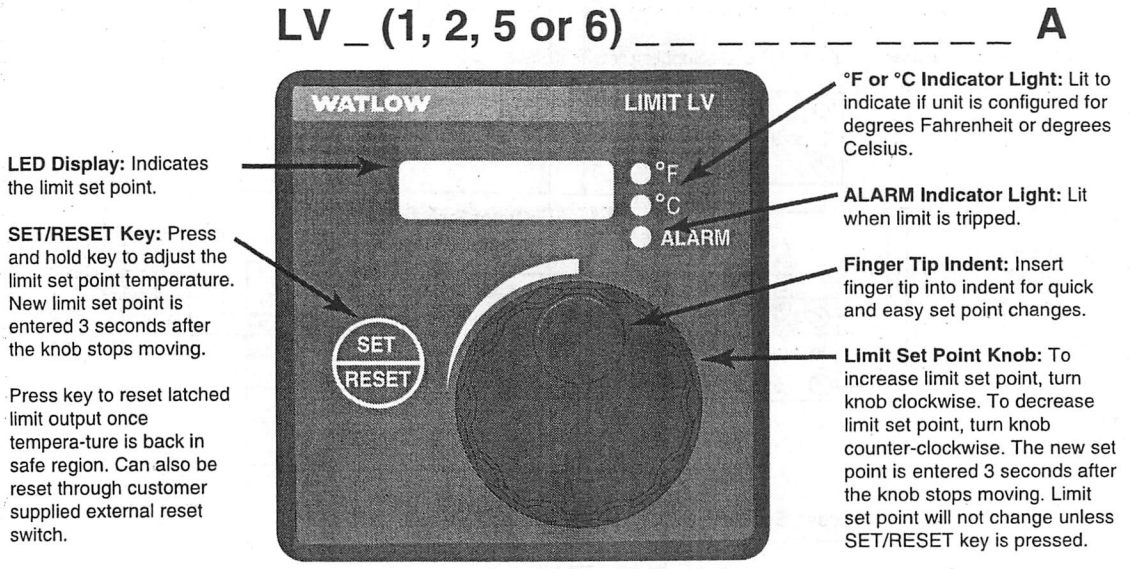
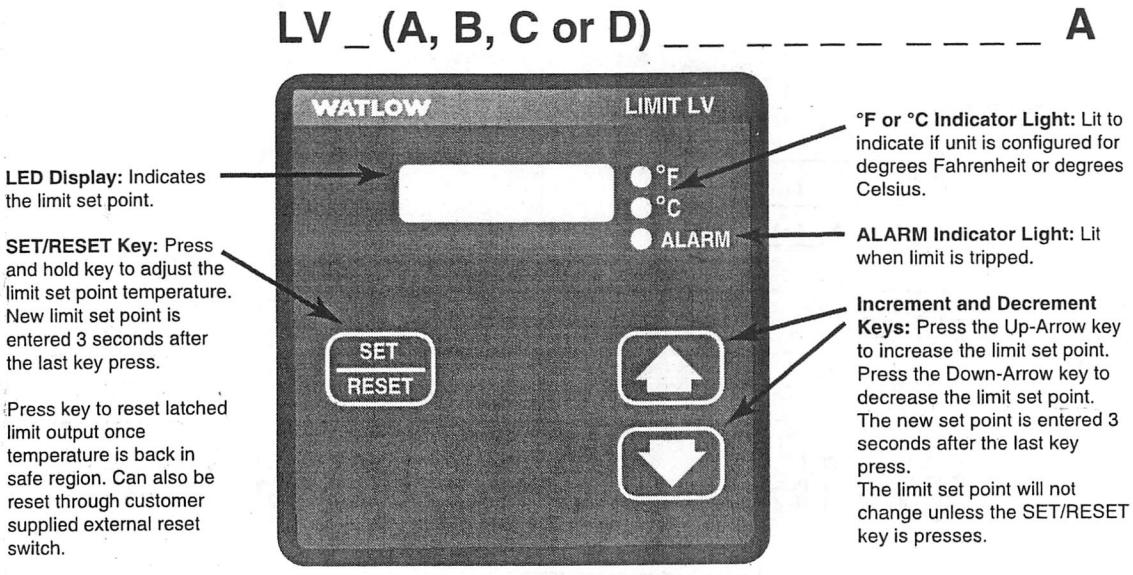


Figure 10 — Variable Limit Set Point, Standard Interface



⚠ Caution: FM approval requires limit switches to be suitably enclosed to restrict casual user adjustment.

To adjust the Calibration Offset on models with tactile keys, first hold down both the Increment and Decrement keys for five seconds. The display will first show CAL for five seconds, then it will display the Calibration Offset value. Adjust the value with the Increment and Decrement keys (range: -30 to 30°). The new value will take effect three seconds after the last key stroke. The display will blink, then return to the primary display after five seconds.

