



Commercial Electric Energy Saver Water Heater

IMMERSION AND SURFACE MOUNTED THERMOSTAT MODELS



SERVICE MANUAL

**Troubleshooting Guide
and Instructions for Service**
(To be performed ONLY by
qualified service providers)

For Models
50(A)*(SF, CF)-**
80(A)*(SF, CF)-**
120(A)*(SF, CF)-**

*Denotes kW Rating
**Denotes Wiring Code



Commercial Electric

Water Heaters

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Introduction

This service manual is designed to aid service and maintenance professionals in the function, proper diagnosis and repair of Bock Water Heaters Commercial Electric Water Heaters.

The text and illustrations in this manual provide step-by-step instructions to facilitate proper operation and troubleshooting procedures. Contact Bock Water Heaters Technical Support immediately if diagnosis cannot be made using the methods described in this service manual.

Tools

- Multi-Meter
- 1-1/2" Deep Well Socket
- 1-1/16" Deep Well Socket
- 1/4" Nut Driver
- Philips Head Screw Driver
- Common Screw Driver
- Thermometer
- Drain Hose.

Other hand tools: pipe wrench, channel locks, pliers (common & needle nose), wire cutters, wire strippers, allen wrench set, flash light.



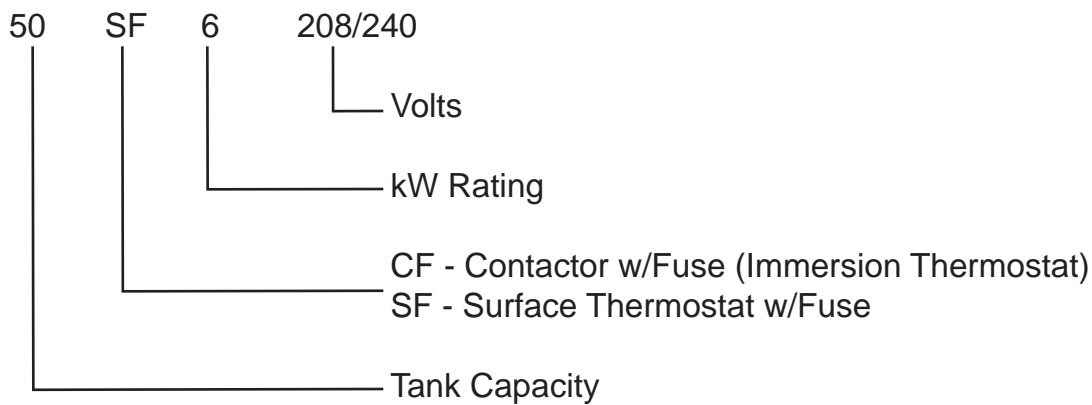
Commercial Electric

General Information

Bock Waters Heaters Commercial Electric water heaters can be manufactured with a choice between two different types of thermostat control options as follows:

- Surface Mounted Thermostats.
- Immersion Thermostat (contactor models).

The model number is coded to identify the specific thermostat control system used for a particular unit. Below is a typical model number and coded definitions.



Model Number →

Electrical Characteristics →

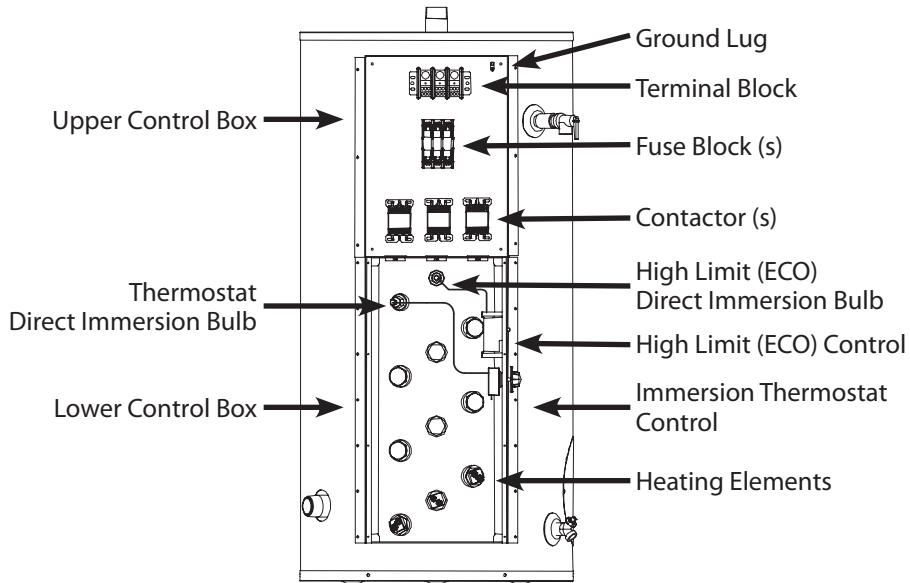
MFG FOR: BOCK WATER HEATERS, INC.
110 S. DICKINSON, MADISON WI 53703
Model No: 50SF-6, 208/240
Serial No: ZB2564812
Cap. 50(gal.)/189.3(liters)
Press: Test 300(psi), Working 150(psi)

Volts	240	Max Temp	180°	
Phase	Three	Amps	29	
kW Each	4	Total kW	12	3 Elements
Wattage rating based upon 60 Hz				

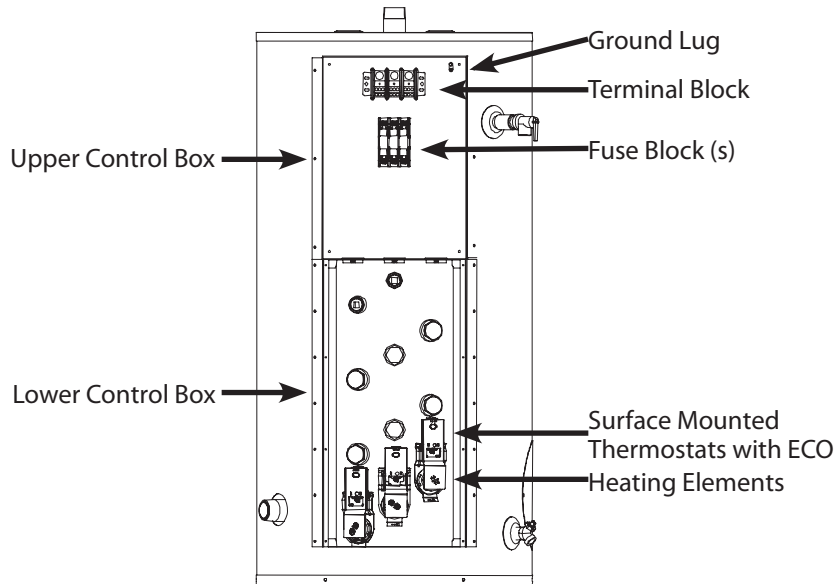
Typical Rating Plate
Located on Front of Water Heater



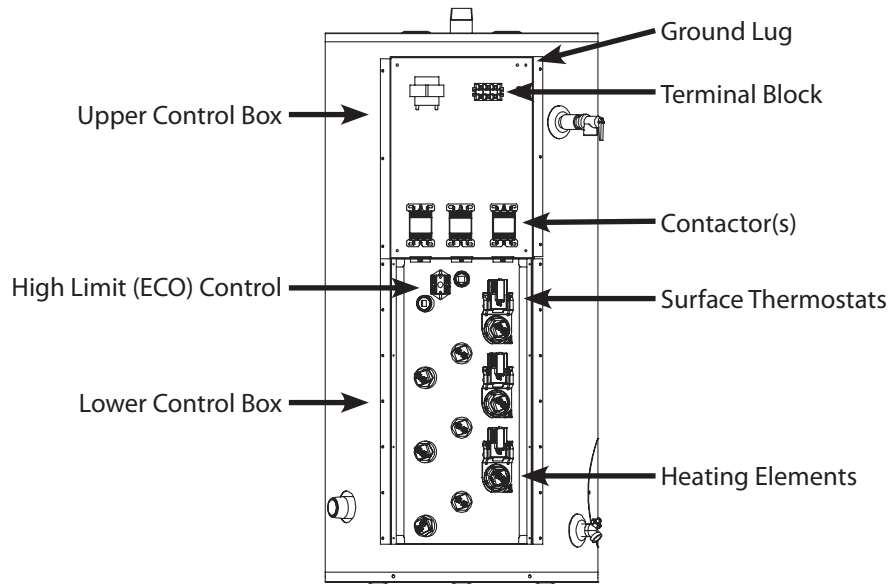
Contactor Models General Controls Layout



Surface Mounted Thermostat Models General Controls Layout

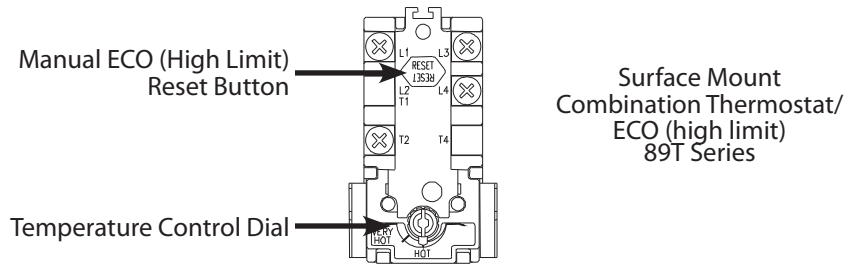


600V Surface Thermostat (w/Contactors) Models General Controls Layout



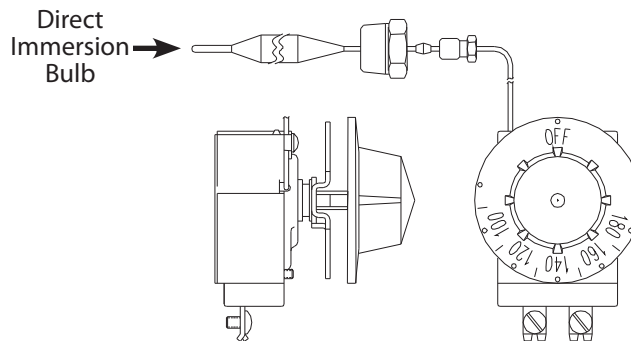
Surface Mounted Thermostats

Surface mounted thermostats are mounted into a bracket above each heating element. The bracket holds the thermostat against the side of the tank responding to tank surface temperatures to sense a call for heat, set point temperature and high limit (ECO) activation. As each element has a dedicated thermostat (for all models excluding 600V), it is possible to sequence the elements by varying the settings on the thermostats.



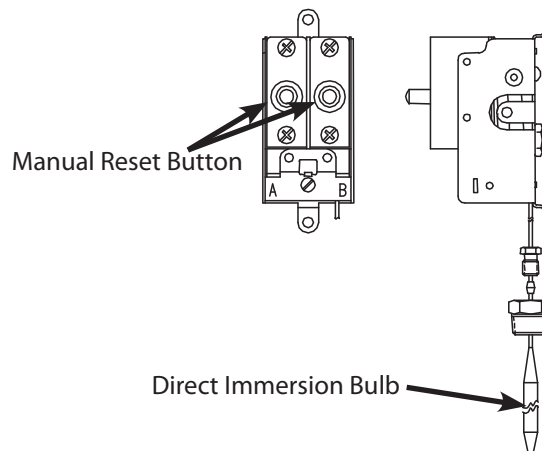
Immersion Style Thermostat Control for Contactor Models

The thermostat will complete control circuit voltage upon a call for heat. Likewise, the control will interrupt control circuit voltage when the water temperature is sufficient to satisfy the adjustable temperature limit of control.



Immersion Style High Limit (ECO) Control for Contactor Models

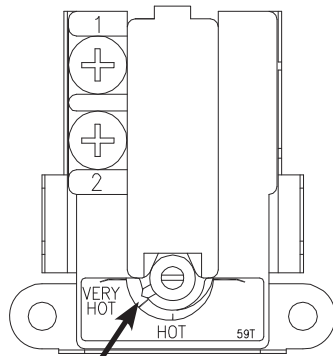
The high limit (ECO) control will interrupt control circuit voltage causing the heater to shut down when the high temperature limit of the control is reached (196° F ± 4° F). Once the cause for overheated water has been determined, the control must be manually reset to restore normal operation.



