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Questions, comments, and suggestions for this manual may be directed to the Technical Training Administrator.

*** * *Caution and Warning* * ***

Before inspecting, diagnosing, repairing or operating any water heater, be sure to examine all of the safety and warning labels on the tank. Follow the instructions on these warning labels. Read and understand the Use and Care Manual that was shipped with the water heater. Failure to do so can result in unsafe operation of the water heater resulting in property damage, bodily injury, or death. Should you have any problems reading or following the instructions in the Use and Care Manual, seek the help of a licensed and qualified professional.

Please ensure you check and comply with all local codes and ordinances regarding water heating products.

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RHEEM WATER HEATERS

**RUUD
WATER
HEATERS**

**Technical Support Line
Service Department
1-800-HEATER3
1-800-432-8373**



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Montgomery, AL 36109-1413
FAX (334) 260-1341
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NOTES

This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

RESIDENTIAL ELECTRIC **SEQUENCE OF OPERATIONS**

This sequence is for a residential non-simultaneous operation
240 volt water heater.

Tank is cold, full of water and power connected to upper thermostat	NO	Fill tank Ensure power connections are present (tank must be filled with water when power is applied to prevent dry firing ele- ments)
YES		
Power is applied to the upper thermostat	NO	Check L1 and L2 leg for 240V at terminals 1 and 3 before the high limit switch. Replace fuse or reset break- er. Check each leg (L1 and L2) for 120V
YES		
Power is routed through the high limit switch	NO	Press and reset high limit switch (red button) Check for 240V at terminals 2 and 4 past high limit switch
YES		
Upper thermostat is cold and calls for heat. Element receives power and heats the water	NO	Check for 240V at terminal 2 past the thermostat switch pole and terminal 4 past the high limit switch Check continuity and grounding of upper heating element
YES		
Upper thermostat is satisfied and routes power to lower thermostat	NO	Check for 240V at terminal 4 past the high limit switch and terminal 4 on upper ther- mostat
YES		

Table 1 - Residential Electric Sequence of Operations

Lower thermostat is cold and calls for heat. Element receives power and heats the water	NO	Check for 240V at terminal 4 past the high limit switch and terminal 1 and 2 on lower thermostat Check continuity and grounding of lower heating element
YES		
Lower thermostat is satisfied; thermostat opens	NO	Call for heat has ended. Water is heated to thermostat setting

ELECTRIC THERMOSTATS

A thermostat is a heat sensitive mechanical device that controls the flow of electrical current to various parts of the water heater. First, the thermostat senses the presence of heat through bi-metal disc located on the back side of the thermostat. Second, by sensing the presence of heat, the thermostat can control electrical current that is sent to another thermostat or to a heating element. A water heater may contain one or two thermostats, called upper and lower thermostats. In this configuration, each thermostat controls one heating element.

Figure 1 - Upper Thermostat

The upper thermostat, Fig. 1, contains the ECO and the thermostat itself. If you look on the back side of the thermostat, you will see the ECO temperature limit. This particular thermostat will heat water to 150° F and the ECO will trip at 170° F.

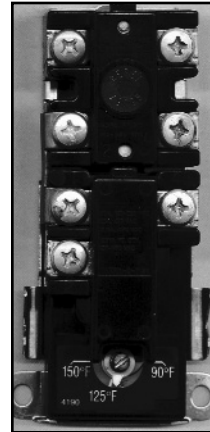


Figure 2 - Upper Thermostat ECO Trip

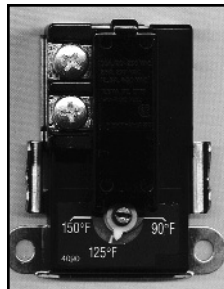


Figure 3 - Lower Thermostat

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SIMULTANEOUS AND NON-SIMULTANEOUS OPERATIONS

A residential electric water heater may operate in a simultaneous or non-simultaneous mode. Simultaneous means that both heating elements, the upper and the lower, can heat at the same time. This is useful when there is a requirement for a rapid recovery time. Non-simultaneous operation means that only one of the heating elements, either the upper OR the lower, may heat at a time. As hot water is drawn from the tank, it is replaced by cold water from the dip tube. The cold water enters the bottom of the tank and the lower thermostat senses a heat change. The lower heating element will heat the incoming cold water. If you use all the hot water in the tank, the upper thermostat will demand heat and withdraw power from the bottom of the tank.

THERMOSTAT SEQUENCE OF OPERATIONS

Therm-O-Disc Thermostats -Non-Simultaneous Operation: (only one element can operate at a time)

1. Check data plate for heater rating

Upper element	4500 watts
Lower element	4500 watts
Total	4500 Watts

2. Sequence of Operation (2-wire; 240V residential non-simultaneous):

Each heating element has 120 VAC going to one side of the element at all times. The upper and lower thermostat operation control the other 120 VAC flow to the other side of the heating elements. The heating elements require 240 VAC to heat the water. Here is how it works:

Tank water is cold.

Therefore upper thermostat contacts are closed (current is allowed to flow)

Power (120VAC) from L1 is passed through the ECO and out the yellow wire to one side of the upper heating element.

Power (120VAC) from L2 is passed through the ECO and out the blue wire to the other side of the upper heating element.

The upper heating element now has 240 VAC and begins heating.

Element heats until the upper thermostat is satisfied and opens (no current flow) at the temperature setting.

Power is discontinued to the upper element because power is interrupted through the yellow wire.

The water in the upper third to one-half of the tank is hot; while

the bottom portion of the tank still contains cold water. As long as the upper thermostat is satisfied, it will redirect power to the lower thermostat.

3. Once the upper thermostat is satisfied, the contacts move and extend power out the black lead to the lower thermostat.

The lower thermostat contacts are closed because of the cold water in the bottom of the tank.

Power is extended to the lower element through the black lead

Power (120VAC) from L2 is passed through the ECO and out the red wire to the other side of the lower heating element.

The lower heating element now has 240VAC and begins heating.

Element heats until the lower thermostat is satisfied and opens (no current flow) at the temperature setting.

Power is discontinued to the lower element because power is interrupted through the black wire.

All the water in the tank is now hot.

4. As hot water is used, it is replaced by cold water entering the tank through the dip tube. The dip tube deposits the cold water into the bottom of the tank. The upper thermostat is still satisfied because the colder water has not reached it. While the upper thermostat is satisfied, the contacts are directing power to the lower thermostat.

Figure 4 - Therm-O-Disc Thermostat Wiring



The lower thermostat is the first thermostat to sense a change in temperature and the contacts close. Power is extended to the lower element through the black lead and the cycle starts again.

5. The lower thermostat will continue to heat until it is satisfied or the upper thermostat receives a demand for heat. This will take place when there is a high hot water demand, such as lengthy or multiple showers. When the upper thermostat receives a demand for heat, it opens (suspends power) to the lower thermostat and sends power to the upper heating element.

Pocket Diagnostics Manual (Rev 1)
HOW TO CHECK THERMOSTATS

To perform this test you will need a multimeter capable of reading voltage. You may also use a test lamp to measure voltage; however, test lamps do not discriminate between 120V and 208V and 240V. Some of these test procedures will not be accurate if a heating element is defective. It is recommended that you check the heating elements for open circuits or grounding before you check the continuity of the thermostats.

Check for power to the water heater:

1. Check manual switch, fuses and breakers.

2. Determine power to heater.
Check with a multimeter or test lamp across terminals 1 and 3 (L1 black and L2 red). If power is being supplied, meter will register 240V or lamp will light.
NOTE: If you are using a wide spectrum test lamp (50-400V) you may receive a false reading. If there is no power supply to the thermostat, the problem is not the heater; the problem is the power feed to the heater.

3. Determine power through the high limit switch. Place test prongs on terminals 2 and 4. If power is being supplied, meter will register 240V or lamp will light.

Check operation of upper thermostat:



Figure 5 - Upper Thermostat & Heating Element Wiring

1. Turn the temperature dial on the upper thermostat to its highest setting. Turn the temperature dial on the lower thermostat to its lowest setting. This forces the upper thermostat to call for heat and the lower thermostat to turn off. Place the test prongs on terminal 1 (bottom of the bus bar) and the blue wire side of the upper heating element. This test checks for the presence of power between the thermostat and the heating element. If power is being supplied, the meter will register 240V or lamp will light.