To change the temperature units on models with tactile keys, first hold down both the Increment and Decrement keys for ten seconds. The display will show F C for two seconds. Adjust the units with the Increment and Decrement keys. The new value will take effect three seconds after the last key stroke. The display will blink, then return to the primary display after five seconds. The set point value, process value and offset will automatically adjust to the new temperature scale.

Troubleshooting

Indication	Probable Cause(s)	Corrective Action
On indicating limits, the display is not illuminated.	• Power supply switch off. • Fuse blown. • Breaker tripped. • Safety interlock door switch activated. • Wiring incorrect or open. • Power supply voltage incorrect. • Defective limit.	• Turn switch on. • Replace fuse (check cause of failure). • Reset breaker (check cause of failure). • Close door. • Check wiring. • Verify input power • Repair or replace limit.
Troubleshooting thermocouple inputs		
Temperature reading is incorrect, showing a sensor error, Er. In, or ALARM LED is switching at the wrong temperature.	• Setting for degree C or F is incorrect.	• Check the model part number for Degree C or F. If the model has Increment/Decrement keys, then the C/F setting is adjustable.
	• Sensor or limit may be bad. Sensor connections may be bad.	• Place a jumper wire across the thermocouple input terminals. The display should indicate ambient temperature. If it does, the limit is OK. - For high limit: Start with limit set point above ambient temperature, ALARM LED should be off. Decrease limit set point until ALARM LED goes on. It should be approximately ambient temperature. - For low limit: Start with limit set point below ambient temperature, ALARM LED should be off. Increase limit set point until ALARM LED goes on. It should be approximately ambient temperature.
	• Ambient temperature in the control cabinet is over 70°C.	• Measure temperature in cabinet to ensure it is below 70C. Vent cabinet or add fans if necessary.
	• Ground loop problem. Can occur when using a switched DC output and a grounded thermocouple.	• Remove power from the system. Use an ohm meter to measure resistance between output DC- and the thermocouple sheath. If there is continuity, replace sensor with an ungrounded thermocouple.
Temperature seems to be decreasing, but actual process is increasing.	• Thermocouple polarity is reversed. In the US, red wire insulation denotes the negative wire.	• Check thermocouple connections. All connections, including extension wire must maintain the correct polarity. Correct polarity problems.
Temperature seems to be reading low and not increasing while actual process temperature is increasing.	• Sensor is bad. Thermocouple is shorted.	• Check thermocouple connections. Check thermocouple wire insulation to make sure it is not damaged, causing the wires to short (making a new junction).
Temperature seems to be offset from actual process temperature, or the ALARM LED switches on at the wrong temperature. The offset changes with changes in process temperature.	• Copper wire was used instead of thermocouple extension wire. Connectors of metals different than thermocouple metal were used to splice or make connections.	• Check thermocouple connections. Check to make sure that only thermocouple extension wire of the correct type was used to extend thermocouple leads. Replace if necessary.

Indication	Probable Cause(s)	Corrective Action
Troubleshooting RTD inputs		
Temperature reading is incorrect, showing a sensor error, Er. In, or ALARM LED is switching at the wrong temperature.	• Setting for degree C or F is incorrect.	Check model part number for Degree C or F. If the model has Increment/Decrement keys, then the C/F setting is adjustable.
	• Sensor or limit may be bad. Sensor connections may be bad.	• Place a 110 ohm resistor across the sensor input terminals. - For high limit: Start with limit set point above ambient temperature, ALARM LED should be off. Decrease limit set point *until* ALARM LED goes on. It should be approximately ambient temperature. If it does, the limit is OK. Sensor or connections may be bad. - For low limit: Start with limit set point below ambient temperature, ALARM LED should be off. Increase limit set point until ALARM LED goes on. It should be approximately ambient temperature. If it does, the limit is OK. Sensor or connections may be bad.
	• Ambient temperature in the control cabinet is over 70°C (158°F).	• Measure temperature in cabinet to ensure it is below 70°C (158°F). Vent cabinet or add fans if necessary.
	• Sensor connections may be bad. Excessive lead wire resistance.	• Check sensor connections. Measure lead wire resistance. There will be a 2.6C (4.7°F) error for every ohm of lead wire resistance.
Troubleshooting limit outputs		
ALARM is not tripped when it should be. ALARM LED is not on (relay is energized in safe condition, N.O. contact is closed and N.C. contact is open).	• Temperature appears to be incorrect. See input troubleshooting.	• See input troubleshooting.
	• Limit set point is not set correctly.	• Verify limit set point setting.
ALARM is tripped when it should not be. ALARM LED is on (relay is de-energized in limit condition, N.O. contact is open and N.C. contact is closed).	• Limit output is tripped (latched).	• Press RESET key to reset limit.
	• Output wiring is incorrect.	• Verify wiring. Relay outputs act as a switch, they do not source power.
	• Temperature appears to be incorrect, see input troubleshooting.	• See input troubleshooting.
	• Limit set point is not set correctly.	• Verify limit set point setting.
	• Limit output is defective.	• Repair or replace limit.
Limit output signal is on when it should not be on. Load LED is on.	• Temperature reading is incorrect on display of indicating controls or limit, see input troubleshooting.	• See input troubleshooting.
	• Set point is not set correctly.	• Verify limit set point setting.
Limit load is on when it should be off. ALARM LED is off.	• Power switching device (mechanical relay, contactor, etc.) is shorted. Limit output shorted.	• Remove wires from output of limit to input of power switching device. If load is still on, replace power switching device. If load turns off, replace limit or sensor. See input troubleshooting.
	• Output wiring is incorrect.	• Verify wiring.