Surface Mounted Thermostats (w/Contactors) for 600V Models

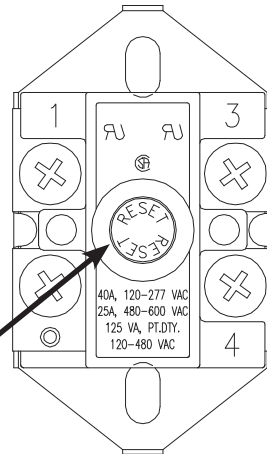
600V models use contactors to deliver line voltage to the heating elements. However, rather than the immersion type high limit and thermostat devices, surface mounted thermostats are used to operate the control circuit of the water heater.

Surface Mounted
Thermostat
59T Series



Temperature Control Dial

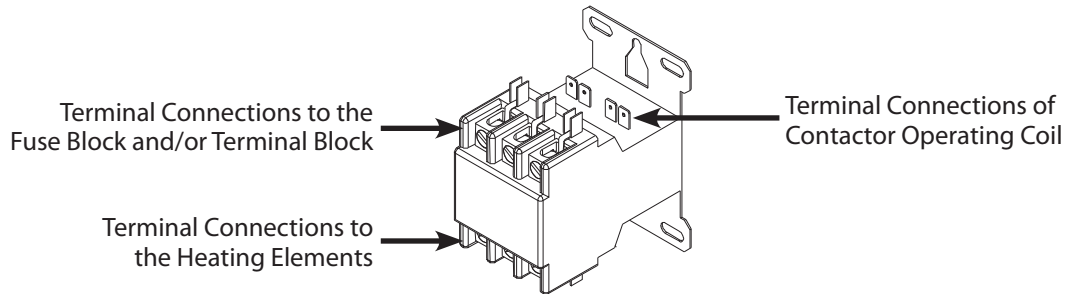
Surface Mounted
ECO (High Limit)



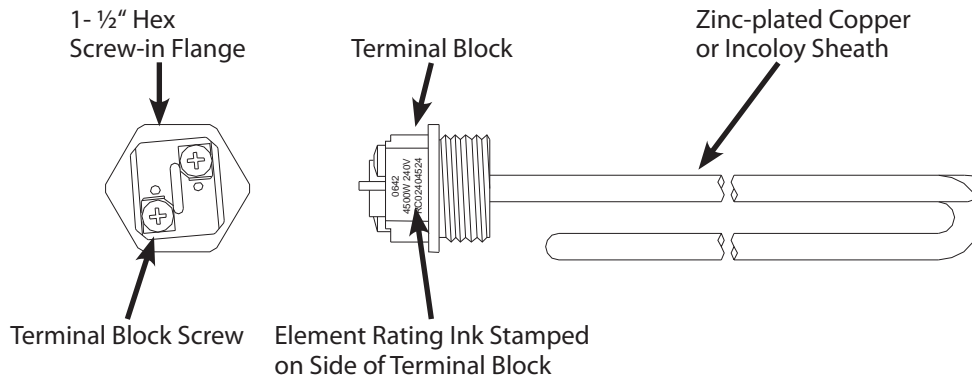
Manual Reset Button

Contactor

Contactor operation is achieved by energizing an operating coil in response to a call for heat from the immersion thermostat. Upon a call for heat, one or more contactors will energize all heating elements simultaneously. The operating coils are voltage specific. When contactor replacement is required be sure to order the proper operating coil based on the voltage rating found on the rating plate located on the front of the water heater.



Direct Immersion "Screw-in" Type Heating Element



Commonly Used Formulas

(Single Phase)

$$\text{Amps} = \frac{\text{Watts}}{\text{Volts}}$$

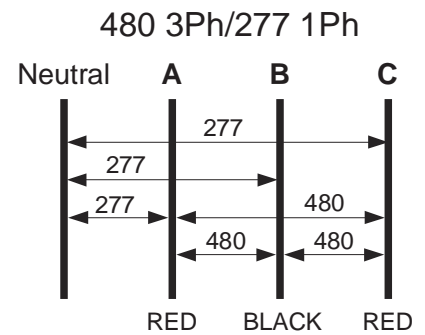
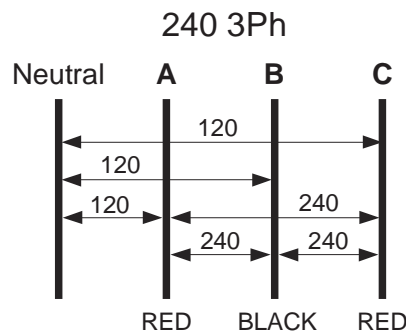
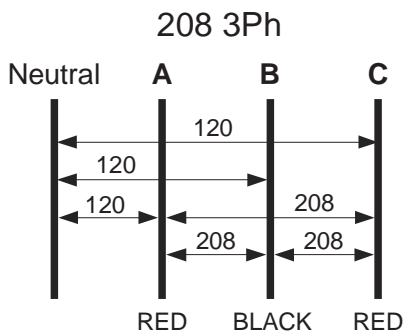
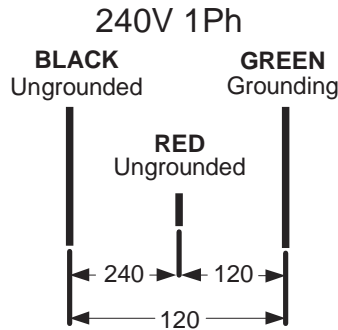
(Balanced 3 Phase)

$$\text{Amps} = \frac{\text{Watts}}{\text{Volts} \times 1,732}$$

$$\text{Watts} = \text{Amps} \times \text{Volts}$$

$$\text{Ohms} = \frac{\text{Volts}^2}{\text{Watts}}$$

Common Service Wire Configurations



Commonly Used Formulas

kW	208 Volt		240 Volt		277 Volt	380 Volt	415 Volt	480 Volt		600 Volt
	1 Phase	3 Phase	1 Phase	3 Phase	1 Phase	3 Phase	3 Phase	1 Phase	3 Phase	3 Phase
6	28.8	16.6	25.0	14.4	21.6	9.1	8.3	12.5	7.2	5.8
9	43.2	25.0	37.2	21.6	32.4	13.6	12.5	18.7	10.8	8.7
12	57.6	33.3	50.0	28.9	43.3	18.2	16.7	25.0	14.4	11.5
13.5	64.9	37.5	56.2	32.5	48.7	20.5	18.8	28.1	16.2	13.0
15	72.1	41.6	62.5	36.1	54.1	22.7	20.9	31.2	18.0	14.4
18	86.5	50.0	75.0	43.4	64.0	27.3	25.0	37.5	21.6	17.3
24	115.4	66.7	100.0	57.8	86.6	36.4	33.4	50.0	28.9	23.1
27	129.8	75.0	112.5	65.0	97.4	41.0	37.5	56.2	32.5	26.0
30	144.2	83.3	125.0	72.2	108.3	45.6	41.7	62.5	36.1	28.9
36	173.0	100.0	150.0	86.7	129.9	54.7	50.1	75.0	43.3	34.6
45	216.3	125.0	187.5	108.3	162.4	68.4	62.6	93.7	54.1	43.3
54	259.6	150.0	225.0	130.0	194.9	82.0	75.1	112.5	65.0	52.0



Bock's commercial electric water heaters can use either **immersion thermostats** (contactor models) or **surface mounted thermostats**. Sequence of operation for each configuration is explained below. It would be impractical to show all wire diagrams applicable to both configurations. A "typical wiring diagram" is illustrated to aid in understanding the principles of the operating sequence.

Immersion Thermostats (Contactor Models): Configured to use a single immersion thermostat to control one or more contactors to energize or de-energize all elements simultaneously. In addition, a separate high limit (ECO) control with manual reset is wired in series with the thermostat. Both controls use a direct immersion bulb inserted into the tank to sense water temperature. Immersion thermostat and high limit control are mounted to provide temperature adjustment and manual reset access from the exterior of the unit.

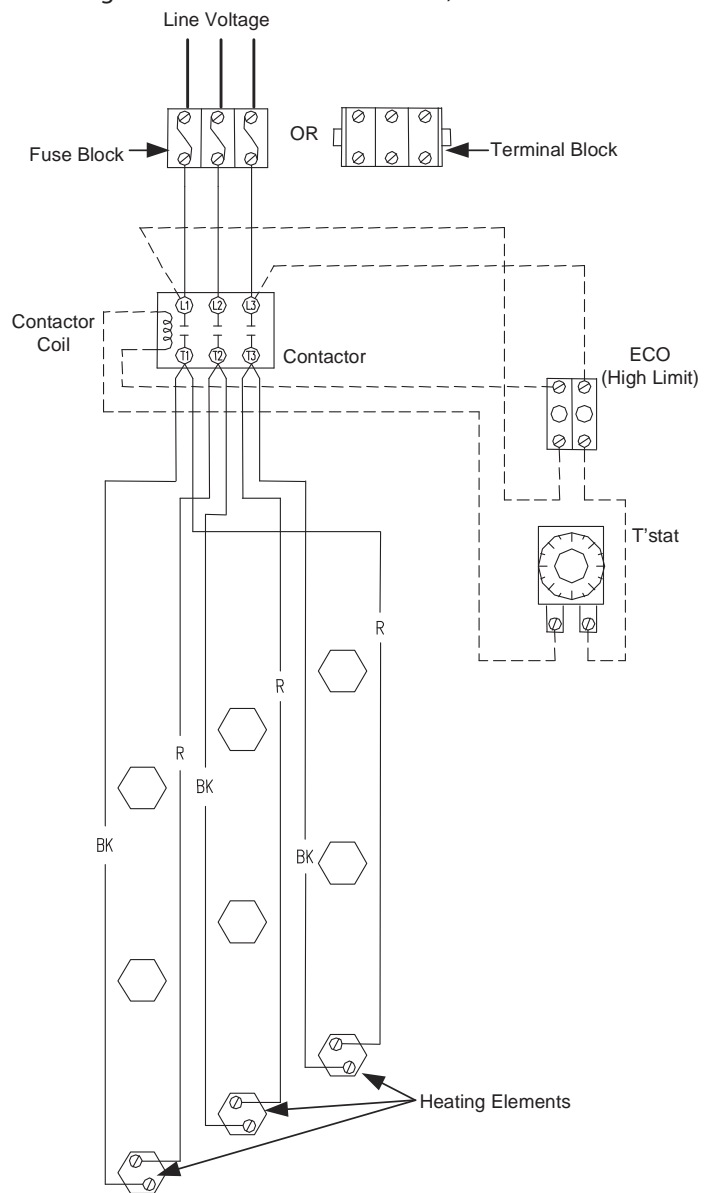
Surface Mounted Thermostats: Surface mounted thermostats are mounted inside the lower control box, in a bracket above each heating element. The bracket holds the thermostat against the side of the tank, responding to tank surface temperatures to sense a call for heat, set-point temperature and high limit (ECO) activation. As each element is controlled by a dedicated thermostat, it is possible to sequence the elements by varying the settings on the thermostat. However, 600V models with surface mounted thermostats operate contactors in the same manner as an immersion thermostat model, only using surface thermostats to sense the call for heat.

Sequence of operation for each system is explained below.