2. Move the test prong from terminal 1 to terminal 2; the other test prong remains on the blue wire side of the upper heating element. This test checks the operation of the switch pole between the upper thermostat and upper element. If power is being supplied, the meter will register 240V or the lamp will light. If meter fails to register, the upper thermostat is defective and should be replaced. (This portion of the test will prove faulty if the heating elements is open or grounded.)

Check operation of the lower thermostat:

1. Turn the temperature dial on the upper thermostat to its lowest setting. Turn the temperature dial on the lower thermostat to its highest setting. This forces the upper thermostat to satisfy, redirect power to the lower thermostat and the lower thermostat to call for heat. Place the test prongs on terminal 1 of the lower thermostat the red wire side of the lower heating element. This test checks the operation of the switch pole between the upper and lower thermostat and checks for the presence of power between the lower thermostat and the heating element. If power is being supplied, the meter will register 240V or lamp will light. If meter fails to register, the upper thermostat has a defective switch pole and should be replaced.



Figure 6 - Lower Thermostat & Heating Element Wiring

2. Move the test prong from terminal 1 of the lower thermostat to terminal 2; the other test prong remains on the red wire side of the lower heating element. This test checks the operation of the switch pole on the lower thermostat. If power is being supplied, the meter will register 240V or the lamp will light. If meter fails to register, the lower thermostat is defective and should be replaced.

REPLACING THE THERMOSTAT

This procedure applies to either the upper or lower thermostat.

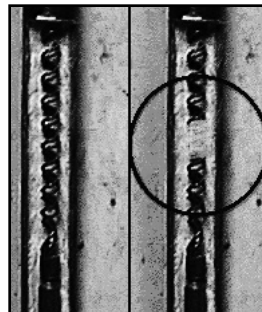
Before replacement, be sure you have selected the same identical thermostat type as on the water heater. Please note- Upper thermostats are usually not the same as the lower thermostat.

1. Before servicing the water heater, DISCONNECT or TURN OFF the main electric power breaker feeding the water heater. This is normally located on the electric service panel.
2. Remove the cover panel and insulation to expose the thermostat. Remove the plastic protective cover over the thermostat.
3. Before servicing the water heater thermostat, verify with a voltmeter, that voltage/power has been disconnected to the water heater. Measure for voltage at the top two screws of the thermostat. There should not be any power.
4. Disconnect the thermostat leads. Tag the leads before removal from the screw terminals to eliminate incorrect wiring problems.
5. Remove the thermostat by lifting it out of the retaining bracket. Be careful not to pull too hard on the retaining bracket. Breaking the bracket will require the entire water heater to be replaced.
6. Replace the unserviceable thermostat with a new identical thermostat. Ensure the back of the thermostat is pressing tightly against the tank. Re-wire per diagram in the Use and Care booklet that came the water heater or your tagged leads.
7. Double check to be sure your wire connections are correct and they are firm and tight.
8. Replace the plastic protective cover to the thermostat.
9. Re-establish the electric power to the water heater.
10. Adjust the thermostat so the water temperature does not exceed 120° F.
11. Cycle test the water heater to be certain of proper operation.
12. Replace the insulation and cover panel.

HOW TO CHECK AN OPEN HEATING ELEMENT

Figure 7 - Broken (open) Heating Element

An open element is a condition where the nichrome filament wire is broken somewhere on the inside of the heating element and you cannot tell by a visual inspection. The electrical connection is 'open' and the electrical current cannot flow along the path of the filament.



1. Turn off the power to the water heater. Check for the presence of power with a multimeter.

2. Remove both wires from the screw terminals of the heating element.

3. Place test probes of the OHM meter on both screw terminals. If the OHM meter does not register a resistance, the element is open and should be replaced.

HOW TO CHECK FOR A GROUNDED ELEMENT

4. With the power remaining off place one test probe on either of the screw terminals and the other test probe to the steel inner tank. If the OHM meter registers any resistance, the element is grounded and should be replaced.

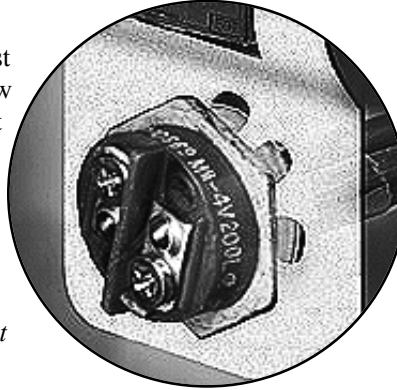


Figure 8 - Heating Element Head

REPLACING THE HEATING ELEMENT

Heating elements in Rheem electric water heaters are screw in immersion type equipped with a one inch threaded pug. They can best be replaced with a standard 1 1/2 inch hex socket wrench.

1. Turn off the power to the water heater. Check for the presence of power with a multimeter or test lamp.
2. Turn off the cold water supply at the shut off valve. Open a hot water faucet or the T&P valve to relieve the pressure inside the tank. Open the drain valve at the bottom of the tank and drain water to below the level of the element.
3. Remove both wires from the element terminal screws.
4. Using a 1 1/2 inch hex socket wrench, remove the element. Check the shoulders of the element seat on the tank and remove any remainder of the gasket material.
5. Install a new element and gasket. Reconnect wires to the terminal screws.
6. Insure drain valve at the bottom of the tank is closed. Turn on the cold water supply and fill the tank. Purge all the air from the tank through the open faucet in step 2.
7. Close faucet, check for leaks and return power to the water heater.
8. Check thermostat for a safe temperature setting.

Branch Circuit Sizing Guide						
Total Water Heater Wattage	Recommended Over Current Protection (Fuse or Circuit Breaker) Amperage Rating			Copper Wire Size AWG based on N. E. C. Table 310-16 (60°)		
	120V	208V	240V	120V	208V	240V
1,500 *	20	15	15	12	14	14
1,700	20	- - -	- - -	12	- - -	- - -
2,000	25	15	15	10	14	14
2,500	30	15	15	10	14	14
3,000	35	20	20	8	12	12
3,500	- - -	25	20	- - -	10	12
3,800	- - -	25	20	- - -	10	12
4,000	- - -	25	25	- - -	10	10
4,500	- - -	30	25	- - -	10	10
5,000	- - -	30	30	- - -	10	10
5,500	- - -	35	30	- - -	8	10
6,000	- - -	40	35	- - -	8	8
9,000	- - -	60	50	- - -	6	6
10,000	- - -	70	60	- - -	4	6
11,500	- - -	- - -	60	- - -	- - -	6
* Less than 1,500 watts may be wired 14 gauge with 15 amp protection. Check local codes, as they will apply.						

Table 2 - Branch Circuit Wiring Table

HEATING ELEMENT PROPERTIES						
Wattage	120 Volts		208 Volts		240 Volts	
	Amps	Ohms	Amps	Ohms	Amps	Ohms
1500	12.5	9.6	7.2	28.8	6.3	38.4
2000	16.7	7.2	9.6	21.6	8.3	28.8
2500	20.8	5.8	12.0	17.3	10.4	23.0
3000	25.0	4.8	14.4	14.4	12.5	19.2
3500	--	--	16.8	12.4	14.6	16.5
4000	--	--	19.2	10.8	16.7	14.4
4500	--	--	21.6	9.6	18.8	12.8
5000	--	--	24.0	8.7	20.8	11.5
5500	--	--	26.4	7.9	22.9	10.5
6000	--	--	28.8	7.2	25.0	9.6

Table 3 - Heating Element Properties

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RESIDENTIAL ELECTRIC TROUBLESHOOTING
TABLE

NATURE OF TROUBLE	POSSIBLE CAUSES	SERVICE
No Hot Water	1. Manual switch turned off 2. Blown fuse of breaker 3. High limit switch tripped 4. Upper Thermostat defective 5. Upper Element Defective 6. Grounded thermostat 7. Thermostat out of calibration 8. Improper wiring a. Shorted or loose wiring b. Undersized service wire	Turn to ON Replace or reset Manually reset ECO button Check and replace Check and replace Check and replace Check, tighten and replace Check and replace Rewire per wiring diagram
Not Enough Hot Water	1. Thermostat set too low 2. Defective lower element 3. Defective lower thermostat or mis-wired thermostat 4. Improper wiring 5. Loose wiring 6. Improper heating elements 7. Scale formation on heating elements 8. Thermostat not flush with tank 9. Poor grounding of tank 10. Heater is under-sized 11. Damaged dip tube	Increase thermostat setting not to exceed 120 degrees Check and replace Check and replace Rewire per wiring diagram Check and tighten Check wattage and replace Check elements; clean or replace Position thermostat so back touches the tank Check grounding and tighten Resize residence and compare Check and replace