Specifications

Controller
- Microprocessor based, limit controller.
- Nominal switching hysteresis, typically 1.7°C (3°F)
- High or low limit, factory selectable.
- Latching output requires manual reset upon over or under temperature condition.
- Manual or automatic reset on power loss, factory selectable.
- Internal front panel or external customer supplied momentary reset switch.
- Input filter time: 1 second.

Operator Interface (model dependent)
- Four digit , 7 segment LED displays, .28" high.
- °F or °C indicator LED.
- ALARM indicator LED.
- Continuous turn, velocity sensitive rotary encoder for limit set point adjustment.
- Front panel SET/RESET key on variable set point models.
- No operator interface on fixed set point models.

Standard Conditions For Specifications
- Rated line voltage, 50 to 60Hz, 0 to 90% RH non-condensing, 15-minute warm-up.

Calibration ambient range: 25°C (77°F) ±3°C

Sensor Input

Thermocouple
- Grounded or ungrounded.
- Type E, J, K, T thermocouple types.
- >10 MΩ input impedance.
- 250 nV input referenced error per 1 Ω source resistance.

RTD
- 2-wire platinum, 100 Ω.
- DIN curve (.00385 curve).
- 125 µA nominal RTD excitation current.

Input Accuracy Span Range

Thermocouple Input

Type E	-200 to	800°C	or	-328 to	1,470°F
Type J:	0 to	750°C	or	32 to	1,382°F
Type K:	-200 to	1,250°C	or	-328 to	2,282°F
Type T:	-200 to	350°C	or	-328 to	662°F
RTD (DIN):	-200 to	800°C	or	-328 to	1,472°F

- Calibration accuracy: ±1% of input accuracy span, ±1° at standard conditions and actual calibration ambient.
  Exception: Type T, ±2.4% of input accuracy span for -200 to 0°C (-328 to 32°F)
- Temperature stability: ±0.3 degree per degree change in ambient.

RTD Input
- Calibration accuracy: ±1% of input accuracy span ±1° at standard conditions and actual calibration ambient.
- Temperature stability: ±0.2 degree per degree change in ambient

Allowable Operating Ranges

Type E	-200 to	800°C	or	-328 to	1,470°F
Type J:	-210 to	1,038°C	or	-346 to	1,900°F
Type K:	-270 to	1,370°C	or	-454 to	2,500°F
Type T:	-270 to	400°C	or	-454 to	750°F
RTD (DIN):	-200 to	800°C	or	-328 to	1,472°F

External Reset Switch
- Momentary, dry contact closure. See wiring section.

Output Types

Electromechanical Relay, Form C
- Minimum load current: 100 mA.
- 8 A @ 240V~ (ac) or 30V⎓ (dc) maximum, resistive.
- 250 VA pilot duty, 120/240V~ (ac) maximum, inductive.
- Use RC suppression for inductive loads.
- Electrical life 100,000 cycles at rated current.

Agency Approvals

Series LF (potted version only)
- UL 991 recognized temperature limit for food service industry.
- RoHS Directive (2002-95-EC)

Series LV and Series LF (including potted version)
- UL 873 recognized temperature regulator. File #E43684.
- UL 197 reviewed for use in food service appliances.
- ANSI Z21.23 Gas appliance thermostat approval.
- CSA C22.2#24 approved temperature control. File #30586.
- FM Class 3545 temperature limit switches. File #3017239.
- NEMA 4X/IP65 on panel-mount versions with tactile keys for set point adjustment.
- W.E.E.E.; CE - see Declaration of Conformity.
- RoHS Directive (2002-95-EC)

Terminals
- 6.4 mm (0.25 in) quick connect, push-on terminals. See order options. Refer to Wiring section for crimp-on terminal recommendations.
- Removable screw clamp style terminal blocks. See order options.
- Wire gauge 0.1 to 4 mm^2 (30 to 12 AWG). Strip length, 8 mm (0.30 in).
- Torque: 0.8 Nm (7 in-lb) maximum.