**Sequence of Operation:
Immersion Thermostat (Contactor Models).**

The system has two distinct circuits:

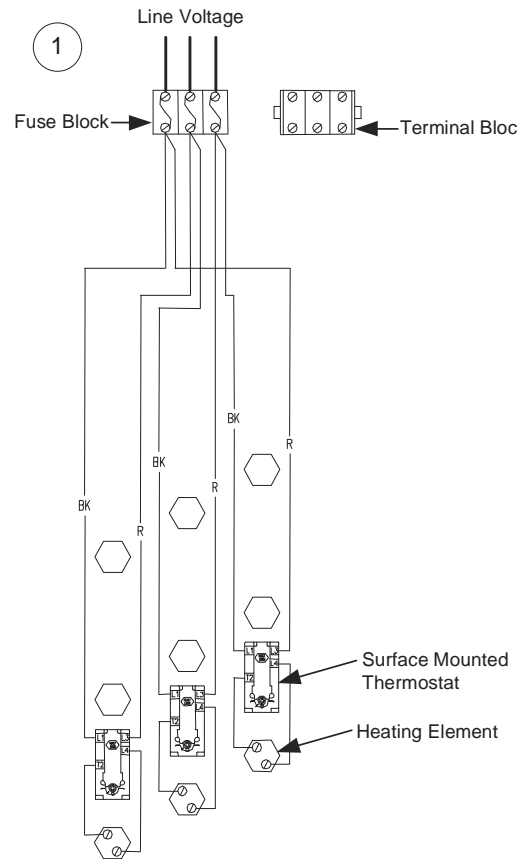
1. Power Circuit (solid line).
 2. Control Circuit (dotted line).
1. Line voltage is applied across terminals of fuse block or a terminal block. Line voltage continues down and connects to terminals L1, L2 and L3 of one or more contactors.
 - A. Contactor is open (no call for heat), so there is no voltage across terminals T1, T2 and T3 of contactor.
 - B. The contactor is controlled by the control circuit consisting of the immersion thermostat, ECO (high limit) and contactor coil.
 2. When the thermostat calls for heat, contacts close inside the thermostat completing the circuit through the ECO and energizing the contactor coil.
 3. The energized contactor coil causes the contactor to close energizing the elements from terminals T1, T2 and T3 of the contactor.
 4. When the temperature setting of the thermostat is reached, the contacts in the thermostat open. This interrupts current flow through the control circuit de-energizing the contactor coil.
 5. The de-energized contactor coil causes the contactor to open, interrupting current flow through the elements. The heater is now in stand-by, waiting for the next call for heat.



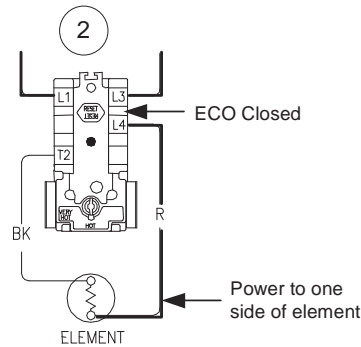
SEQUENCE OF OPERATION

Sequence of Operation: Surface Mounted Thermostats.

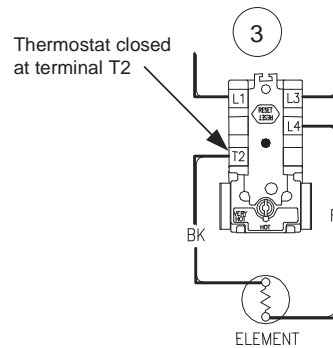
1. Line voltage is applied across terminals of fuse block or a terminal block. Line voltage continues down and connects to surface mounted thermostats at terminals L1 and L3.



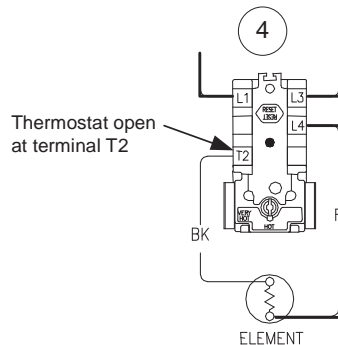
2. ECO (high limit) in thermostat is closed, so there is line voltage present at terminal L4 of thermostats and to one side of each element.



3. Water in the tank is cold, so all thermostats are closed at terminal T2 (calling for heat). This completes the circuit and allows current to flow through heating elements.



4. As each thermostat is satisfied, it opens at terminal T2, interrupting current flow through the respective element. The system is now in stand-by mode waiting for the next call for heat.

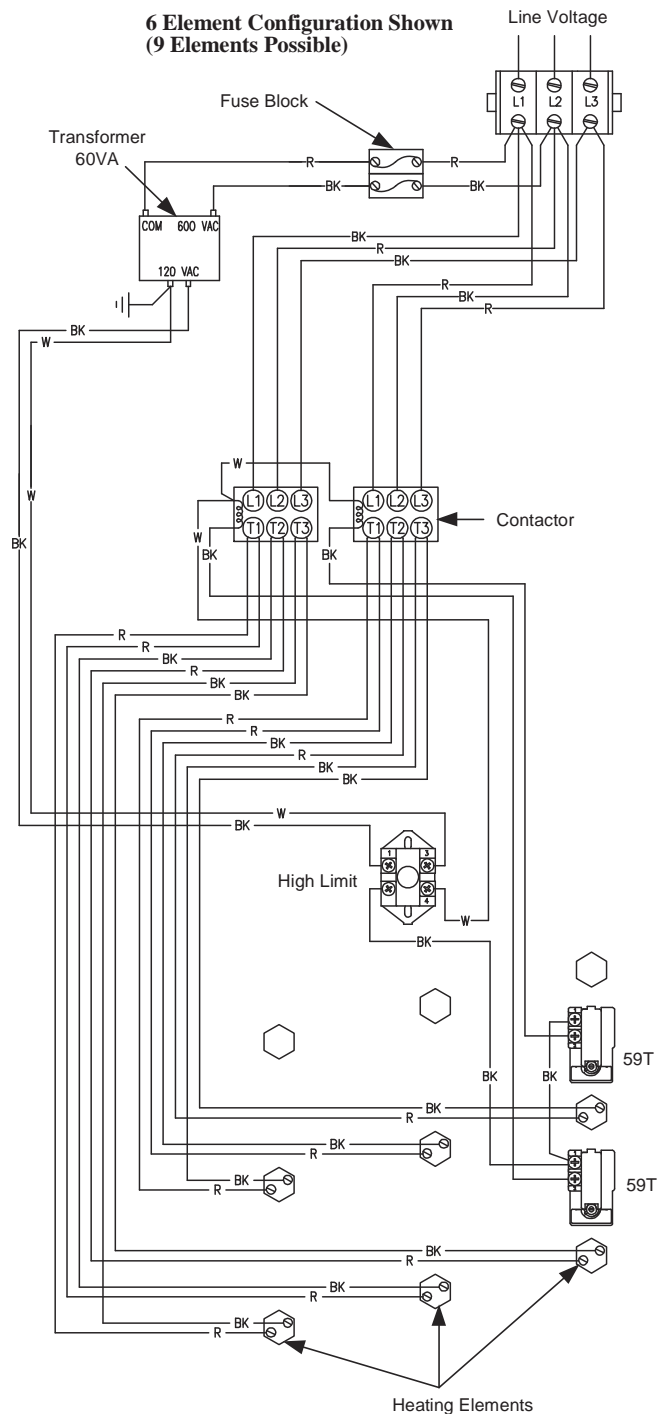


SEQUENCE OF OPERATION

Sequence of Operation: 600V Surface Mounted Thermostats (w/Contactors).

The system has two distinct circuits.

1. Power Circuit - Line Voltage (600V)
 2. Control Circuit - 120V
1. Line voltage is applied across terminals of fuse block or a terminal block. Line voltage continues down and connects to terminals L1, L2 and L3 of one or more contactors.
 - A) Contactor is open (no call for heat), so there is no voltage across terminals T1, T2, and T3 of contactor.
 - B) The contactor is controlled by the control circuit consisting of the surface mounted thermostat, ECO (high limit) and contactor coil.
 2. When the thermostat calls for heat, contacts close inside the thermostat completing the circuit through the ECO and energizing the contactor coil.
 3. The energized contactor coil causes the contactor to close, energizing the elements from terminals T1, T2 and T3 of the contactor.
 4. When the temperature setting of the thermostat is reached, the contacts in the thermostat open. This interrupts current flow through the control circuit de-energizing the contactor coil.
 5. The de-energized contactor coil causes the contactor to open, interrupting current flow through the elements. The heater is now in stand-by waiting for the next call for heat.
 6. Notice in the wiring diagram at right that each row of elements is equipped with a surface mounted thermostat on the highest element in the row. These thermostats are individually wired in series to the contactor whose line voltage corresponds to the same row of elements. Each thermostat and contactor combination are wired to the ECO in parallel. This allows for each row of elements to be powered "ON" independent of the other element rows. However, the ECO is wired in series so that voltage can be interrupted to the entire control circuit if the ECO senses that the tank water has become overheated.



The most common cause of improper electric water heater operation can be linked to heating element failure.

When troubleshooting an electric water heater with the incidence of “no hot water” or “insufficient amount of hot water” it is always a good idea to check the heating elements first following the procedure on Page 15.

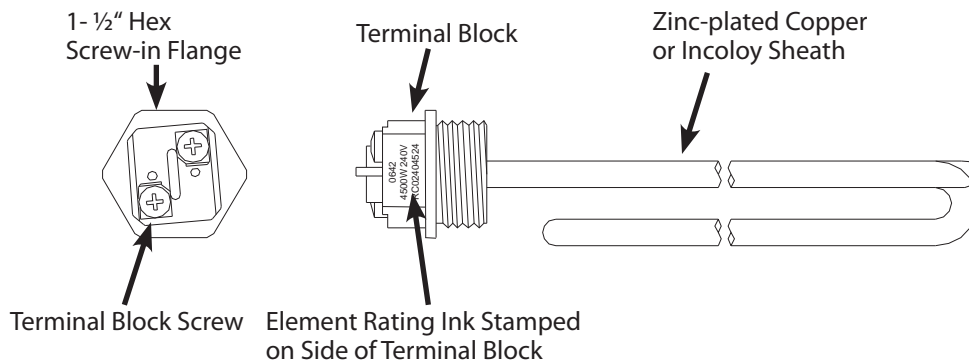
Common heating element failures are:

1. **Dry Firing.** Elements may be partially submerged in water or most likely, completely exposed with no water in the tank at all. In open air, an energized element (dry-fired) will become completely inoperable within seconds. In some cases sediment or lime build up around an element can eventually cause an air pocket, resulting in a dry-fired element. When element replacement is required, be sure tank is full of water prior to energizing the water heater.
2. **Grounded Element.** In most cases, an element with a short circuit to ground will cause the circuit breaker in the service panel to open or shut off. In some cases there may not be enough current draw for the circuit breaker to open. This will allow the heating element to be in continuous operation resulting in overheated water, limited only by the ECO located in the thermostat circuit. Repeated actuation of the ECO usually is the result of a grounded heating element.
3. **Sediment Buildup.** Slow hot water recovery can usually be traced back to sediment or lime build-up around heating element. Sediment build-up can also, over time, cause a dry-fired element.

If a heating element is found to be inoperative, it must be replaced. Follow service procedure MCE-XV on Page 30.

The illustration below shows a common “screw-in” type heating element identifying certain features commonly referred to throughout this manual.

Typical Direct Immersion “Screw-In” Type Heating Element



Quick Step Plan to Hot Water

1. **STOP, DANGER! Turn power "OFF" to water heater.**
2. Check all wire connections to insure that they are snug and corrosion free.
3. Reset high limit (ECO) (Page 18-20).
4. Check for inoperative heating element (Page 15).
5. Check line voltage (Page 16), and internal fuses (Page 17).
6. Refer to table below if items 1 through 5 above do not correct problem.

⚠ WARNING
High voltage exposure. Use caution when making voltage checks to avoid hazard to life or property.