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NATURE OF TROUBLE	POSSIBLE CAUSES	SERVICE
Water too hot	1. Thermostat setting too high 2. Thermostat out of calibration 3. Thermostat not flush with tank 4. Grounded element	Lower thermostat setting Check and replace Position thermostat so back touches the tank Check and replace
Slow hot water recovery	1. Heating elements too small 2. Lower thermostat is defective	Check wattage and replace Check lower thermostat and replace
Noisy heating element	1. Scale build-up on elements 2. High watt density elements in the heater	Remove, clean or replace Install low watt density elements
Excessive relief valve operation	1. Excessive water pressure 2. Excessive temperature	Install proper pressure reducing valve on cold side. Check for open or closed system. Install expansion tank. Check thermostat; lower setting or replace
Rusty or black water	1. Anode rod dissolved 2. Excessive sediment build-up	Check anode rod and replace Drain tank; replace tank if sediment build up is excessive
Smelly water (rotten egg odor)	Sulfate reducing bacteria formation inside water tank	Clean tank using chlorine bleach Replace anode rod if deteriorated Add automatic chlorine feeder to cold water inlet side of tank

Table 4 - Res Electric Troubleshooting & Repair Table

Pocket Diagnostics Manual (Rev 1)
RESIDENTIAL GAS STANDING PILOT

SEQUENCE OF OPERATIONS FLOWCHART

This sequence is for a residential standing pilot gas water heater.

Tank is cold, full of water and gas supply is connected to gas control valve	NO	Fill tank Ensure gas connections are present and no leaks Ensure water heater is properly vented
YES		
Gas cock knob is turned counter-clockwise to PILOT position	NO	Set gas cock knob to PILOT
YES		
Red pilot plunger is pushed down. Gas flows through control valve to pilot supply tube to pilot burner	NO	Check gas pressure Check for clogged pilot supply tube Check for clogged pilot burner
YES		
Flame is applied to pilot burner. Pilot gas ignites and begins heating thermocouple	NO	Check gas pressure Check for clogged pilot supply tube Check for clogged pilot burner
YES		
Thermocouple lead heats producing milivolt output to the ECO and thermocouple connection on the gas valve	NO	
YES		
Once heated, the milivolt current holds the magnet coil assembly open	NO	Test Thermocouple and magnet assembly Test ECO
YES		
Pilot plunger is released. Thermocouple holds gas valve open	NO	Test Thermocouple and magnet assembly; Test ECO
YES		

Table 5 - Residential Gas Sequence of Operations

Pocket Diagnostics Manual (Rev 1)

Pilot light remains lit		Test Thermocouple magnet assembly Check gas pressure Check pilot burner & pilot orifice Check pilot supply tube for crimping
-------------------------	--	---

NO

YES

Turn gas cock ON		
------------------	--	--

NO

YES

Gas flows through gas valve and main burner supply tube to burner plate		Check gas pressure Check main burner orifice for obstructions. Check main burner supply tube for obstructions. Check main burner venturi and ports for obstructions.
---	--	---

NO

YES

Pilot ignites main burner		Check gas pressure Check main burner orifice for obstructions. Check main burner supply tube for obstructions. Check main burner venturi and ports for obstructions
---------------------------	--	--

NO

YES

Main burner remains lit. Heats water to thermostat setting		Check gas pressure Check main burner orifice for obstructions. Check main burner supply tube for obstructions. Check main burner venturi and ports for obstructions.
--	--	---

NO

YES

Invar rod actuates main valve closed. Gas supply is interrupted		
---	--	--

NO

YES

Thermostat bulb expands pushing invar rod	NO	
YES		
Main burner shuts off. Water is hot	NO	
YES		
Pilot remains lit	NO	
YES		

GAS CONTROL VALVES

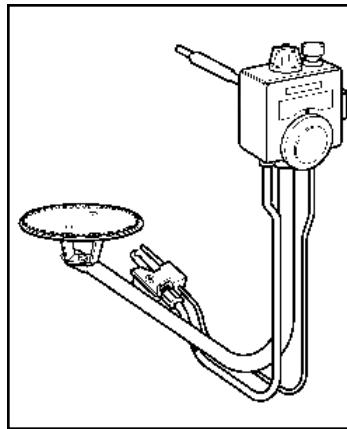
How it works

Let's start by setting the thermostat to the lowest setting and lighting the standing pilot. By pressing the red reset knob (pilot lighting knob) gas is introduced into the gas control valve. The gas cock knob has indentations that allow only one function at a time. The PILOT position allows gas to flow only through the gas valve to the pilot supply tube.

This gas is routed through the valve and independent pilot gas regulators (inside the gas control valve) to the pilot supply tube. The pilot supply tube carries the gas to the pilot burner. Before we can let go of the red reset knob, the thermocouple must heat. The thermocouple provides a milivolt electrical current to a magnetic assembly that holds the main inlet safety valve open.

Figure 9 - Burner Assembly

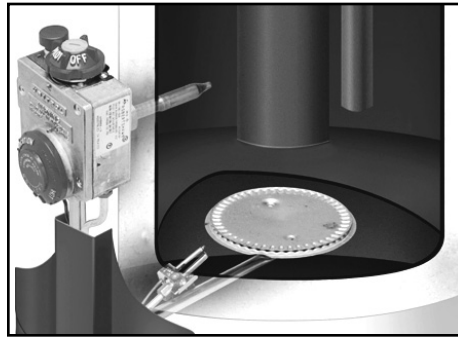
The thermocouple operates based on the binding of two dissimilar metals. The thermocouple is made of iron and nickel bonded at one end to form a hot junction. As the heat from the pilot burner (or match) is applied to the end of the thermocouple, the dissimilar metals produce a small electrical current called milivolt. The milivolt current is passed to the gas valve at the ECO and thermocouple connection. The milivolt current energizes the coil to the core making it a small magnet. This magnet holds open a safety valve that lets supply gas flow into the gas control valve. As long as the tip of the thermocouple



is hot, the milivolt current is produced, the magnet is energized and the gas valve is open.

With the thermocouple and magnet assembly energized, the red reset button is released. We now have a good pilot flame and supply gas pressure to the gas control valve. Next we would position the gas cock knob to the ON position. This will allow supply gas through the independent pilot regulator and the main valve regulator. The next component to activate is the thermostat.

The thermostat is immersed inside the water heater. It measures the temperature of the water and opens or closed the main valve, located inside the gas control valve housing. The copper thermostat bulb contains a rod called the invar rod. This rod moves back and forth as the copper thermostat expands and contracts in reaction to the heated water. The invar rod is connected to a snap action rocker mechanism. The thermostat dial on the outside of the gas control valve is also connected to the snap action rocker.



*Figure 10 -
Combustion
Chamber*

The thermostat senses the temperature change in the water. As the water heats the invar rod moves toward the snap rocker mechanism due to the expansion

of the copper thermostat bulb. At the proper temperature setting on the red thermostat dial, the rocker mechanism snaps the main valve closed. With the main valve closed, gas is interrupted to the main burner assembly and the flame is extinguished.

These three items, the thermostat dial, the snap rocker mechanism and the invar rod are all mechanically connected to react precisely with the temperature of the heated water to open and close the main valve. This rocker mechanism is either 'open' or 'closed'. We start with a cold tank of water, so the invar rod is withdrawn away from the rocker mechanism snapping the main valve open and sending gas through the main burner supply tube.