Power

- 24V~ (ac) +10%; -15%; 50/60 Hz, ±5%
- 120V~ (ac) +10%; -15%; 50/60 Hz, ±5%
- 208 to 240V~ (ac) +/-10%, Series LF and CF only
- 230 to 240V~ (ac) +10%; -15%; 50/60 Hz, ±5%
- 10VA maximum power consumption.
- Data retention upon power failure via nonvolatile memory.

Operating Environment

- 0 to 70°C (32 to 158°F)
- 0 to 90% RH, non-condensing.
- Storage temperature: -40 to 85°C (-40 to 185°F)

Dimensions

- DIN Rail model can be DIN rail or chassis mount DIN rail spec, DIN 50022, 35 mm x 7.5 mm (1.38 in x 0.30 in)

Style	Width	Height	Depth
Open board	61.7 mm (2.43 in)	61.7 mm (2.43 in)	45.1 mm (1.78 in)
Potted	70.1 mm (2.76 in)	102.9 mm (4.05 in)	46.6 mm (1.84 in)
DIN Rail	78.1 mm (3.08 in)	112.3 mm (4.42 in)	90.7 mm* (3.57 in)
Square 1/8DIN Panel	72.4 mm (2.85 in)	72.4 mm (2.85 in)	Behind panel 51.7 mm (2.04 in)

*Depth including DIN rail, 94.7 mm (3.73 in)

Note: These specifications are subject to change without prior notice.

Glossary

automatic power reset — A feature in latching limit controllers that does not recognize power outage as a limit condition. When power is restored, the output is re-energized automatically, as long as the temperature is within limits.

latched output — Limit control output latches in de-energized condition when over or under temperature condition occurs and cannot be reset unless temperature drops below set point.

limit or limit controller — A highly reliable, discrete safety device (redundant to the primary controller) that monitors and limits the temperature of the process or a point in the process. When temperature exceeds or falls below the limit set point, the limit controller interrupts power through the load circuit. A limit controller can protect equipment and people when it is correctly installed with its own power supply, power lines, switch and sensor.

manual power reset — A feature in latching limit controllers that does recognize power outage as a limit condition. When power is restored, the output is not re-energized automatically, even if the process is within limits. An operator must use the reset key or switch to manually re-energize the output on power up.

manual reset — A feature on a limit controller that requires human intervention to return the limit to normal operation after a limit condition has occurred.

safety limit — An automatic limit intended for use in applications where an over-temperature fault may cause a fire.

Ordering Information and Model Numbers

Limit Control no user interface L F _ _ _ _ _ _ _ _ A A A A _

Set Point Type

F	Fixed Limit Set Point

Line Voltage

C	120V~ (ac)
E	230 to 240V~ (ac)
G	24V~ (ac)

Controller Package

1	Panel Mount, Square 1/8 DIN, Spade Terminals
2	DIN Rail Mount, Spade Terminals
3	Open Board, not potted, Spade Terminals
4	Potted Case, Spade Terminals
5	Panel Mount, Square 1/8 DIN, Screw Terminals
6	DIN Rail Mount, Screw Terminals
7	Open Board, not potted, Screw Terminals

Sensor and Sensor Operating Range

H	Type J -346 to 1,900°F
J	Type J -210 to 1,038°C
K	Type K -454 to 2,500°F
L	Type K -270 to 1,370°C
M	Type T -454 to 750°F
N	Type T -270 to 400°C
P	100 Ω RTD -328 to 1,472°F
R	100 Ω RTD -200 to 800°C
S	Type E -328 to 1,470°F
T	Type E -200 to 800°C

Limit Type

U	High Limit, External manual reset on power up, external manual reset on over temperature
W	High Limit, Auto reset on power up, external manual reset on over temperature
Y	Low Limit, External manual reset on power up, external manual reset on under temperature
Z	Low Limit, Auto reset on power up, external manual reset on under temperature

Fixed Limit Set Point Value *

XXXX	Limit Set Point Value**

Overlay/Custom Option

A	Standard

*Note: Limit set point must fall within the sensor operating range.