<u>SYMPTOM</u>	<u>PROBABLE CAUSE</u>	<u>CORRECTIVE ACTION</u>	<u>SERVICE PROCEDURE</u>
No Hot Water	<ol style="list-style-type: none"> 1. No power to heater. 2. Blown water heater fuses. 3. Loose wire connections. 4. Inoperative heating elements. 5. Inoperative thermostat(s) 6. Open ECO. 7. Inoperative contactor(s). 	<ol style="list-style-type: none"> 1. Check circuit breakers at service panel. 2. Check water heater fuses. 3. Check all wire connections. 4. Check heating element(s). 5. Check thermostat(s) operation. 6. Reset (check) ECO. 7. Check contactor operation. 	<ol style="list-style-type: none"> 2. III, Page 17 4. I, Page 15 5. VII-IX, Page 21-23 6. IV, VI, Page 18-20 7. X, Page 24-25
Not Enough Hot Water or Continues Operation	<ol style="list-style-type: none"> 1. Inoperative heating element. 2. Sediment or lime buildup on element(s). 3. Thermostat(s) set too low. 4. Inoperative thermostat(s). 5. Inoperative contactor(s). 6. Loose wire connection. 7. High demand period. 8. Undersized heater. 9. Very cold inlet water to heater. 10. Plumbing connections reversed. 	<ol style="list-style-type: none"> 1. Check heating element(s). 2. Clean or replace heating element(s). 3. Increase thermostat setting. 4. Check thermostat(s). 5. Check contactor operation. 6. Check all wire connection. 7. Reduce demand. 8. Replace with larger heater. 9. Temper water to heater. 10. Correct plumbing connections. 	<ol style="list-style-type: none"> 1. I, Page 15 2. XV, Page 30 4. VII-IX, Page 21-23 5. X, Page 24-25
Slow Hot Water Recovery	<ol style="list-style-type: none"> 1. Sediment or lime buildup on element(s). 2. Loose wire connections. 3. Inoperative thermostat(s). 4. Inoperative contactor(s). 5. Derated heating element installed. 	<ol style="list-style-type: none"> 1. Clean or replace heating elements. 2. Check all wire connections. 3. Check thermostat(s). 4. Check contactor operation. 5. Verify element voltage and wattage rating. 	<ol style="list-style-type: none"> 1. XV, Page 30 3. VII-IX, Page 21-23 4. X, Page 24-25 5. See Page 8
Overheated Water	<ol style="list-style-type: none"> 1. Surface thermostat(s) not flush with tank. 2. Grounded heating element(s). 3. Thermostat set too high. 4. Inoperative thermostat(s). 5. Inoperative ECO. 	<ol style="list-style-type: none"> 1. Check surface thermostat(s) mounting. 2. Check heating element(s). 3. Adjust thermostat(s) to desired setting. 4. Check thermostat(s). 5. Check ECO. 	<ol style="list-style-type: none"> 1. XI, Page 26 2. I Page 15 4. VII-IX, Page 21-23 5. IV-VI, Page 18-20
Noisy (singing or hissing) Elements	<ol style="list-style-type: none"> 1. Lime formation on element(s). 2. High or low line voltage. 	<ol style="list-style-type: none"> 1. Clean or replace heating element(s). 2. Verify line voltage to heater. 	<ol style="list-style-type: none"> 1. XV, Page 30 2. II, Page 16
Noisy Contactor	<ol style="list-style-type: none"> 1. Low line voltage. 2. Debris between contactor plates. 3. Incorrect or defective operating coil. 4. Loose wire connections. 	<ol style="list-style-type: none"> 1. Verify line voltage to heater. 2. Replace contactor. 3. Replace contactor. 4. Check wire connections. 	<ol style="list-style-type: none"> 1. II, Page 16

SERVICE PROCEDURE I Heating Element Testing

Test for Open or Burned Out Element.

1. **STOP, DANGER! Turn power "OFF" to water heater.**
2. Remove access cover from lower control box. Remove insulation from inside of control box.
3. Disconnect wires from heating element.
4. Set multi-meter to "ohms" setting.
5. Touch probes of multi-meter to screw terminals of heating element (see illustration 1).
6. Reading should be 12.8 ohms ($\pm 6\%$) for a 240 volt, 4500 watt element, see table below for other elements.

$$\text{Ohms} = \frac{\text{Volts}^2}{\text{Watts}}$$

A reading outside the range using the formula above ($\pm 6\%$) indicates a bad element and the element must be replaced.

Ohms of Electrical Resistance for Commonly Used Elements

Element Wattage	<u>Voltage Rating of Element</u>		
	208	240	480
2000	21.6	28.8	115.2
3000	14.4	19.2	76.8
4000	10.8	14.4	57.6
4500	9.6	12.8	51.2
5000	8.7	11.5	46.1
6000	7.2	9.6	38.4

Test for Grounded Heating Element (Damaged Heating Element with Short Circuit to Ground).

1. **STOP, DANGER! Turn power "OFF" to water heater.**
2. Remove access cover from lower control box. Remove insulation from inside of control box.
3. Disconnect wires from heating element.
4. Set multi-meter to "ohms" setting.
5. Touch one probe of multi-meter to either screw terminal of heating element and the other on the element flange (see illustration 2). There should be no reading on the ohm meter. Any reading indicates a grounded element and the element must be replaced. Repeat this step for the other screw terminal.

⚠ WARNING
High voltage exposure. To avoid hazard to life or property, be sure power is turned OFF to water heater while performing this procedure.

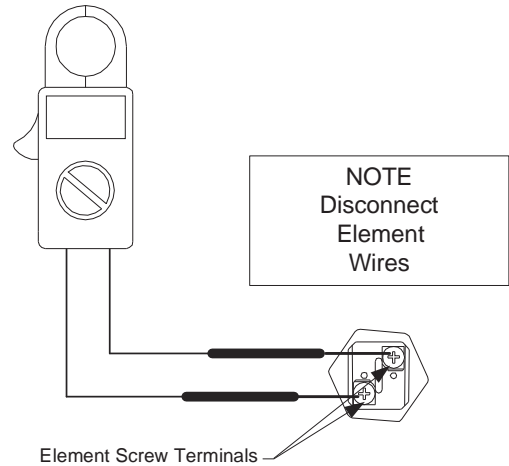


Illustration 1

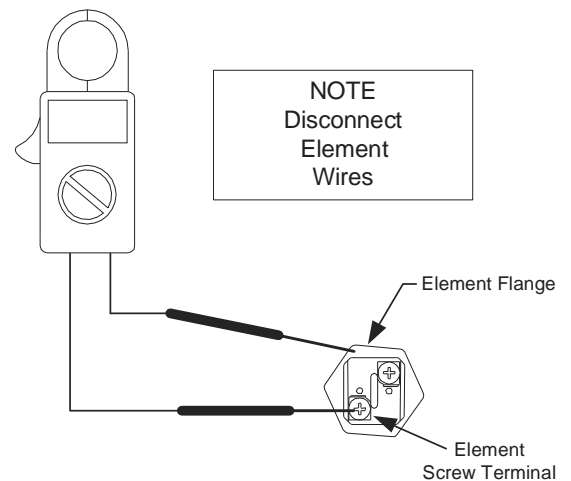


Illustration 2

SERVICE PROCEDURE II Line Voltage Testing

Line Voltage Testing.

Line voltage (single phase or three phase) will connect to a terminal block or directly to a fuse block located inside the control panel.

Determine heaters voltage and phase by referring to the rating plate located on the front of the water heater. Apply the appropriate phase procedure below to determine if proper line voltage is present.

Single Phase Line Voltage Testing.

1. **STOP, DANGER! Turn power "OFF" to water heater.**
2. Open upper control panel door.
3. Determine connection point for line voltage from service panel, **terminal block** or **fuse block**.
4. Set multi-meter to volts AC. Be sure to scale meter for appropriate voltage.
5. Use caution and turn power "ON" to water heater.
6. Use caution and check voltage across top terminals where service voltage connects to water heater (see illustration 3).
 - A) Rated voltage IS present, power to the water heater is okay.
 - B) Rated voltage NOT present, check service panel.

Three Phase Line Voltage Testing.

1. **STOP, DANGER! Turn power "OFF" to water heater.**
2. Open upper control panel door.
3. Determine connection point for line voltage from service panel, **terminal block** or **fuse block**.
4. Set multi-meter to volts AC. Be sure to scale meter for appropriate voltage.
5. Use caution and turn power "ON" to water heater.
6. Use caution and check voltage across top terminals where service voltage connects to water heater (see illustration 4).
 - A) Rated voltage IS present, power to the water heater is okay.
 - B) Rated voltage NOT present, check service panel.

⚠ WARNING
High voltage exposure. To avoid hazard to life or property, use extreme caution when making voltage checks.

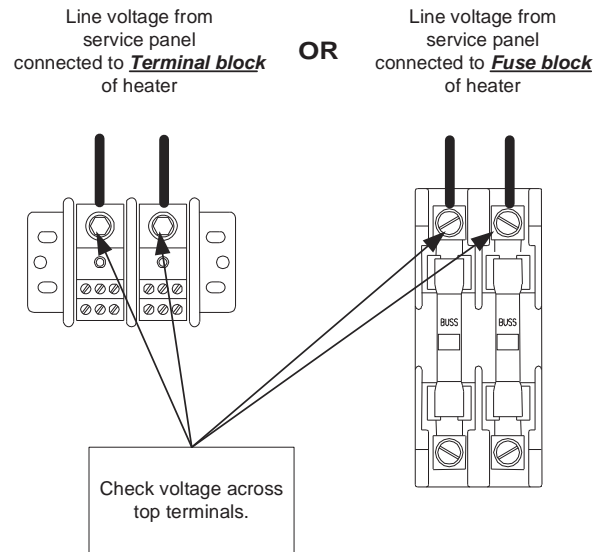


Illustration 3

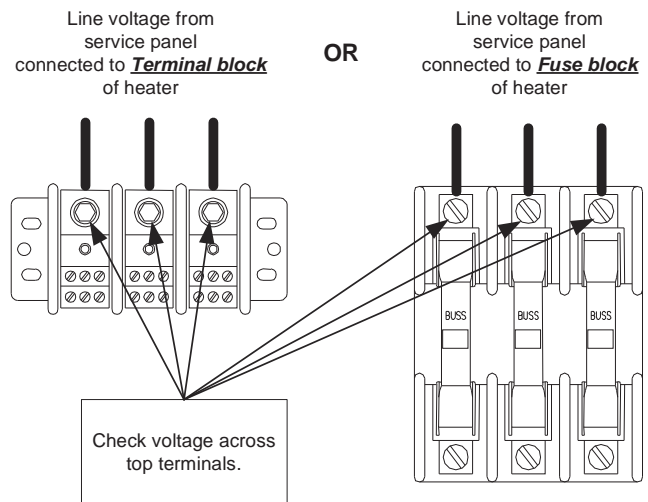


Illustration 4

SERVICE PROCEDURE III Fuse Testing

Fuse Testing.

1. **STOP, DANGER! Turn power "OFF" to water heater.**
2. Open upper control box to allow access to fuse block.
3. Locate fuse block and remove fuses.
4. Set multi-meter to the ohms setting.
5. Check continuity across fuse (see illustration 5).
 - A) Continuity IS present, fuse is okay.
 - B) Continuity NOT present, replace fuse.

⚠ WARNING

High voltage exposure. To avoid hazard to life or property, be sure power is turned OFF to water heater while performing this procedure.

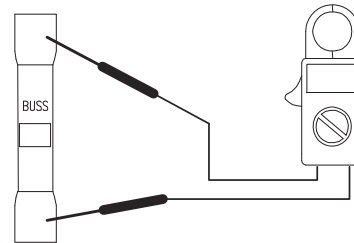


Illustration 5

SERVICE PROCEDURE IV High Limit (ECO) Testing

High Limit Control (ECO) Testing for Surface Thermostat Models (NOT including 600V)

1. This procedure assumes line voltage and fuses are in working order.
2. This procedure illustrates testing of just one surface thermostat. Repeat this procedure for all surface thermostats on the water heater.
3. Turn power "OFF" to water heater.
4. Remove lower control box cover and remove insulation from inside of control box.
5. Remove plastic cover from thermostat(s).
6. Turn power "ON" to water heater.
7. Use caution and check voltage across terminals L1 and L4 for all thermostats (see illustration 6).
 - A) Rated voltage IS present, ECO is okay.
 - B) Rated voltage NOT present, proceed to step 8.
8. Turn power "OFF" to water heater and firmly press ECO reset button on thermostat(s). Turn power "ON" to water heater and recheck voltage across terminals L1 and L4 of thermostat(s).
 - A) Rated voltage IS present, the ECO has previously opened indicating the water in the tank, at some point, did overheat. Check the following:
 1. Thermostat must be in full contact with tank.
 2. Be sure heating element(s) is not shorted to ground (see Page 15).
 3. Proper thermostat operation (see Page 21).
 - B) Rated voltage NOT present, water in tank may be overheated.
 1. If water is overheated, turn "OFF" power to water heater and flow water through tank to cool below set point of upper thermostat. Reset ECO and recheck voltage.
 2. If water is cool, replace thermostat(s).

⚠ WARNING
High voltage exposure. To avoid hazard to life or property, use extreme caution when making voltage checks.

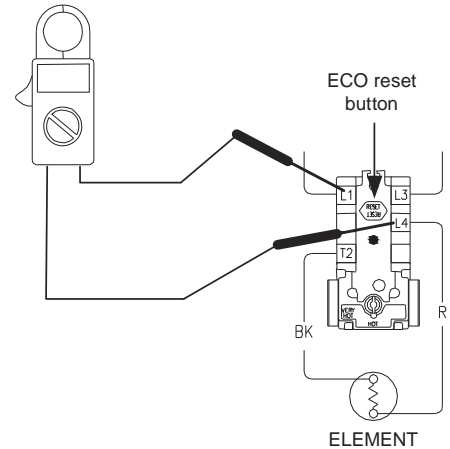


Illustration 6

SERVICE PROCEDURE V High Limit (ECO) Testing

High Limit Control (ECO) Testing for 600V Surface Thermostat Models.