HOW TO CHECK THERMOSTAT CALIBRATION

The UNITROL thermostat is built into the gas control valve. It is a precision instrument which should never need recalibration. Check thermostat calibration by conducting a partial draw test at the closest hot water faucet. Let the hot water run for a few seconds to bleed off the cold water in the pipes. Water temperature should be within (+ or -)10° F of the thermostat setting. If not, replace the gas control valve. You can verify the accuracy of the thermostat by measuring hot water from the T&P valve. Compare the temperature of the water to the setting on the thermostat. Temperature should be at least the thermostat setting

HOW TO CHECK THERMOCOUPLE AND MAGNET ASSEMBLY

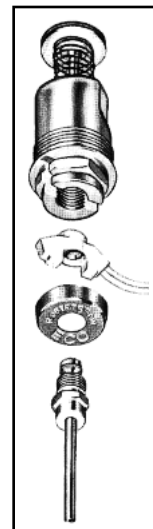
To conduct this test you will need a thermocouple adapter and a milivolt multimeter.

1. Remove thermocouple from the gas control valve. Connect the adapter to the magnet base of the gas control valve and reconnect the thermocouple. Be certain all connections are tight.
2. Connect once alligator clip to the thermocouple adapter housing. Connect the other alligator clip to the original thermocouple tube.
3. Set milivolt meter to thermocouple setting.
4. Follow standard lighting procedures to relight the water heater. Allow to burn for three minutes.
5. If meter reads 13 milivolts or higher, thermocouple is good.
6. If meter reads less than 13 milivolts, replace the thermocouple.

NOTE: If thermocouple is good, proceed to step 7 to check the magnet.

7. Leave meter connected to the adapter and with closed circuit output in excess of 13 milivolts, extinguish the pilot.
8. Watch the meter reading and listen for the magnet to release. A good magnet will remain closed for a drop of at least 5 milivolts.
9. If the magnet does not remain closed for a drop of at least five milivolts, the magnet assembly is defective. Replace the gas control valve.

Figure 11 - Thermocouple & Magnetic Safety Assembly



HOW TO CHECK ENERGY CUT OFF SWITCH

The energy cut off device is to provide a gas safety shut off in case of exceedingly high water temperature in the heater. The UNITROL R110RTSP gas control incorporates a single use energy cut off. If the ECO activates, the entire gas control valve must be replaced.

Using an OHM meter -

1. Remove the thermocouple from the thermostat.
2. Set meter for continuity check (OHMS).
3. Attach one alligator tip (or probe) to the pilot tube.
4. Insert meter probe fully into magnet opening where thermocouple was attached. Be sure the probe is straight, applying slight upward pressure. Make sure one probe touches only the contact in the center of the magnet. Do not touch the thermocouple threading. (TIP: Wrap the end of the probe with electrical tape. Leave approximately 1/32 " exposed.)
5. If continuity is indicated - ECO is good. If continuity is not indicated - the ECO is faulty. Replace the gas control valve.

HOW TO CHECK GAS PRESSURE

This procedure assumes a supply gas pressure of 14" water column. It will adjust the main burner gas supply pressure. The pilot pressure is non-adjustable.

1. Turn off main burner at gas cock knob.
2. Remove gas pressure check plug using a 3/16" hex key wrench.
3. Connect manometer to 'Press Tap'.
4. Turn on main burner.
5. Gauge should read 4" for natural gas or 10" for L.P. gas. If OK, turn main burner off, remove gauge and replace 'Press Tap' plug.



Figure 12 - Gas Pressure Check

NOTE: The pressure is factory set and should rarely need adjustment. If adjustment is necessary, continue to step 6.

6. Remove regulator adjustment screw cap on gas cock knob by inserting a small screwdriver in slot and rotating counter clockwise.

7. Remove sealant with screwdriver.
8. Rotate adjustment clockwise to increase pressure or counter clockwise to decrease pressure.
9. Recheck gauge and replace adjustment cap.
10. Replace 'Press Tap' plug.

HOW TO CHECK GAS CONTROL VALVE

The gas control valve is a self contained operating valve that cannot be repaired. The UNITROL gas valve has a combination of valves, diaphragms and springs located within the gas valve housing. These devices accurately control the pressure and rate of delivery of the gas supply to the pilot burner and main burner assemblies.

The only adjustment is the main burner gas pressure. The UNITROL natural gas valve has a pressure adjustment range of 3.2" to 4.8 " water column. The UNITROL LP gas valve has a pressure adjustment range of 10" to 12" water column. So how do we test the gas control valve?

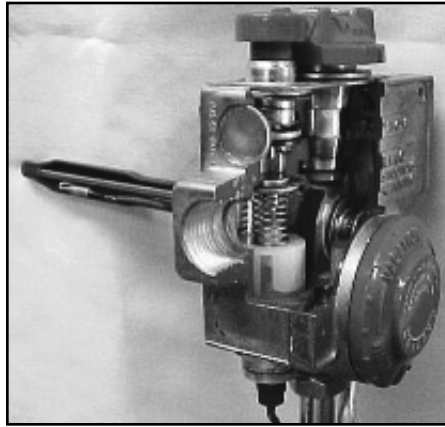


Figure 13 - Gas Valve Check

Testing the gas control valve is mostly a process of elimination. If the heater is not functioning, perform service checks for the thermocouple, magnet assembly, ECO, inlet gas pressure and regulated gas pressure at the pressure tap. If the heater components check out, then the gas valve may be faulty.

Here are some tips:

If the pilot fails to light, you have check all the components and gas pressure, and you have removed the pilot supply tube and cleaned it out - then the pilot supply vein of the gas valve is probably clogged. Replace the gas valve.

If the pilot is lit, then you have gas pressure through the safety devices of the gas valve and the pilot supply vein. If the main burner fails to light, then the main valve assembly is probably stuck closed. Replace the gas valve.

Pocket Diagnostics Manual (Rev 1)
**RESIDENTIAL STANDING PILOT GAS
TROUBLESHOOTING TABLE**

NATURE OF TROUBLE	POSSIBLE CAUSES	SERVICE
No Hot Water	1. Gas supply turned off 2. Pilot not lit 3. Main burner not lit	Turn on gas supply See Unable to light pilot and Pilot does not stay lit See Main burner will not stay lit
Not Enough Hot Water	1. Thermostat set too low 2. Burner orifice is clogged 3. Low gas pressure 4. Venting down-draft (or other improper draft) 5. Clogged flue 6. Defective thermostat 7. Defective dip tube 8. Heater is under-sized	Adjust thermostat Inspect and clean Check gas supply pressure and manifold pressure Check for proper up draft venting. Check for other drafts that could blow out the pilot light Inspect and clean flue way Conduct partial draw test Replace gas control valve if required Check and replace dip tube Adjust Peak Hour Demand
Main burner will not stay lit	1. Low gas pressure 2. Main burner orifice or supply tube clogged or pinched 3. Defective magnet assembly 4. Defective thermocouple 5. Poor thermocouple connection 6. Defective main valve 7. Improper venting	Check gas supply pressure Clean, repair or replace Check and replace gas control valve Check and replace thermocouple Inspect and tighten Replace gas control valve Check venting for proper sizing and down drafts

Table 6 - Res Gas Troubleshooting & Repair Table

Pocket Diagnostics Manual (Rev 1)

NATURE OF TROUBLE	POSSIBLE CAUSES	SERVICE
Unable to light pilot	1. Gas supply turned off 2. Gas cock knob dial not positioned correctly 3. Defective thermocouple 4. Defective safety magnet assembly 5. Pilot burner orifice clogged 6. Pilot tube pinched or clogged 7. Poor thermocouple connection 8. Air in gas line 9. Thermostat's single use ECO is tripped 10. Gas valve defective	Turn on gas supply Check lighting instructions. Set control knob Check and replace thermocouple Check and replace gas valve Clean or replace Clean, repair or replace Check and tighten Purge air from gas line Check ECO and replace gas valve Check gas valve
Pilot does not stay lit	1. Poor thermocouple connection 2. Thermocouple defective 3. Thermocouple not in pilot flame 4. Defective safety magnet assembly 5. Venting down-draft (or other improper draft) 6. Clogged flue 7. Pilot partially clogged 8. Improper gas pressure	Tighten connection at gas valve Check thermocouple and replace Move tip of thermocouple so it is immersed in pilot flame Check magnet and replace gas valve Check for proper up draft venting. Check for other drafts that could blow out the pilot light Inspect and clean flue way. Check for dislodged baffle. Inspect and clean supply tube, pilot burner and pilot orifice Check and adjust supply side