**Note: A (-) is used in the left digit of the operating range to indicate negative values.

Ordering Information and Model Numbers

Limit Control, LED display, front panel reset switch L V _ _ _ _ _ _ _ _ _ _ _ _ _

Set Point Type

V	Variable Limit Set Point

Line Voltage

C	120V~ (ac)
E	230 to 240V~ (ac)
G	24V~ (ac)

Controller Package

1	Panel Mount, Square 1/8 DIN, Rotary Knob, Spade Terminals
2	DIN Rail Mount, Rotary Knob, Spade Terminals
5	Panel Mount, Square 1/8 DIN, Rotary Knob, Screw Terminals
6	DIN Rail Mount, Rotary Knob, Screw Terminals
A	NEMA 4X/IP65, Panel Mount, Tactile Keys, Spade Terms
B	DIN-rail Mount, Tactile Keys, Spade Terminals
C	NEMA 4X/IP65, Panel Mount, Tactile Keys, Screw Terms
D	DIN-rail mount, Tactile Keys, Screw Terminals

Sensor and Sensor Operating Range

H	Type J -346 to 1,900°F
J	Type J -210 to 1,038°C
K	Type K -454 to 2,500°F
L	Type K -270 to 1,370°C
M	Type T -454 to 750°F
N	Type T -270 to 400°C
P	100 Ω RTD -328 to 1,472°F
R	100 Ω RTD -200 to 800°C
S	Type E -328 to 1,470°F
T	Type E -200 to 800°C

Limit Type

U	High Limit, Manual Reset on power up, manual reset on over temperature
W	High Limit, Auto Reset on power up, manual reset on over temperature
Y	Low Limit, Manual Reset on power up, manual reset on under temperature
Z	Low Limit, Auto Reset on power up, manual reset on under temperature

Low Limit Set Point Range Limit*

XXXX	Low Limit Set Point Operating Range Value**

High Limit Set Point Range Limit*

XXXX	High Limit Set Point Operating Range Value

Overlay/Custom Option

A	Standard

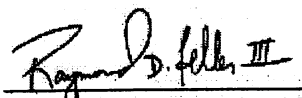
*Note: Set point ranges must fall within the sensor operating range.

**Note: A (-) is used in the left digit of the operating range to indicate negative values.

Declaration of Conformity

Raymond D. Feller III
Name of Authorized Representative

General Manager
Title of Authorized Representative



Signature of Authorized Representative

Winona, Minnesota, USA
Place of Issue

February 2008
Date of Issue

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Your Authorized Watlow Distributor

TOTAL CUSTOMER SATISFACTION
3 Year Warranty

Declaration of Conformity

Series L

CE

Watlow Winona, Inc.
1241 Bundy Blvd.
Winona, MN 55987 USA

Declares that the following product:

Designation:	Series L
Model Numbers:	LF – (C, E or G)(1, 2, 3, 4, 5, 6 or 7)(any letter)(U, W, Y or Z) – (any four numbers or – and three numbers) – (AAAA) – may be followed by additional numbers or letters LV – (C, E or G)(1, 2, 5 or 6)(any letter)(U, W, Y or Z) – (any four numbers or – and three numbers) – (any four numbers) – may be followed by additional numbers or letters
Classification:	Temperature Regulator, Installation Category II, Pollution degree 2
Rated Voltage:	24 V, 120 V, 230/240 V~ (ac)
Rated Frequency:	50/60 Hz
Rated Power Consumption:	10 VA maximum

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

2004/108/EC Electromagnetic Compatibility Directive

EN 61326:1997 + A1:1998, A2:2001	**Electrical equipment for measurement, control and laboratory use – EMC requirements (Industrial Immunity Class B Emissions).**
EN 61000-4-2:1996 + A1, 1998	Electrostatic Discharge Immunity
EN 61000-4-3:1997	Radiated Field Immunity
EN 61000-4-4:1995	Electrical Fast-Transient / Burst Immunity
EN 61000-4-5:1995 + A1, 1996	Surge Immunity
EN 61000-4-6:1996	Conducted Immunity
EN 61000-4-11:1994	Voltage Dips, Short Interrupts and Variations - Immunity
EN 61000-3-2: ED.2. 2000	Harmonic Current Emissions – Class A equipment.
EN 61000-3-3:1995 + A1:1998	Voltage Fluctuations and Flicker

2006/95/EC Low-Voltage Directive

EN 60730-1:2000 +A11:2002 and EN 60730-2-9:2002 LXX4 units	**Automatic electric controls for household and similar use: Particular requirements for temperature sensing controls.**
EN 61010-1:2001 All other units	**Safety Requirements of electrical equipment for measurement, control and laboratory use. Part 1: General requirements**

Meets the European Union Limits for hazardous material content as defined by:

2002/95/EC RoHS Reduction of Hazardous Substances Directive

2002/96/EC W.E.E.E Waste Electrical and Electronic Equipment Directive.

Equipment contains metals and Polycarbonate enclosure and every effort shall be made to recycle and recover these materials.

Calibration of Watlow Controllers

Occasionally questions come up with regard to calibration of Watlow controllers. This paper will attempt to address some of the more common questions on this subject.

Verification of controller calibration.
Many people want to jump in right away and begin performing a calibration procedure before verification. Before you would attempt to calibrate a Watlow controller, verify that the controller is in need of calibration. If you verify that readings of the controller first, you may not have to go through the more involved process of changing the calibration settings. In this document is a general procedure that shows the process to verify the calibration of the controller.