1. This procedure assumes line voltage, transformer, fuses and thermostat are in working order.
2. Turn power "OFF" to water heater.
3. Remove lower control box cover and remove insulation from inside of control box.
4. Use caution and check continuity across terminals 1 and 2 (see illustration 7).
 - A) Continuity IS present, ECO is okay.
 - B) Continuity NOT present, proceed to step 5.
5. Turn power "OFF" to water heater and firmly press ECO reset button on thermostat(s). Turn power "ON" to water heater and recheck continuity across terminals 1 and 2 of thermostat(s).

- A) Continuity IS present, the ECO has previously opened indicating the water in the tank, at some point, did overheat. Check the following:

1. Thermostat must be in full contact with tank.
2. Be sure heating element(s) is not shorted to ground (see Page 15).
3. Proper thermostat operation (see Page 22).

- B) Continuity NOT present, water in tank may be overheated.

1. If water is overheated, turn "OFF" power to water heater and flow water through tank to cool below set point of upper thermostat. Reset ECO and recheck continuity.
2. If water is cool, replace ECO.

⚠ WARNING
High voltage exposure. To avoid hazard to life or property, use extreme caution when making voltage checks.

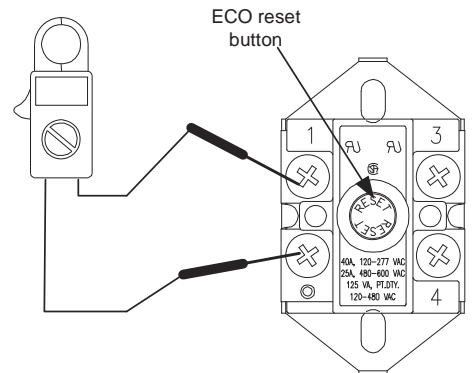


Illustration 7

SERVICE PROCEDURE VI High Limit (ECO) Testing

High Limit Control (ECO) Testing for Contactor Models

Switch Contacts:

Normally closed.

Open on rise @ 196°F ± 4°F.

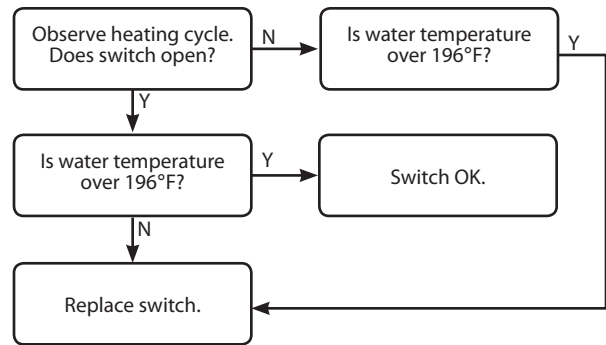
Manual Reset.

1. Determine if high limit (ECO) has actuated. This can be done by simply depressing the reset buttons. If you hear and/or feel a small click, the switch has actuated.
2. Use caution and turn power on to water heater and observe heating cycle following the high limit heating cycle flow chart.

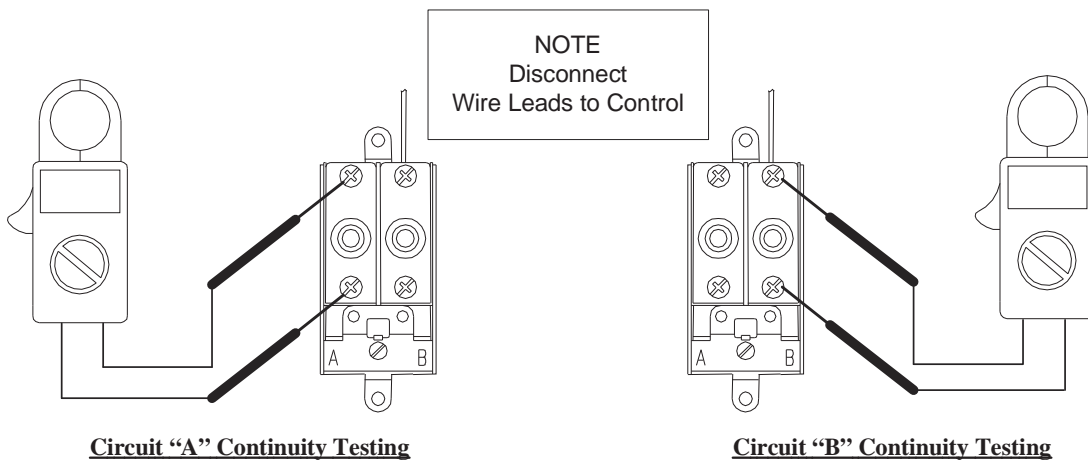
High Limit Control Continuity Testing for Contactor Models

1. **STOP, DANGER! Turn power "OFF" to water heater.**
2. Water temperature must be below 196°F ± 4°F.
3. Remove high limit switch from control panel. It is not necessary to remove immersion bulb from tank at this time. See general controls layout on Page 4 for location.
4. Disconnect wire leads to high limit control during this test.
5. Depress reset buttons to insure switch contacts are closed.
6. Set multi-meter to ohms setting. Check continuity through circuit A and B as showing in the illustrations below.
 - A) Continuity IS present, switch is okay.
 - B) Continuity NOT present, replace switch.

⚠ WARNING
High voltage exposure. To avoid hazard to life or property, be sure power is turned OFF to water heater while performing this procedure.



High Limit Heating Cycle Flow Chart



SERVICE PROCEDURE VII Thermostat Testing

Surface Mounted Thermostat.

Operation Testing (NOT including 600V).

Water in Tank is Cold with Power ON.

1. This procedure assumes line voltage, ECO and elements are in working order.
2. Turn power "OFF" to water heater.
3. Remove access cover from lower control box. Remove insulation from inside of control box. Remove plastic cover from thermostat.
4. Turn power "ON" to water heater.
5. Set multi-meter to Volts AC.
6. Use caution and check voltage across terminals L1 and L3 for all thermostats (see illustration 8).

- A) Rated voltage NOT present, check fuses and/or line voltage.
- B) Rated voltage IS present, proceed to step 7.

7. Check across terminals L4 and T2 of thermostat (see illustration 9).

- A) Rated voltage NOT present, recheck ECO. If ECO is okay, replace thermostat.
- B) Rated voltage IS present, thermostat is calling for heat, go to step 8.

8. Check across element terminals (see illustration 10)

- A) Rated voltage NOT present, check wire connections from thermostat to element.
- B) Rated voltage IS present, repeat element testing (see Page 15).

Water in Tank is Above Thermostat Settings.

1. This procedure assumes line voltage, ECO and elements are in working order.
2. Turn power "ON" to water heater.
3. Set multi-meter to Volts AC.
4. See illustration 9, check across terminals L4 and T2 of thermostat.
 - A) Rated voltage IS present, replace thermostat.
 - B) Rated voltage NOT present, thermostat is okay.
 - C) Lower than rated voltage IS present, recheck for grounded element (see Page 15).

⚠ WARNING
High voltage exposure. To avoid hazard to life or property, use extreme caution when making voltage checks.

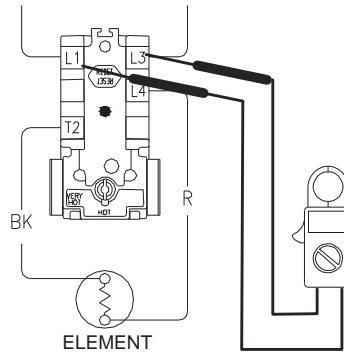


Illustration 8

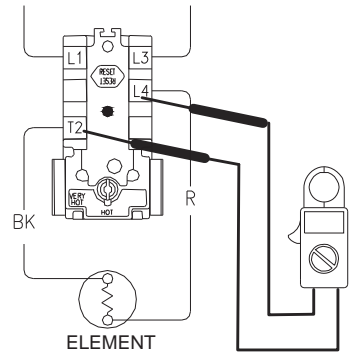


Illustration 9

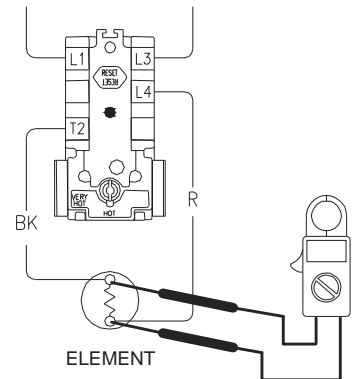


Illustration 10

SERVICE PROCEDURE VIII Thermostat Testing

600V Surface Mounted Thermostat Models Operation Testing.

Water in Tank is Cold with Power ON.

1. This procedure assumes line voltage, ECO, transformer, thermostat, and elements are in working order.
2. Turn power "OFF" to water heater.
3. Remove access cover from lower control box.
Remove insulation from inside of control box.
4. Using a phillips head screwdriver, disconnect the wire lead at terminal 2 of the thermostat. Only check one thermostat at a time to insure wires are correctly reinstalled upon completion. Mark wires if necessary for reinstallation.
5. Set multi-meter to check continuity.
6. Use caution and check continuity across terminals 1 and 2 for all thermostats (see illustration 11).
 - A) Continuity NOT present, replace thermostat.
 - B) Continuity IS present, thermostat is okay.

⚠ WARNING
High voltage exposure. To avoid hazard to life or property, use extreme caution when making voltage checks.

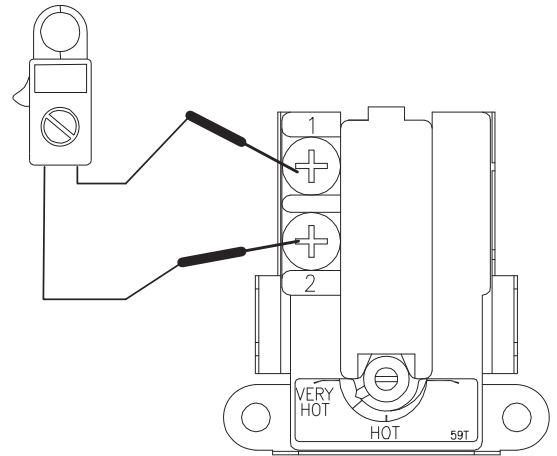


Illustration 11

Water in Tank is Above Thermostat Settings.

1. This procedure assumes line voltage, ECO, thermostat, transformer, and elements are in working order.
2. Turn power "OFF" to water heater.
3. Remove access cover from lower control box. Remove insulation from inside of control box.
4. Using a phillips head screwdriver, disconnect the wire lead at terminal 2 of the thermostat. Only check one thermostat at a time to insure wires are correctly reinstalled upon completion. Mark wires if necessary for reinstallation.
5. Set multi-meter to check continuity.
6. Use caution and check continuity across terminals 1 and 2 for all thermostats (see illustration 11).
 - A) Continuity NOT present, replace thermostat.
 - B) Continuity IS present, thermostat is okay.

SERVICE PROCEDURE IX Thermostat Testing

Immersion Thermostat Operation Testing.

Thermostat Specification.

Calibration: 184°F/176°F

Max Differential: 6°F

Operating Range: 80°F to 180°F

Providing the water temperature in tank is within the operating range of the thermostat, checking thermostat operation can be as simple as rotating the thermostat dial and listening to the contactor(s) to see if they respond to a call for heat.

Use caution and turn power "ON" and rotate the thermostat dial to call for heat. With water temperature below the thermostat setting, the contactor(s) close. With the contacts closed, use caution and check for rated voltage across lower terminals of contactor(s) (see illustration 12). If rated voltage is present, the thermostat is calling for heat.

Rotate thermostat dial to the minimum setting. With water temperature above the thermostat setting the contactor(s) will open. With the contacts open, voltage should not be present at lower terminals of contactor(s).

Thermostat Control Continuity Testing.