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NATURE OF TROUBLE	POSSIBLE CAUSES	SERVICE
Scale on burner and pilot assemblies	1. Condensation 2. Contaminated atmosphere	Excessive condensation caused by undersized heater, poor venting or continued use Check for contaminant causing chemicals near the heater
Sooting	1. Combustion air inlets or flueway is restricted 2. Not enough combustion or ventilation air supplied to room 3. Improper gas pressure 4. Burner orifice dirty	Remove obstruction or debris from heater or flue-way Improve combustion air or ventilation air supply Check and adjust Inspect and clean
Yellow flame	1. Scale on top of burner 2. Burner orifice dirty 3. Flue way clogged 4. Improper gas pressure	Shut off heater; allow to cool; clean burner plate Inspect and clean Inspect and clean Check and adjust
Burner flame noisy - whistling	1. Improper gas pressure 2. Burner orifice dirty	Check and adjust Inspect and clean
Burner flame floats	1. Improper gas pressure 2. Wrong orifice 3. Clogged flue	Check and adjust Install correct orifice Inspect and clean flue way
Burner flame too high	1. Improper gas pressure 2. Wrong orifice	Check and adjust Install correct orifice

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NATURE OF TROUBLE	POSSIBLE CAUSES	SERVICE
Water too hot (followed by pilot outage)	1. Thermostat setting too high 2. Thermostat out of calibration 3. Thermostat out of calibration	Adjust thermostat to lower setting Check and replace thermostat Check and replace thermostat
Slow hot water recovery	1. Burner orifice clogged 2. Excessive drafts 3. Clogged flue 4. Improper fuel type or low gas pressure	Check and clean Locate and eliminate drafts Clean flue chamber Check and adjust
Noisy water heater (rumbling and sizzling)	1. Scale or sediment build up in bottom of tank 2. Baffles loose 3. Condensation on main burner	Clean tank Reset baffle hanger brackets and tighten Inspect for condensation (normal) and tank leaks
Excessive relief valve operation	1. Excessive water pressure 2. Excessive temperature	Install proper pressure reducing valve on cold side. Check for open or closed system. Install expansion tank. Check thermostat; lower setting or replace
Rusty or black water	1. Anode rod dissolved 2. Excessive sediment build-up	Check anode rod and replace Drain tank; replace tank if sediment build up is excessive
Milky water	Aerated water - microscopic air bubbles in the water	Allow a glass of hot water to set for a few minutes. If the water turns clear, the condition is a natural occurrence.

Pocket Diagnostics Manual (Rev 1)

NATURE OF TROUBLE	POSSIBLE CAUSES	SERVICE
Water heater is leaking (Gas water heaters produce condensation that may drip on the floor. Condensation will produce only a few drops or small puddles that evaporate.)	1. Cold in or hot out joints 2. T&P valve 3. Immersion thermostat or anode rod is loose 4. Inner tank has a pin hole	Check joint and repair Check valve and replace (Caution: Do not confuse normal T&P operation as a leaking tank. If the puddle dries up, then look for a T&P problem.) Check, tighten and replace Replace water heater (When diagnosing a leaker - you will notice a puddle of water on the floor, next to the heater, that will not go away.)
Smelly water (rotten egg odor)	Sulfate reducing bacteria formation inside water tank	Clean tank using chlorine bleach Replace anode rod if deteriorated Add automatic chlorine feeder to cold water inlet side of tank

Pocket Diagnostics Manual (Rev 1)
MANUFACTURED HOUSING

ELECTRIC

The installation of this water heater must be in accordance with the Manufactured Home Construction and Safety Standards (Title 24, CFR; Part 3280) and local codes governing the installation of water heaters in manufactured homes.

**ELECTRIC SEQUENCE OF OPERATIONS
DOUBLE ELEMENT**

All sequence of operations and diagnostics for the manufactured housing double element nonsimultaneous operation water heater is the same as Tables 1 and 4.

SINGLE ELEMENT (120V) SEQUENCE OF OPERATIONS

1. Power (120VAC) from L1 (**black** wire) is passed through the ECO and thermostat and out the **black** wire to one side of the heating element.
2. Return (or neutral) is passed through the heating element along the **white** wire.
3. The heating element now has 120 VAC and begins heating.
4. Element heats until the thermostat is satisfied and opens (no current flow) at the temperature setting.
5. Power is discontinued to the element because power is interrupted through the **black** wire. The water in the tank is hot.

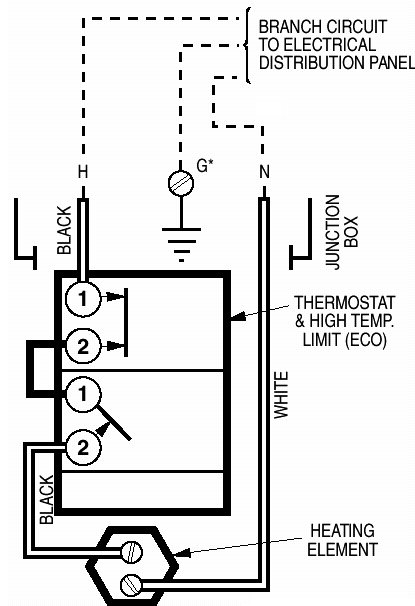
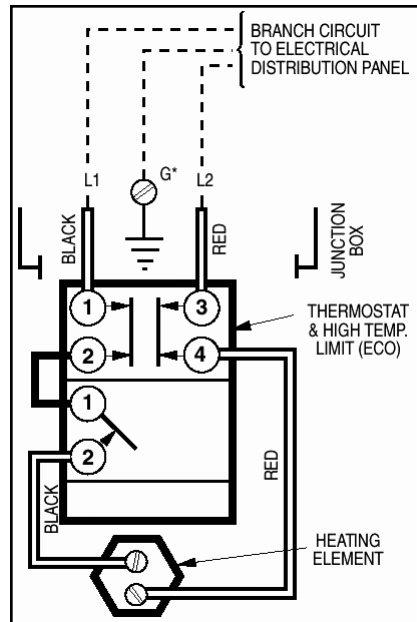


Figure 14 - 120V Single

Element Wiring

SINGLE ELEMENT (240V) SEQUENCE OF OPERATIONS

1. Power from L1 (**black** wire) is passed through the ECO and thermostat and out the **black** wire to one side of the heating element.
2. Power from L2 (**red** wire) is passed through the ECO and out the **red** wire to the other side of the heating element.
3. The heating element now has 240 VAC and begins heating.



4. Element heats until the thermostat is satisfied and opens (no current flow) at the temperature setting.
5. Power is discontinued to the element because power is interrupted through the **black** wire. The water in the tank is hot.

Figure 15 - 240 V Single Element Wiring

SIDE CONNECT INSTALLATION

Sides connect models are equipped with a special **HOT OUTLET TUBE ASSEMBLY**. Do not rotate the tube assembly when making water connections. The nipple **MUST** remain in a position with indicating mark UP.

This unit is highly prone to draining if the water is turned off for any reason. Once drained, the heating elements will dry fire when the thermostats call for heat. The water heater's warranty does not cover damage or failure resulting from operation with an empty or partially filled tank.

TOP CONNECT INSTALLATION

Most conventional manufactured homes use the side connect model. Top connect models may be installed as a replacement heater. Additional piping may be required for a top connect model. This unit is not prone to draining if the water is turned off; therefore the incidence of dry fired elements is not as common.