Are you performing calibration of the controller or the whole system of which the controller is a part?
Sometimes people confuse the controller's calibration with calibration of the system, which contains the controller. A controller calibration would of course start with verification. Provide the controller a known, calibrated input from a calibrator, and verify that the controller's indicated reading is within specifications.

By contrast, performing a system calibration involves using a separate calibrated temperature sensor and indicator to validate the temperature reading indicated by the controller using the system's sensor. The designer of the system set the accuracy specifications for the system, and the exact method to test that accuracy. If the system is outside of the accuracy specification, you could use the controller's calibration offset parameter to offset the reading indicated by the controller.

It may not be possible to readily perform this sort of comparison for system calibration. For instance, the systems temperature sensor may be embedded within a heater or a block of some material such as steel. In a situation like this, you may be only able to sense the outer surface temperature of the block, so there is likely to be a difference between the reading indicated by the controller and the reading indicated by the calibrated source. In some cases you may want to offset the controller's reading, allowing the controller to indicate a temperature that may better reflect the system temperature rather that the internal block or heater temperature. Again, the designer of the system set the exact test method and accuracy specification.

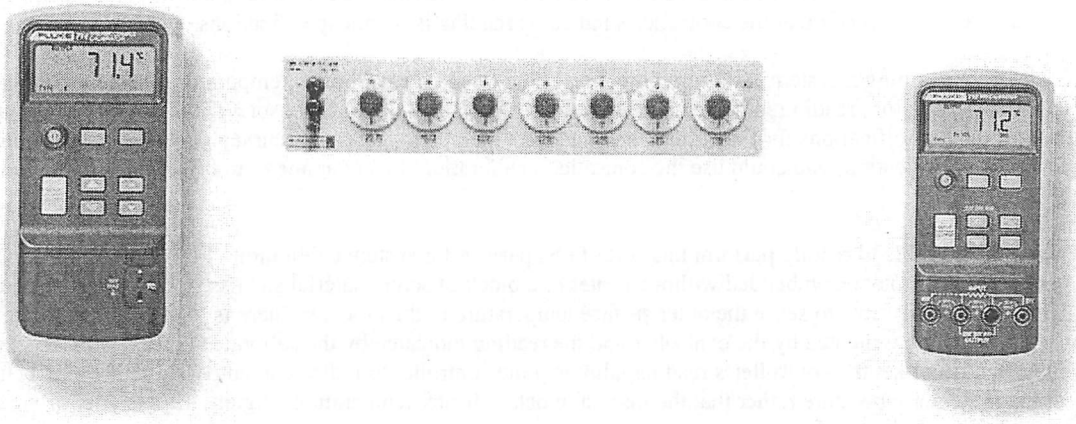
Does the controller come from Watlow calibrated?
Yes, the controller comes calibrated from the factory. It is calibrated to a level of precision that will meet the needs of the majority of customers. For most customers their controller will not require re-calibration for the lifetime of the product.

How often do I need to calibrate the controller?
Calibrate the controller as often as you find the calibration is out of specification. If you are verifying calibration first (see "Verification of calibration"), the answer to this question becomes self-evident. Perhaps the question you mean to ask is "How often do I need to verify calibration of the controller?"

How often do I need to verify calibration of the controller?
As was mentioned, a Watlow controller's calibration is very stable. Stable enough such that the majority of users would not need to calibrate their controllers within the lifetime of the product. In general for most instruments and equipment, you may want to monitor calibration by doing verification at a regular interval. This would detect calibration drift as well as failures in your system that could result in degradation in your process. Proceed by arbitrarily picking a time interval such as six months based on how critical the instrument is to the process. Then based on the results of repeated verification at this time interval, increase the time interval if no drift was experienced or decrease the time interval if adjustment was necessary.

What if a mistake or problem occurred while calibrating the controller?
If a mistake or problem occurred while calibrating a controller use the calibration restore parameter to recover the original factory calibration settings. Watlow's recent microprocessor based controllers allow the calibration restore. This is a useful feature in troubleshooting accuracy and calibration problems. After performing a calibration restore, the controller should be indicating readings that are at worst case (assuming you had an unusually excessive amount of calibration drift) a few degrees outside of the accuracy specification. If the reading is extremely far off or if the controller is indicating a sensor error, then there is a problem other than calibration. Possible issues are; the controller is not programmed correctly, the calibrator is not wired correctly, the calibrator is not operating properly, or perhaps the controller is defective.

Types of Calibration equipment



Thermocouple simulation
For thermocouple inputs you can use an instrument called a thermocouple simulator that allows you to input a temperature setting in degrees and it will output the equivalent mV signal representing that temperature. Simulators are capable of producing signals for several different thermocouple types.