1. This procedure assumes line voltage, ECO and contactor(s) are in working order.
2. Turn power "OFF" to water heater.
3. Remove access cover from lower control box. Remove insulation from inside of control box.
4. Locate thermostat control (see general controls layout on Page 4) and remove wire leads to control screw terminals.
5. Water temperature in tank must be within operating range of thermostat for this test. If above or below, it will be necessary to drain tank and remove thermostat immersion bulb from tank to warm or cool the bulb to be within operating range of thermostat.
6. Set multi-meter to the "Ohms" setting.
7. Rotate thermostat dial to highest setting.
8. Check across screw terminals of control (see illustration 13).
 - A) Continuity NOT present, replace thermostat.
 - B) Continuity IS present, proceed to step 9.
9. Rotate thermostat dial to lowest setting.
10. Check across screw terminals of control (see illustration 13).
 - A) Continuity NOT present, thermostat is okay.
 - B) Continuity IS present, replace thermostat.

⚠ WARNING
High voltage exposure. To avoid hazard to life or property, use extreme caution when making voltage checks.

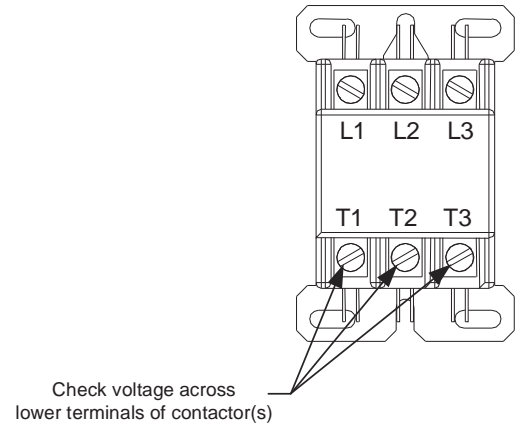


Illustration 12

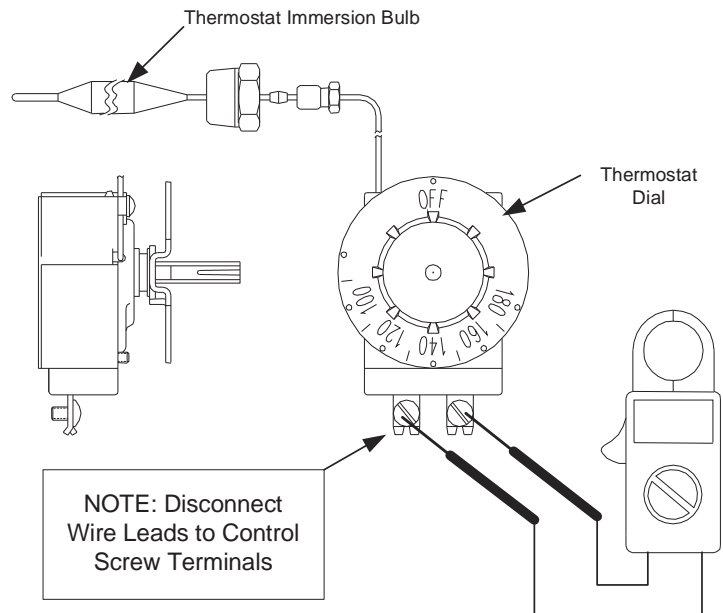


Illustration 13

SERVICE PROCEDURE X

Contactors Testing

Contactor Operation Testing.

⚠ WARNING
High voltage exposure. To avoid hazard to life or property, use extreme caution when making voltage checks.

Noisy Contactor.

Noisy or chattering contactor operation in most cases is due to voltage variations being supplied to the water heater. Extended periods of voltage variations will cause damage to the operating coil of the contactor causing noisy operation. Determine that service voltage to the unit meets the electrical requirements per the rating plate located on the front of the water heater.

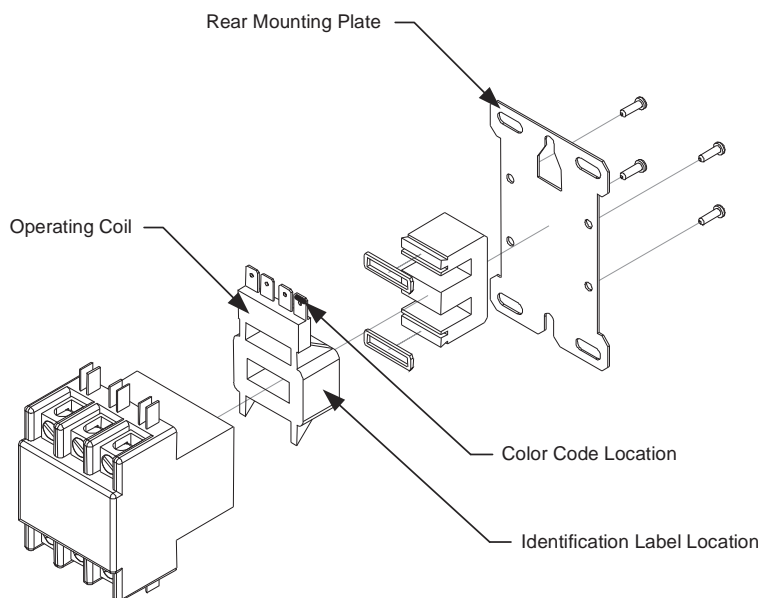
In addition, debris between the contact plates will cause noisy operation.

Contactor Operating Coils.

Contactor operation is achieved by energizing an operating coil in response to a call for heat from the thermostat. There are three different operating coils used depending on voltage rating of the water heater as follows:

<u>Description</u>	<u>Color Code</u>
208/240 Volt Coil	Green
277 Volt Coil	Blue
480 Volt Coil	Black

All the coils have a color code for visual confirmation. In addition, the 277 and 480 volt coils are labeled with voltage rating for proper identification. All contactors supplied for replacement are equipped with the 208/240 volt operating coil. By removing the rear mounting plate of the contactor, the operating coils can be changed based on desired service voltage. When contactor replacement is required be sure to order the proper operating coil base on the voltage rating found on the rating plate located on the front of the water heater.



SERVICE PROCEDURE X Contactor Testing

Contactor Operation Testing (continued).

This procedure assumes control circuit is operating correctly.

Providing the water temperature in tank is within the operating range of the thermostat, checking contactor operating can be as simple as rotating the thermostat dial and listening to the contactor(s) to see if they respond to a call for heat.

1. Turn power "ON" and rotate thermostat dial to the maximum setting. With water temperature in tank below the thermostat setting the contactor(s) will close. With the contacts closed, check for line voltage across operating coil terminals (see illustration 14).

- A) Line voltage IS present, go to step 2.
- B) Line voltage NOT present, verify control circuit operation.

2. Check for rated voltage across lower terminals of contactor(s) (see illustration 15).

- A) Rated voltage IS present, go to step 3.
- B) Rated voltage NOT present, replace contactor.

3. Rotate thermostat dial to the minimum setting. With water temperature in tank above thermostat setting, the contactor(s) will open. With the contacts open, voltage should not be present at lower terminals of contactor(s).

4. Check for line voltage across operating coil terminals (see illustration 14).

- A) Line voltage IS present, verify control circuit operation.
- B) Line voltage NOT present, go to step 5.

5. Check for rated voltage across lower terminals of contactor(s) (see illustration 15).

- A) Rated voltage IS present, replace contactor.
- B) Rated voltage NOT present, contactor is okay.

⚠ WARNING
High voltage exposure. To avoid hazard to life or property, use extreme caution when making voltage checks.

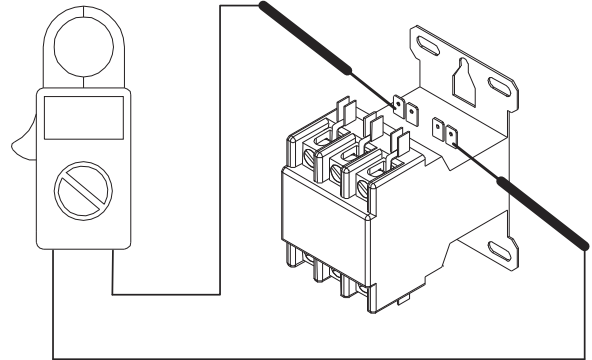


Illustration 14

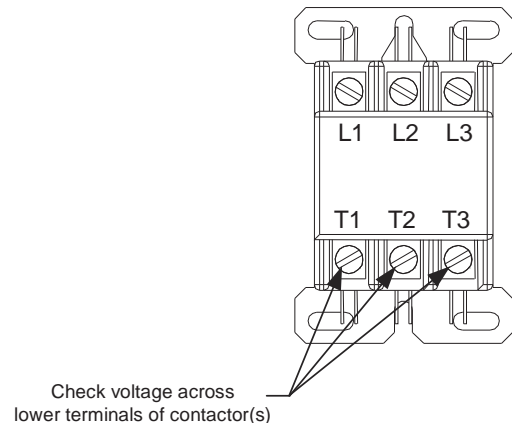


Illustration 15

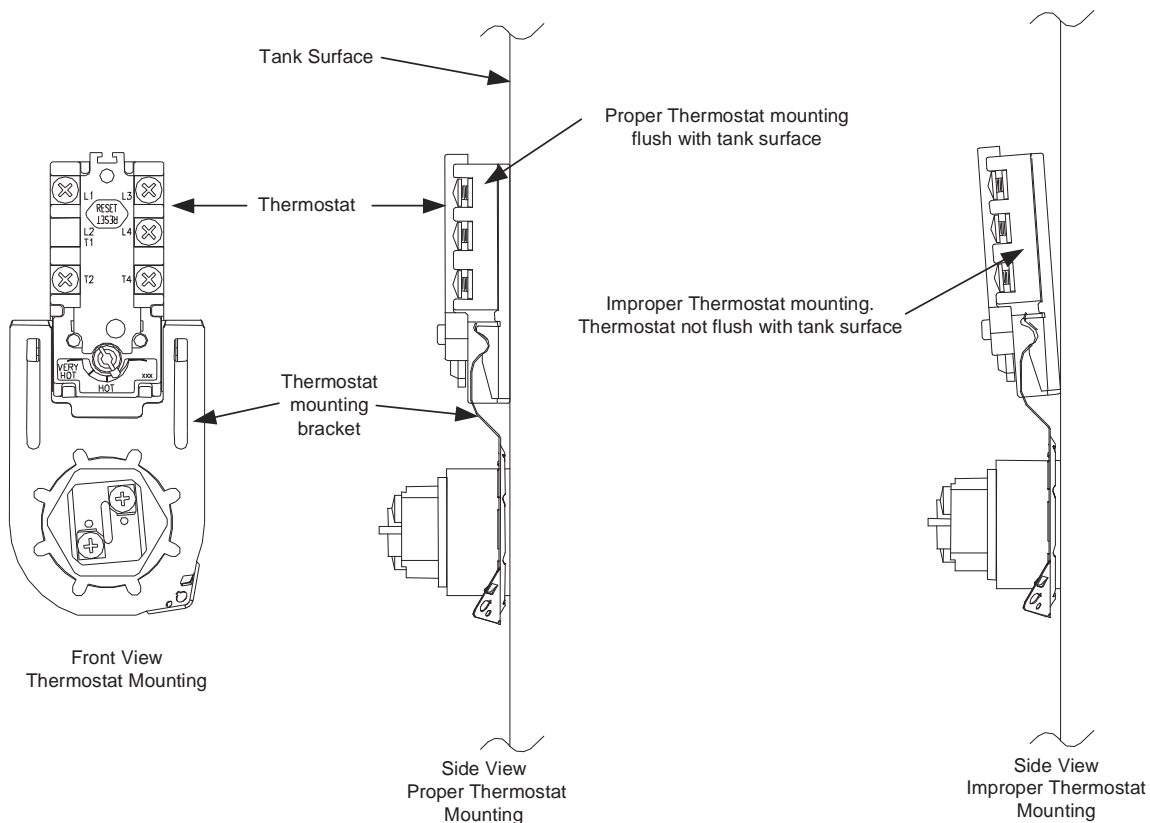
SERVICE PROCEDURE XI

Thermostat Removal and Replacement

Surface Mounted Thermostat Removal and Replacement

1. **STOP, DANGER! Turn power "OFF" to water heater.**
2. Remove access cover from lower control. Remove insulation from inside of control box. Remove plastic cover from thermostat.
3. Disconnect wires from thermostat terminals. It may be necessary to label wires for proper reconnection to new thermostat.
4. Note thermostat temperature setting for proper setting of new thermostat.
5. Slide thermostat upwards and out of mounting bracket.
6. Use a stiff brush to remove any debris or loose scale from tank surface where new thermostat will be installed.
7. Slide new thermostat down into thermostat bracket until it snaps into place. **IMPORTANT** - thermostat must set completely flat or flush to tank surface. An improperly installed thermostat will cause improper water heater operation.
8. Refer to the wire diagram located on the inside of the upper control box cover and reconnect wires to the thermostat. Be sure wire connections are snug and corrosion free. Do not over tighten as that may damage thermostat.
9. Set thermostat to the original thermostat setting found on the old thermostat.
10. Restore power to water heater and verify proper heater operation.