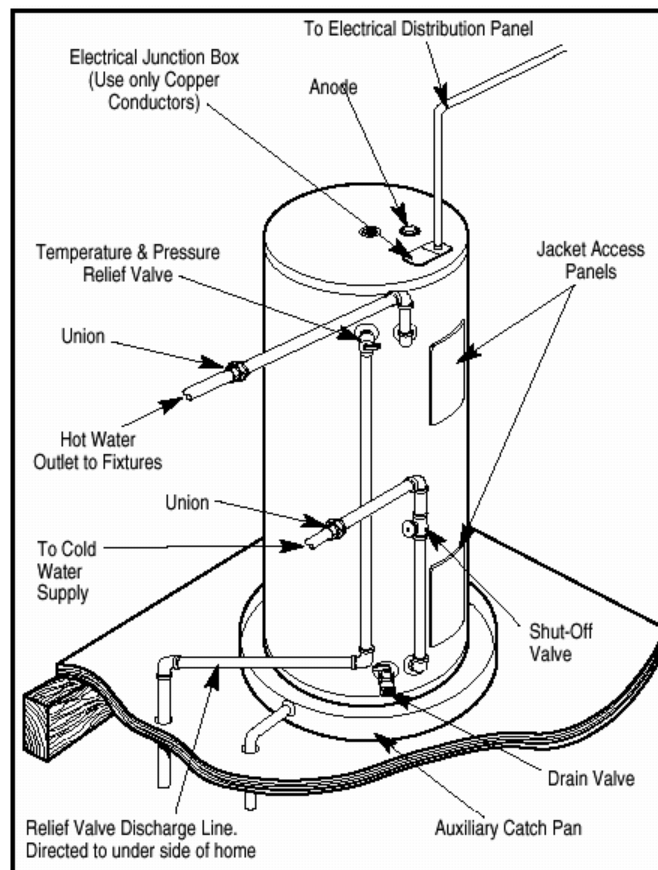
CAUTION:

On both the side and top connect models, ensure the unit is filled

with water before electrical connections are made. Once electrical power has been applied, there is a high incidence of dry fired elements because the tank has not been filled with water. Dry fired elements are not covered under warranty.

Figure 16 - Manufactured Housing Side-Connect Electric

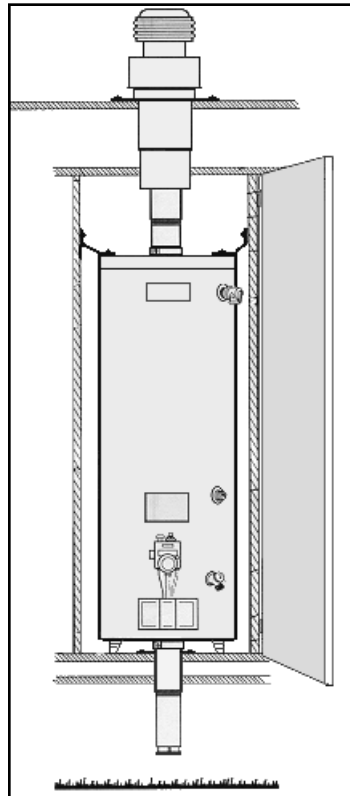
GAS



This section discusses gas fueled water heaters installed in manufactured housing. There are two models manufactured by Rheem. The first model is a *natural draft* gas water heater. You can instantly identify this model because it has a draft diverter at the top of the water heater. All fresh air for combustion is drawn from outside the home through air inlet tubes or through holes cut in the floor or door to the water heater's installation area. All combustion by-products are vented through the

roof jack kit. The natural draft model must have an access from outside the home. It may not have access from inside the home.

The second model is a direct vent gas water heater. You can instantly identify a direct vent water heater because it does not have a draft diverter. Metal clamps, supplied with the heater, are secured to the air inlet assembly at the bottom of the heater and the roof jack kit. The roof jack kit for the direct vent also has silicone rubber seals (big rubber bands). This seal is used to provide an airtight joint between the connections of the vent connector pipes. The direct vent model may have an access from inside the home.



The direct vent water heaters produced by Rheem Manufacturing Company are designed for use in manufactured housing and are required to comply with the provisions of ***UL Standard 307, Gas Burning Heating Appliances for Manufactured Homes and Recreational Vehicles***. Section 2.3, Terminology, defines an 'appliance' to include water heaters.

The direct vent water heaters produced by Rheem Manufacturing Company are designed for use in manufactured housing and are required to comply with the provisions of ***UL Standard 307, Gas Burning Heating Appliances for Manufactured Homes and Recreational Vehicles***. Section 2.3, Terminology, defines an 'appliance' to include water heaters.

Figure 17 - Direct Vent Manufactured Housing Heater

Extreme care must be taken when placing a manufactured home on a lot with a basement.

The terms and conditions of UL Standard 307B are not exempted by a basement. Once completed the basement becomes part of the living space of the manufactured home. Installation of a direct vent water heater with the air inlet assembly taking its' combustion air from the basement atmosphere is a violation of UL 307B, Section 4.3 (c). See the Use and Care Manual supplied with the water heater for further installation requirements.

All sequence of operations and diagnostics for the manufactured housing gas water heater is the same as Tables 5 and 6.

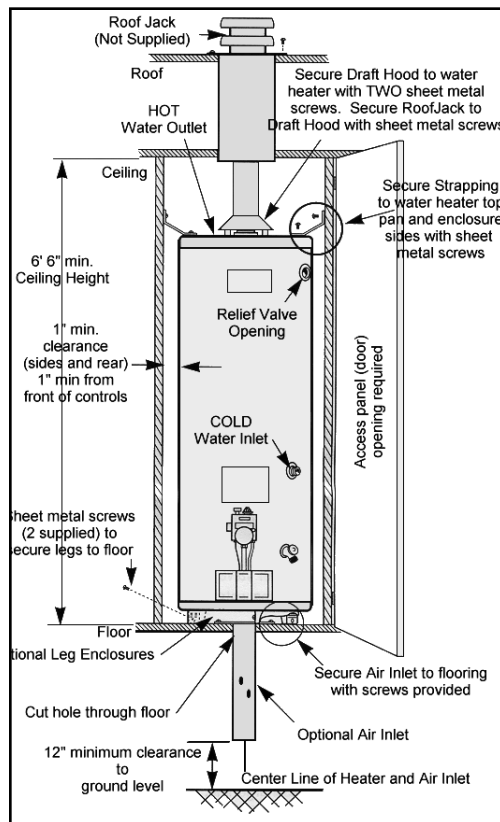
Pocket Diagnostics Manual (Rev 1)
**INSTALLATION AND COMBUSTION AIR
REQUIREMENTS**

Check the Use and Care Manual supplied with the water heater for specific installation steps.

Natural or propane gas fueled water heaters must be installed within an enclosure to separate the water heater's combustion and venting system from the interior atmosphere of the manufactured home. All air for combustion must be obtained from an outside atmosphere and the combustion products (flue gases) must be discharged directly to the outside atmosphere through the gas vent roof jack assembly.

Figure 18 - Natural Draft ("T") Water Heater

This kind of water heating system is referred to as a *balanced flue system*. A flue system is balanced if the air pressure at the intake is equal to that at the exit (exhaust). The hot gases from the combustion will naturally rise creating a movement of air in the flue of the water heater. Any interference in the pressure balance (such as a blocked intake, high winds, or restricted roof jack) will create improper product operation.



Manufactured Home Construction and Safety Standards state that there must

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not be any door or other opening to the gas fuel water heater enclosure from inside the home. This means the water heater must be installed in a mechanical room with a door on the outside of the manufactured home. The only exception to this standard is the *direct vent* water heater. The direct vent heater has a sealed air inlet tube and a sealed venting system that prevents combustion gases from entering the home.

Quick Check: Look for a draft diverter on the top of the water heater. If the unit has a draft diverter, it must be installed in a mechanical room with the only opening on the outside of the manufactured home.

NOTES

[illegible]

POWERVENT

40, 50, 75 GAL. RESIDENTIAL OR COMMERCIAL

Difference between Residential and Commercial models:

PowerVent water heaters are manufactured in three gallon capacities: 40, 50 and 75 gallons. All of these sizes are available for residential installation. Commercial PowerVent heaters are available only in the 75 gallon capacity. Except for the thermostat, blower motor and water line connections, all other components of the PowerVent water heater are the same on all sizes and applications. The 40 and 50 gallon sizes have 3/4 inch water lines and can be vented up to 40 feet. The 75 gallon has a 1 inch water line and can be vented up to 45 feet with a larger blower motor.

The 75 gallon commercial PowerVent has a 75,000 BTU input with either natural or LP gas. It also uses a 170° F thermostat for use in commercial applications such as washing dishes in restaurants. Finally, the commercial PowerVent has a standard three year warranty on the tank. All service and diagnostic procedures described in this training manual apply to both residential or commercial PowerVent models unless specifically stated.