RTD simulation

There exist two common methods for simulating RTD resistances for various temperatures. The first is to use what is commonly referred to as a decade box (pictured above to the left). A decade box contains various size resistors that are connected together through rotary control switches on the front of the box to allow the user to "dial in" the desired resistance value. With a decade box, use a temperature to resistance lookup table to determine the resistance for the RTD.
The second method is to use an electronic RTD simulator (pictured above to the right) that will allow entry of a temperature through a keypad and the simulator will simulate the equivalent resistance for the specified RTD. Most simulators are programmable to simulate several different types of RTDs.

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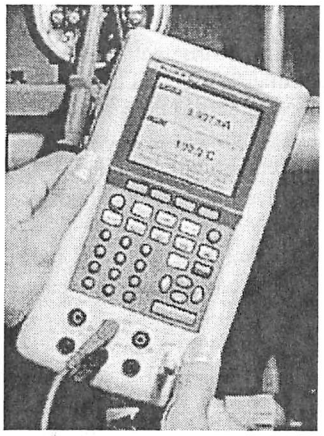
Current and Voltage simulation



Current and/or voltage simulation of process signals is performed with a simulator that allows entry of the desired current/voltage signal. Simulators are designed for both voltage and current simulation Although any power supply that presents the appropriate voltages could be used for voltage calibration, only a source designed specifically for process signal calibration will allow for suitable adjustment and accuracy to perform calibration.

Multi-Function Calibrators

Many simulators on the market sold for calibration purposes can simulate all of the above signals mentioned. These units are handy if you have several different types of signals to simulate for various pieces of equipment that need to calibration.

Calculating specified accuracy

For most controllers, the degree of accuracy depends upon the type of sensor utilized. Most Watlow controller's accuracy is stated as percent of span. The accuracy statements can be found in the specification section of the user's manual.

For instance: a controller accuracy is stated as "± 0.1 % of span, ± 1°C".
The accuracy is dependent on the type of sensor and stated span. Assuming a type J thermocouple's range is 0 to 750°C:

750 – 0 = 750°C	The span is 750°C
0.1% * 750 = 0.75 = 1°C	Round to the nearest whole degree to obtain the error due to span
1° + 1° = ± 2°C	Add ± 1°C which is the second part of the specification
± 2°C	The total calibration error for this controller using type J t/c

This value applies under standard conditions. Standard conditions refer to ambient controller environment temperature at which the controller was originally calibrated, input voltage within rated specifications, and specified humidity range. There are modifiers for going outside of standard conditions. The controller's user manual will specify the details for standard conditions and their modifiers of accuracy.

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General Procedure of Verifying Calibration

1. Obtain the necessary equipment. To verify calibration, you need to obtain a calibration instrument to simulate the input signal you are going to verify. Cabling to attach the calibrator to the controller is required. For RTDs, Voltage, and Current signals, use copper wire to make the connection. For thermocouples, use the appropriate type of thermocouple wire to perform the test.
2. Simulate a temperature. Enter the temperature to simulate into the calibrator. Pick temperatures to simulate that are within your normal operating range. Typically you would pick three temperatures to verify: a high, a low and mid range temperature value for the operating range.
3. Verify that the temperature readings on the controller are within specification. (See calculating accuracy above) If the readings are within specification, no calibration will be necessary. If readings are outside of specification, perform the calibration procedure for the controller.

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WATLOW

Engineering Bulletin

#89.4.3

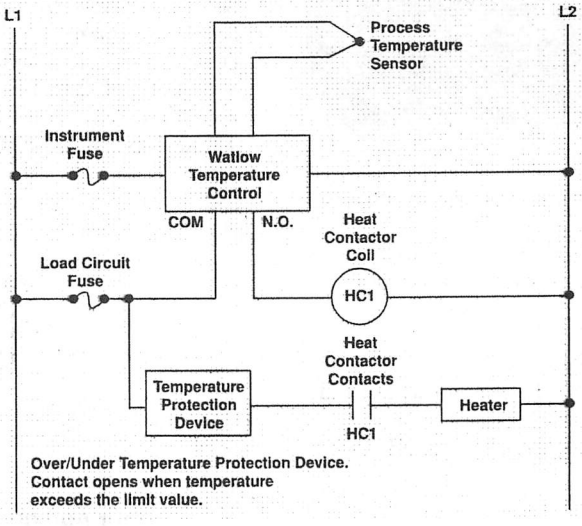
Over/Undertemperature Protection

Failure of components in a temperature control loop, such as the sensor, heater control relay, or main temperature control, can result in damage to a product in process, a meltdown of a heater, and/or a damaging fire.

To protect against this possibility, over/undertemperature protection must be provided to interrupt or remove power from the heater circuit. A "thermal fuse line" at the heater, or a "mechanical thermoswitch" at the heater are examples of recommended over/under temperature protection. For precise, repeatable limit protection, an "electronic limit control" may be used. We recommend the temperature protection device have UL, CSA, or FM approval, and be applied in the classification for which it was tested and approved. An example of a single phase wiring line diagram appears below.