⚠ WARNING
High voltage exposure. To avoid hazard to life or property, be sure power is turned OFF to water heater while performing this procedure.



Immersion Thermostat Removal and Replacement

1. **STOP, DANGER! Turn power "OFF" to water heater.**
2. Turn off cold water supply to heater. Connect hose to drain spigot of water heater and route to an open drain. Open a nearby hot water faucet to vent heater for draining. Open drain spigot of water heater and allow water heater to drain to a point below the immersion bulb location (see illustration 16).
3. Close drain spigot and remove hose.
4. Remove lower control box cover and insulation.
5. Locate thermostat inside lower control box mounted to the right side of the box below the ECO control (see illustration 16).
6. Follow copper capillary tube from thermostat to the immersion bulb location and remove immersion bulb from tank using 11/16" wrench.
7. Remove (pull) thermostat control dial from stem of thermostat.
8. Remove the two thermostat mounting screws located under thermostat dial (see illustration 16).
9. Once thermostat is removed, disconnect wire leads to the thermostat. NOTE: It may be necessary to identify wires for proper reconnection to new thermostat.
10. Refer to wiring diagram located on the inside of the upper control box cover and properly reconnect wire leads to new thermostat and remount control inside control box using screws from step 8.
11. Replace control dial to stem of thermostat.
12. Loosen ferrule nut of immersion bulb (see illustration 17).

⚠ WARNING

High voltage exposure. To avoid hazard to life or property, be sure power is turned OFF to water heater while performing this procedure.

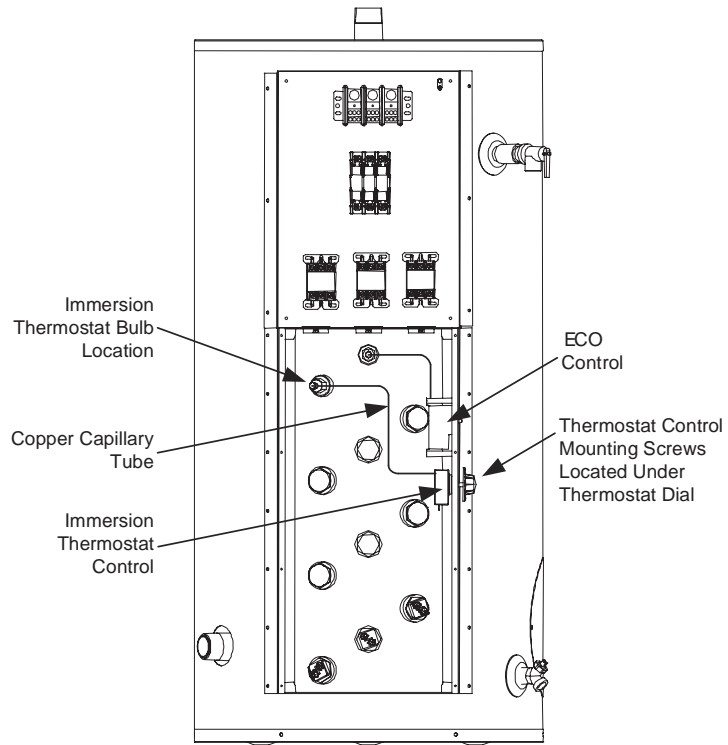


Illustration 16

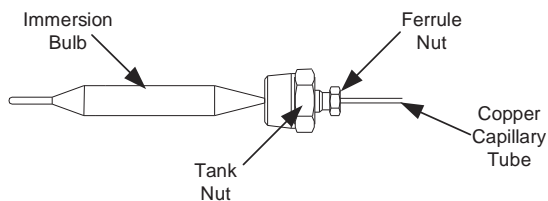


Illustration 17

13. Position tank nut at end of immersion bulb as shown in illustration 17. Insert immersion bulb into tank and tighten tank nut.
14. Gently pull copper capillary tube to insure the immersion bulb is in a horizontal position as shown in illustration 17 and tighten ferrule nut.
15. Resume water supply, full tank and check for leaks.
16. Be sure tank is full of water and resume power supply to water heater. Verify proper thermostat operation.

SERVICE PROCEDURE XIII
Contactor Model High Limit (ECO) Control
Removal and Replacement

**Contactor Model High Limit (ECO) Control
Removal and Replacement.**

1. **STOP, DANGER! Turn power "OFF" to water heater.**
2. Turn off cold water supply to heater. Connect hose to drain spigot of water heater and route to an open drain. Open a nearby hot water faucet to vent heater for draining. Open drain spigot of water heater and allow water heater to drain to a point below the immersion bulb location (see illustration 18).
3. Close drain spigot and remove hose.
4. Remove lower control box cover and insulation.
5. Locate ECO Control inside lower control box mounted to the right side of the box above the thermostat control (see illustration 18).
6. Follow copper capillary tube from ECO Control to the immersion bulb location and remove immersion bulb from tank using 11/16" wrench.
7. Remove the two ECO control mounting screws located outside the lower control box.
8. Once ECO control is removed, disconnect wire leads to the control. NOTE: It may be necessary to identify wires for proper reconnection to new control.
9. Refer to wiring diagram located on the inside of the upper control box cover and properly reconnect wire leads to new ECO control and remount control inside control box using screws from step 7.
10. Loosen ferrule nut of immersion bulb. (see illustration 19).

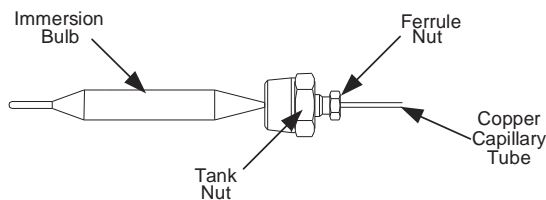


Illustration 19

11. Position tank nut at end of immersion bulb as shown in illustration 19. Insert immersion bulb into tank and tighten tank nut.
12. Gently pull copper capillary tube to insure the immersion bulb is in a horizontal position as shown in illustration 19 and tighten ferrule nut.
13. Resume water supply, full tank and check for leaks.
14. Be sure tank is full of water and resume power supply to water heater. Verify proper ECO operation.

⚠ WARNING

High voltage exposure. To avoid hazard to life or property, be sure power is turned OFF to water heater while performing this procedure.

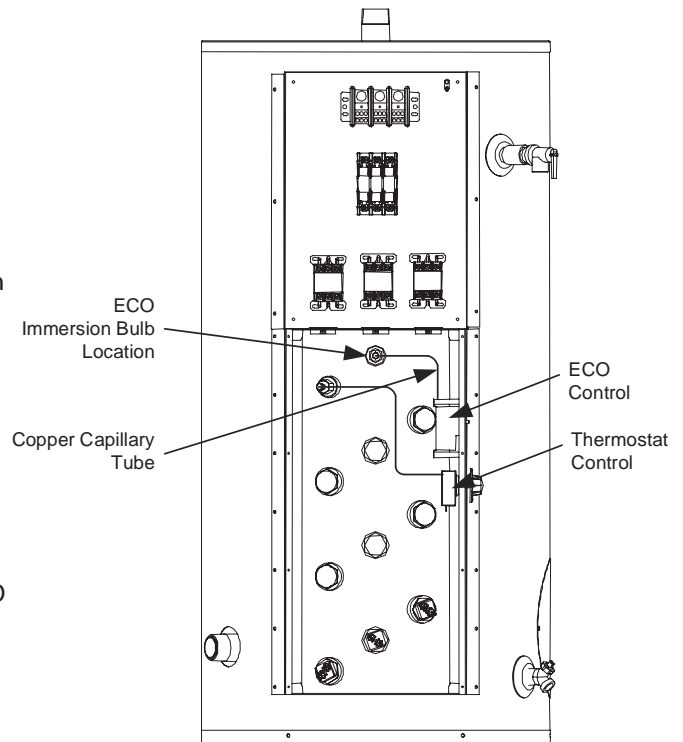


Illustration 18

SERVICE PROCEDURE XIV
600V Model High Limit (ECO) Control
Removal and Replacement

600V Surface Thermostat Model High Limit (ECO) Control Removal and Replacement.

1. **STOP, DANGER! Turn power "OFF" to water heater.**
2. Remove lower control box cover and insulation.
3. Locate high limit switch (ECO) mounted to the tank above the element spuds (see illustration 20).
4. Disconnect wire leads to the ECO. NOTE: It may be necessary to identify wires for proper reconnection to the new control.
5. Remove the two ECO mounting nuts holding the sensor to the tank. Take care not to damage the mounting studs.
6. Fasten the replacement ECO to the tank using the nuts from step 5. Take care not to damage the mounting studs. Refer to wiring diagram located on the inside of the upper control box cover and properly reconnect wire leads to new ECO.
7. Verify proper ECO operation.

⚠ WARNING
High voltage exposure. To avoid hazard to life or property, be sure power is turned OFF to water heater while performing this procedure.

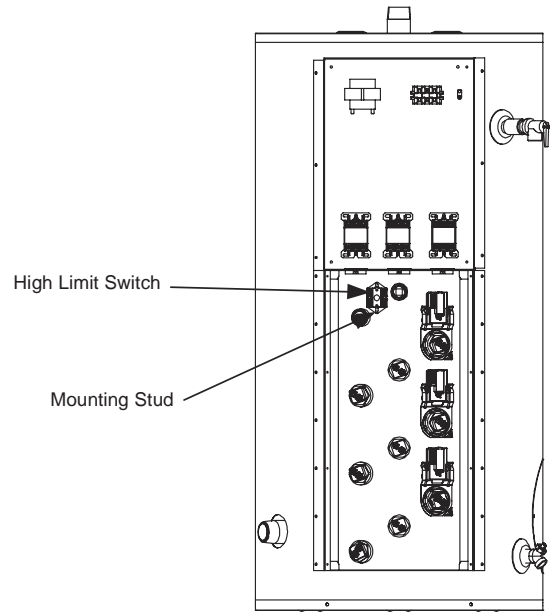


Illustration 20

SERVICE PROCEDURE XV

Heating Element Removal and Replacement

Heating Element Removal and Replacement.

1. **STOP, DANGER! Turn power "OFF" to water heater.**
2. Turn off cold water supply to heater. Connect hose to drain spigot of water heater and route to an open drain. Open a nearby hot water faucet to vent heater for draining. Open drain spigot of water heater and allow heater to drain to a point below the element(s).
3. Close drain spigot and remove hose.
4. Remove access cover and insulation from lower control box. Remove plastic cover from thermostat.
5. Disconnect wires from element terminals.
6. Remove element from tank using 1-1/2" deep well socket or appropriate wrench. Unscrew element counter-clockwise to remove from tank.
7. Be sure to remove old element gasket from the tank. It is recommended to replace the gasket with a new one.
8. Check new element terminal block for proper electrical rating. NOTE: Some elements have dual ratings, be sure to check all surfaces of the element terminal block (see illustration 21).
9. Apply new element gasket to the new element. Be sure gasket is seated flat against element flange without rolls or gaps (see illustration 21).
10. Clean any debris from element fitting on tank.
11. Thread new element clockwise into tank. Tighten element using 1-1/2" deep well socket or appropriate wrench. Do not over tighten, over tightening may damage element gasket.
12. Reconnect wires to element. Be sure connections are snug and corrosion free. Do not over right as that may damage terminal block.
13. Resume water supply to heater. Be sure tank is full of water and check for leaks.
14. Reinstall plastic thermostat protector(s).
15. Reinstall insulation and control box cover.
16. To resume operation **BE SURE TANK IS FULL OF WATER** and restore power to water heater. Verify proper heater operation.