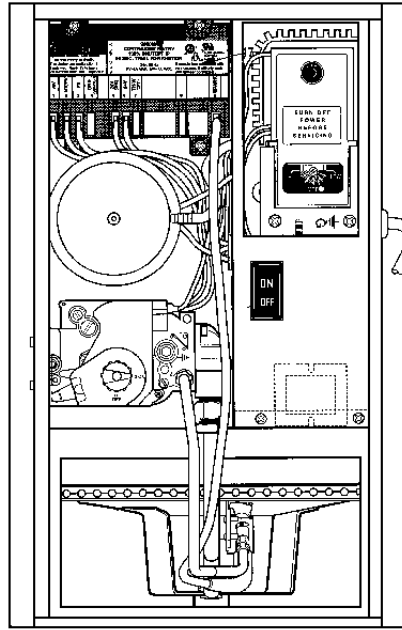
SPARK IGNITION CONTROL ENCLOSURE

Rheem Manufacturing uses the Honeywell Intermittent Pilot Dual Automatic Valve Combination Gas Control for both natural and liquid petroleum (LP) products. These gas controls include a safety shutoff, pressure regulator and pilot adjustment for proper delivery. A diaphragm operated automatic valve opens under the control of an internal regulator. A safety shut off feature of the Honeywell valve will shunt the gas supply if the gas pressure or power supply is interrupted.

How it works

When the thermostat calls for heat, the blower motor starts, the vacuum safety switch closes and the ignition control module is energized. The ignition control activates the first automatic valve by relaying 24V from the PV (pilot valve) terminal to the gas control valve. Pilot gas is allowed to flow through the control to the pilot burner. Simultaneously, the ignition control module generates a 10,000 volt spark at the pilot electrode assembly and lights the pilot. Through a flame recognition of at

least one (1) microamp (a very small electrical current produced by the flame), the ignition control module ends the spark generation.



After the pilot is lit and recognized by the electronic controls, the ignition control module energizes the main valve. The ignition control activates the second automatic valve by relaying 24V from the MV (main valve) terminal to the gas control valve. Gas begins to flow to the main burner while the pilot light remains lit. The main burner lights. At this time there are several safety devices in operation.

Figure 19 - Spark Ignition Control Panel

The first safety is the energy cut off (ECO) located on the thermostat. As long as the water is not exceedingly hot, electricity is extended to the transformer, the control panel and its components. The next safety is the vacuum safety switch. If the blower motor fails or does not induce an adequate vent draft, 24V current is not passed to the ignition control. The third safety is the flame rectification. If the pilot flame is extinguished, the ignition control will not extend power to the gas control valve. Finally, the gas control valve itself is a safety device. If the supply gas pressure drops to below minimums or there is a loss of power, the gas control valve will automatically close all internal valves and shunts the supply of gas to the pilot and main burner.

PowerVent Safety Shut Off

The term safety shut off is used instead of 'lockout'. The term lockout refers to a situation where the heater must be manually reset (unplugged or turned off) before the unit will function again. Older models of PowerVent water heaters used a 'lock-out' control module; current production models use a safety shut off and continuous retry control module.

Rheem Manufacturing uses the Honeywell S8600M Intermittent Pilot Module. The ignition module provides ignition sequence, flame monitoring and safety shutoff for PowerVent water heaters. In the event of a safety shut off, the ignition module waits approximately six minutes and then reinitiates the ignition sequence. The ignition trial, shut off, wait cycle and re-ignition will continue until the pilot lights, the call for heat ends or the unit is turned off. Although designed for use in PowerVent water heaters, these control modules are very sensitive to direct contact with water, high humidity and corrosive atmospheres.

The S8600M ignition module will attempt to light the pilot for 90 seconds. During these 90 seconds, the spark ignitor will continuously spark attempting to light the pilot gas. If after 90 seconds, the control module does not receive a flame rectification signal, the control module will go into 'safety shut off'. The purpose of the safety shut off is to prevent a potential explosion by allowing the unlit gas to dissipate.

After approximately six minutes, the control module will recycle; attempt to light the pilot, and the process starts over. The ignition control module will continue to cycle until the pilot lights, the call for heat ends or the unit is turned off.

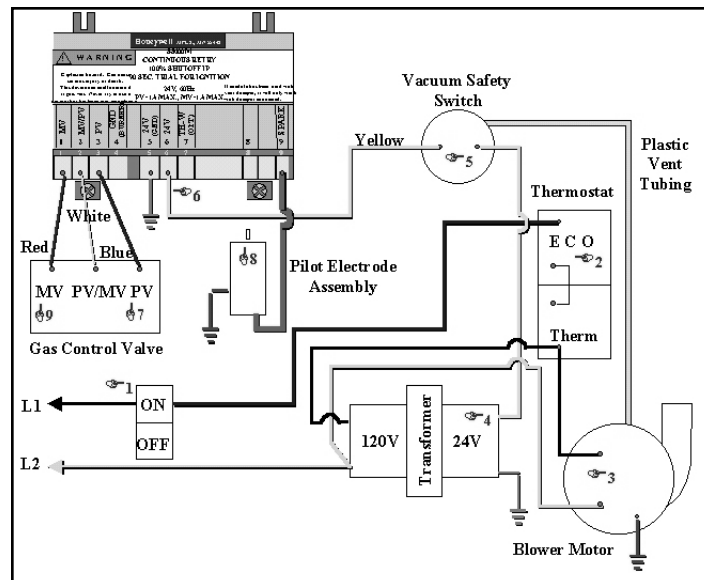


Figure 20 - Spark Ignition Schematic

POWERVERT SEQUENCE OF OPERATIONS

Tank is cold, full of water, gas supply is connected to gas control valve and heater is plugged in to a 120V circuit. Gas valve is set to the ON position.	NO	Fill tank Ensure gas connections are present and no leaks Ensure water heater is properly vented
YES		
Turn electric main power to ON; open control panel and turn ON/OFF switch to ON.	NO	Check circuit breaker Separate breaker circuit is recommended
YES		
120V is extended from the switch to the electric thermostat and ECO. (First safety)	NO	Check for 120V at thermostat terminal 1 Check ECO for 120V at thermostat terminal 2
YES		
120V is extended from the thermostat to: 1.) the blower motor 2.) the 24V transformer	NO	Blower motor begins rotation. Check for 120V at blower motor plug. Check for 24V at far side of transformer
YES		
Blower motor creates vacuum in tube and causes vacuum switch to operate.	NO	Check tube for proper size, serviceability, kinks and blockages. Check vacuum switch
YES		
(Second Safety) Vacuum switch has now provided verification that the blower motor is operating. 24V is allowed to pass through the vacuum switch to the ignition control module.	NO	Check ignition control module for 24V at the "24V" terminal lug. Check vacuum switch Check vacuum tubing Check blower motor
YES		
Ignition module extends 24V to energize the pilot gas valve operator.	NO	Check for 24V on the "PV" terminal lug of the GAS VALVE
YES		

Table 7 - PowerVent Sequence of Operations

Pocket Diagnostics Manual (Rev 1)

Pilot valve opens allowing gas to flow to the pilot burner	NO	Check gas pressure Check pilot burner Check pilot supply tube for crimping Check for 24V on the "PV" terminal lug of the GAS VALVE
YES		
Electric spark generator in the ignition module produces a continuous 10,000V spark pulse through the ignitor cable.	NO	Visually check pilot electrode assembly for spark Check ignitor cable for continuity Check ignition control module
YES		
Gas flows through gas valve and pilot supply tube to pilot burner. Pilot lights and flame is rectified. (Third Safety) Safety shut off with continuous retry for 90 seconds. After a six-minute wait, the ignition module re-starts the ignition sequence.	NO	Check gas pressure Check pilot burner for obstructions. No flame rectification with pilot burner (flame is not pointed in proper direction). Check spark ignitor for cracks.
YES		
Pilot ignites main burner. Spark generator shuts off.	NO	Check for 24V on the "MV" terminal lug of the GAS VALVE Check gas pressure Check main burner orifice for obstructions. Check main burner supply tube and venturi for obstructions.
YES		
Main burner remains lit. Heats water to thermostat setting	NO	Check for 24V on the "MV" terminal lug of the GAS VALVE Check gas pressure Check main burner orifice for obstructions. Check main burner supply tube for obstructions. Check main burner venturi and ports for obstructions.
YES		

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Water is hot. Thermostat contacts open and shunts circuit to: 1). Blower motor 2). 24V transformer	NO Check thermostat. Power is discontinued to the ignition control module. Power is resupplied to the blower motor and 24V transformer when thermostat calls for heat.
YES Pilot and main valve operators on the gas control valve close.	NO 24V power is suspended to all terminal lugs on the ignition control module and gas valve.
YES Main burner and pilot shuts off. Water is hot.	
YES Water heater is in stand by until the thermostat calls for heat.	