STOP **WARNING**

Install high or low temperature control protection in systems where an overtemperature or undertemperature fault condition could present a fire hazard or other hazard. Failure to install temperature control protection where a potential hazard exists could result in damage to equipment and property, and injury to personnel.



Further information is available from Watlow Controls; ask for application assistance.

Disclaimer of Warranty

This document is a presentation of a general overview and statement of the safety-related need for and method of applying "over/undertemperature protection." Because of the diversity of conditions and hazards under which control products may be applied and because of the differences in components and methods of their installation, **no representation or warranty of any kind, express or implied, is hereby made**, that the limit control protection discussed and presented herein will be effective in any particular application or set of circumstances, or that additional or different precautions will not be reasonably necessary for a particular application. We will be pleased to consult with any customer regarding a specific application upon written request.

(1826)

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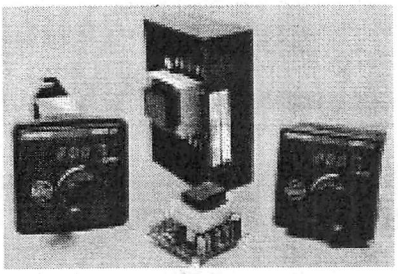
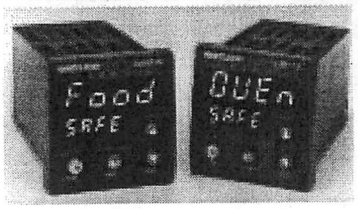
Limit Controls from Watlow

Series L — LV / LF Limit



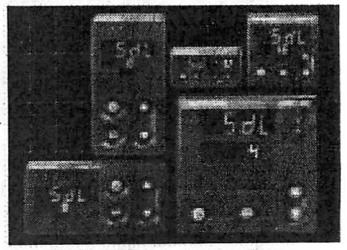
- Open board, potted case, DIN-rail mount or panel mount 1/8 DIN square package styles
- Fixed or push-to-set adjustable set point operation
- High or low limit with auto or manual reset on power loss
- Remote reset capability
- Celsius or Fahrenheit indication (factory selectable)
- Sensor break protection to de-energize system for safety
- Operating environment:
  - 0 to 70°C (32 to 158°F)
  - 0 to 90% RH, non-condensing
- Agency approvals:
  - Series LF (potted version only)
    - UL 991 recognized temperature limit for cooking industry
  - Series LV and Series LF (including potted version)
    - UL 873 recognized temperature regulator
    - ANSI Z21.23 Gas appliance thermostat approval
    - FM Class 3545 temperature limit switches

Series 97 — 1/16 DIN Limit



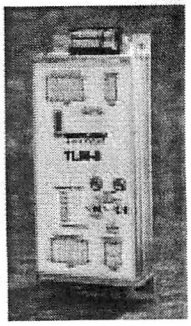
- Programmable messages to display user programmed limit and safe message
- Microprocessor-based for accurate set point settings and quick output response
- Remote reset capability
- Four outputs for high/low limit, alarms, communication, retransmit requirements
- Software and hardware lockouts for high security
- Aesthetic match of Series 96 temperature controller
- Operating environment:
  - 0 to 65°C, 32 to 149°F
  - 0 to 90% RH, non-condensing
- NEMA 4X, 12, IP65 case makes the control water and corrosion resistant
- Agency approvals: FM, CE, NEMA 4X, 12, and IP65

Series SD — Family of Limit Controllers



- Available in a 1/32, 1/16, 1/8 (horizontal or vertical) or 1/4 DIN package
- Up to three outputs (two on 1/32 DIN model) provide high and low limit/alarm capacity
- Lockout functions for increased security
- Flexible high/low alarm output notifies of trouble with flashing display message
- Programmable dual display default shows actual, limit, blank or alarm default display information
- Aesthetic match for Series SD, 96 and F4 PID controllers
- Operating environment:
  - -18 to 65°C (0 to 149°F)
  - 0 to 90% RH, non-condensing
- Agency approvals: FM, CE, NEMA 4X, 12, IP65, and NSF

TLM Series — Multi-Channel Limit Monitor



- Eight channel monitoring in a single compact package
- Multiple sensor types (one sensor type per TLM)
- Selectable limit set points for each channel. TLM-8P has field adjustable limit set points.
- Sub-panel mounting
- Flexible interlocks
- Self-test diagnostics
- Latching alarms
- Operating environment:
  - 0 to 60°C (32 to 140°F)
  - 0 to 90% RH, non-condensing
- Agency approvals: FM, CE, UL listed, C-UL listed

TOTAL
CUSTOMER
SATISFACTION
3 Year Warranty

WATLOW

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