⚠ WARNING

High voltage exposure. To avoid hazard to life or property, be sure power is turned OFF to water heater while performing this procedure.

⚠ WARNING

Heater components and stored water may be **HOT** when performing the following steps in this procedure. Take necessary precaution to prevent personal injury.

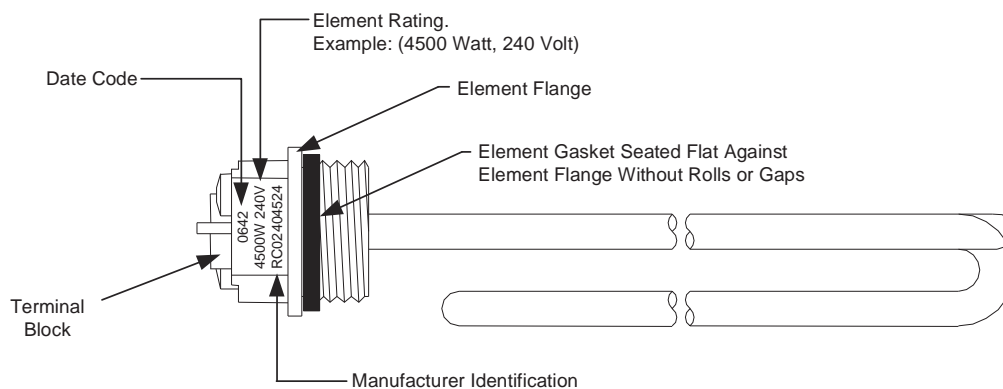


Illustration 21

Anode Rod Inspection and Replacement.

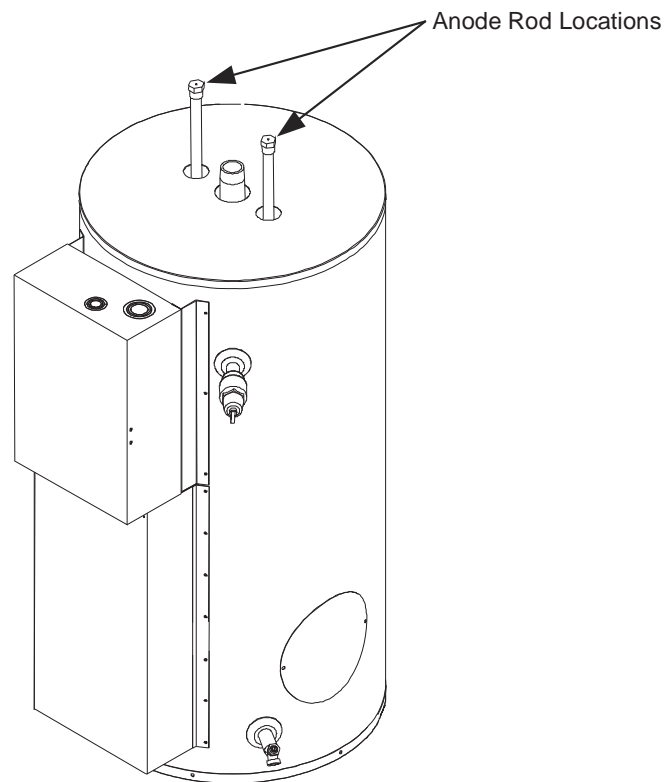
1. **STOP, DANGER! Turn power "OFF" to water heater.**
2. Turn off cold water supply to heater. Connect hose to drain spigot of water heater and route to an open drain. Open a nearby hot water faucet to vent heater for draining. Open drain spigot of water heater and allow heater to drain to a point below the anode rod locations at the top of the tank.
3. Close drain spigot and remove hose.
4. Remove the plastic anode rod access plugs at the anode rod locations.
5. Remove anode rods from the water heater using a 1-1/16" socket wrench.
6. Visually inspect anode rods. Anode rods should show signs of depletion, this is normal. If depletion is 1/2 of the original anode rod diameter (original diameter is approximately 3/4"), replacement is recommended. If any of the steel core of the anode rod is exposed, replacement is recommended.
7. Upon completion of inspection and/or subsequent replacement of the anode rod, reinstall the anode into the water heater, resume water supply, refill water heater with water and check for leaks.
8. To resume operation, **BE SURE TANK IS FULL OF WATER** and turn power "ON" to water heater.

⚠ WARNING

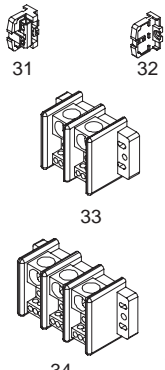
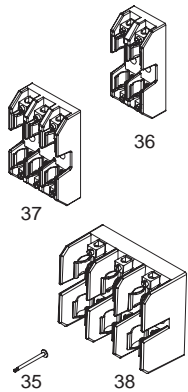
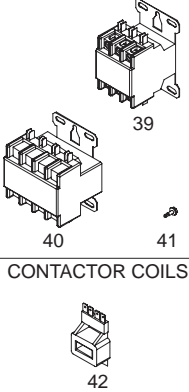
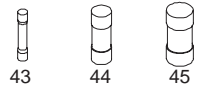
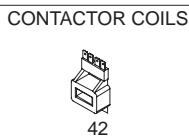
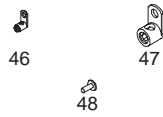
High voltage exposure. To avoid hazard to life or property, be sure power is turned OFF to water heater while performing this procedure.

⚠ WARNING

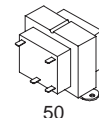
Heater components and stored water may be **HOT** when performing the following steps in this procedure. Take necessary precaution to prevent personal injury.



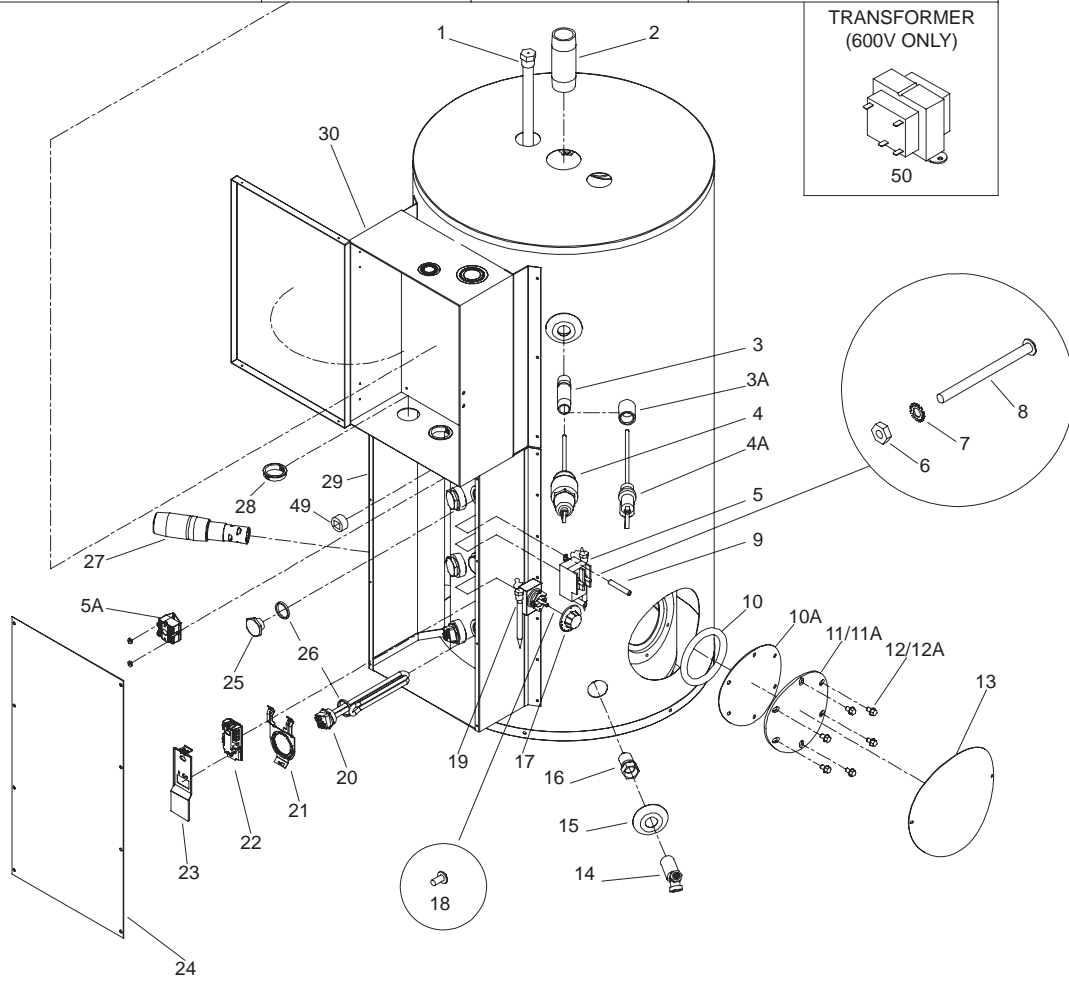
GENERIC PARTS LIST

TERMINAL BLOCKS	FUSE BLOCKS	CONTACTORS	FUSES
 <p>31 32</p> <p>33</p> <p>34</p>	 <p>36</p> <p>37</p> <p>38</p>	 <p>39</p> <p>40 41</p> <p>42</p>	 <p>43 44 45</p>
		<p>CONTACTOR COILS</p>  <p>40 41</p> <p>42</p>	<p>GROUND LUGS</p>  <p>46 47</p> <p>48</p>

TRANSFORMER
(600V ONLY)



50



GENERIC PARTS LIST

<u>Item</u>	<u>Description</u>	<u>Item</u>	<u>Description</u>
1	Anode Rod	24	Lower Control Box Cover
2	Hot Water Outlet Nipple	25	Heating Element Plug
3	T&P Nipple	26	Heating Element Gasket
3A	T&P Coupling	27	Cold Water Inlet Nipple
4	T&P Relief Valve	28	Plastic Snap Bushing
5	High Limit Switch	29	Lower Control Box
5A	Surface High Limit Switch	30	Upper Control Box
6	Hex Nut	31	Terminal Block (Block A)
7	Lock Washer	32	Terminal Block End (used for Block A)
8	Screw	33	Terminal Block 2 Pole
9	High Limit Spacer	34	Terminal Block 3 Pole
10	Cleanout O-Ring	35	Screw
10A	Cleanout Gasket (ASME)	36	Fuse Block 2 Pole, Class G
11	Cleanout Cover	37	Fuse Block 3 Pole, Class G
11A	Cleanout Cover (ASME)	38	Fuse Block 3 Pole, Class J
12	Cleanout Cover Screw	39	Contactor 3 Pole
12A	Cleanout Cover Screw (ASME)	40	Contactor 4 Pole
13	Cleanout Access Cover	41	Screw
14	Brass Drain Valve	42	Contactor Coil
15	Escutcheon	43	Fuse, Class G
16	Drain Extender	44	Fuse, Class J
17	Thermostat Dial	45	Fuse, Class J
18	Screw	46	Ground Lug Small
19	Immersion Thermostat	47	Ground Lug Large
20	Heating Element	48	Screw
21	Surface Thermostat Bracket	49	¾" NPT Plug
22	Surface Thermostat	50	Transformer - 120V
23	Surface Thermostat Cover		

Glossary of Terms

<u>Term</u>	<u>Definition</u>	<u>Unit of Measure</u>
Voltage	Electrical potential	Volts
Current	Rate of voltage flow	Amperes (amp)
Resistance	Ability of a device to dissipate power irreversibly	Ohms
Energy	Ability to do work	kW/hr, Joule
Power	Energy per unit of time	Watts, kW, VA

One Kilowatt (1kW) = 1,000 Watts = 3,412 BTU

DC = Direct Current

AC = Alternating Current

Hz = Hertz

°F = Degrees Fahrenheit

°C = Degree Centigrade

BTUH = British Thermal Units per Hour

PSI = Pounds per Square Inch

GPM = Gallons per Minute

GPH = Gallons per Hour

ECO - Energy Cut Off

NPT - National Pipe Thread

ASME - American Society of Mechanical Engineers





Madison, Wisconsin

***For U.S. and Canada field service,
contact your professional installer or
local Bock Water Heaters sales representative***

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Fax/608-327-3311

Technical Support/888-784-8322

Fax/610-683-9208

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