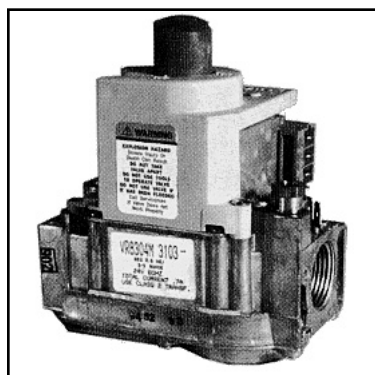
NOTES

This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and extend across the width of the page. There are no margins, text, or other markings on the paper.

Pocket Diagnostics Manual (Rev 1)
HOW TO CHECK GAS PRESSURE - VR8204

This procedure assumes a supply gas pressure of 14" water column.

1. Turn gas cock knob to OFF.
2. Remove gas pressure check plug using a 3/16" hex key wrench.
3. Connect manometer to 'Press Tap'.
4. Turn gas cock knob to ON. Allow main burner to light.
5. Gauge should read 4" for natural gas or 10" for L.P. gas. If OK, turn gas cock knob OFF, remove gauge and replace 'Press Tap' plug.



NOTE: The pressure should normally never need adjustment.

Figure 21 - PowerVent Gas Pressure Check

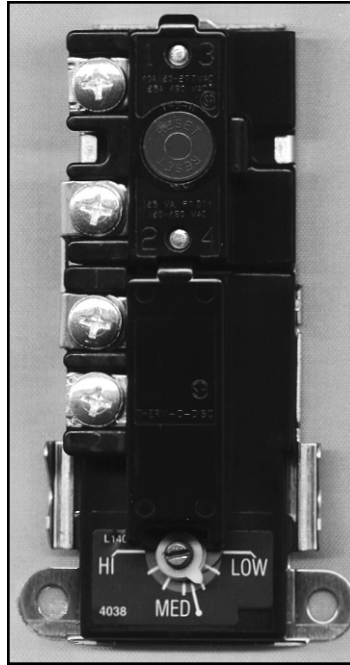
HOW TO CHECK ELECTRIC THERMOSTAT AND ECO SWITCH

Check thermostat calibration by conducting a partial draw test at the closest hot water faucet. Let the hot water run for a few seconds to bleed off the cold water in the pipes. Water temperature should be within 20° F of the thermostat setting. If not, turn off the power to the heater. Reseat the thermostat in the thermostat bracket so it presses against the inner tank wall. Otherwise, replace the thermostat.

Check the functioning of the thermostat and energy cut off (ECO) as follows:

1. Check for 110 volts line voltage at the wall plug and fuse panel. Turn on/off switch to ON. Verify electrical polarity of wall plug.
2. Place one multimeter probe on position # 1 on the upper portion of the thermostat and the other probe on the L2 side of the transformer. Measure for 110 volts. If not, check the line voltage, circuit breakers, wall plug and on/off switch.

3. Check ECO by placing the multimeter probe at position # 2. Measure 110 volts. If not, press the red RESET button on the thermostat and recheck. If not, ECO is damaged; replace thermostat.



4. Turn thermostat to highest temperature setting to demand heat. Place multimeter probe on position # 2 on lower portion of the thermostat and check for 110 volts. If not, replace the thermostat. Return temperature setting to original position.

***QUICK CHECK: Go directly to step 4 above. If 110 volts, then line voltage, on/off switch, ECO and thermostat are all functioning properly.*

Figure 22 - Thermostat and ECO

HOW TO CHECK 24 VOLT TRANSFORMER

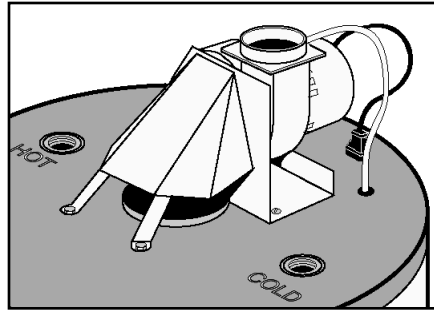
The 24 volt transformer supplies the power to operate the ignition control module and the gas control valve. Assuming the presence of 110 volt power and the thermostat operates -

1. Turn thermostat to highest setting to demand heat.
2. Place the multimeter probe on the 24V (GND) terminal of the ignition control module, place the other probe on the yellow wire leading from the vacuum switch to the transformer. Multimeter should read 24 volts. If not, replace the transformer.
3. Return thermostat to a safe temperature setting.

HOW TO CHECK BLOWER MOTOR

Assuming the presence of power and the thermostat operates -

1. Turn temperature on the thermostat to its highest setting to demand heat.
2. Blower motor should operate.
3. If not check for presence of 110 volts at the power plug at the TOP of the heater. If the plug has power, replace the blower motor.



4. Return thermostat to a safe temperature setting.
5. If the plug does not have power verify presence of power to the heater. Check thermostat and ECO. If there is power to the heater, but not the 110V plug at the top of

the heater, then replace the heater.

Figure 23 - Blower Motor

Reminder: Don't forget to oil the blower motor!

HOW TO CHECK VACUUM SAFETY SWITCH

The vacuum safety switch will prevent the heater from operating. Assuming the presence of power, the thermostat operates, and the blower motor is running -

1. Check for 24 volts at the ignition control module by placing one multimeter probe at the 24V terminal and the other probe on the 24V (GND) terminal. If the meter registers 24 volts, then the vacuum switch is operating normally.
2. If the multimeter does not register 24 volts, the vacuum switch is damaged or there is not enough vacuum pressure to operate the switch.
3. Using a spare 2 foot length of 1/4 inch (I.D.) plastic tubing:
 - a. Remove the vacuum tube from the vacuum switch.
 - b. Place the spare piece of tubing on the vacuum switch.
 - c. Induce a 'vacuum' to the switch by sucking on the tubing like a straw. At the same time, check for 24 volts at the ignition control module by placing one multimeter probe at the 24V terminal (#6) and the other probe on the 24V (GND) terminal (#5). If the meter registers 24 volts, then the vacuum switch is operating normally.

Pocket Diagnostics Manual (Rev 1)

HOW TO CHECK THE VACUUM LINE

This test requires the use of a magnahelic gauge.

Following the instructions with your magnahelic gauge -

1. Place an inline “T” fitting between the vacuum switch and the vacuum line from the blower motor.
2. Turn heater on and adjust to demand heat. The blower motor should be operating.
3. Check the pressure on the magnahelic gauge. If the gauge reads between 0.6 and 1.5 inches water column, then the blower motor is inducing the proper draft and the vacuum lines are not obstructed.
4. If the gauge does not read between 0.6 and 1.5 inches water column -
 - a. Move the inline “T” fitting and place it between the blower motor and the vacuum tube at the top of the heater.
 - b. Check the pressure on the magnahelic gauge. If the gauge reads between 0.6 and 1.5 inches water column, then the blower motor is inducing the proper draft and the vacuum lines are obstructed. Replace the heater.
 - c. If the gauge does not read between 0.6 and 1.5 inches water column, then the blower motor is not inducing the proper draft. Replace the blower motor.

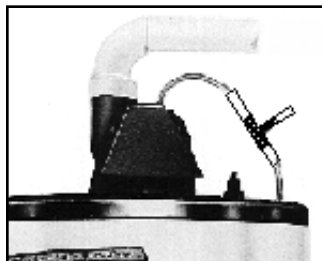


Figure 24 - Checking the Vacuum Line

HOW TO CHECK GAS CONTROL VALVE

If main burner and/or pilot will not light:

1. Check the gas control knob is in the ON position.
2. Verify the presence of a spark at the electrode assembly. You may need to recycle the heater by turning the ON / OFF switch to OFF, waiting one minute and turning the switch back to ON.
3. Adjust the thermostat to its highest setting to demand heat.
4. Using a multimeter check for 24 volts at the gas control:
 - a. If pilot lights, measure across the MV/PV and MV terminals (red & white wires). If multimeter does not register 24 volts, replace the ignition control module. If the multimeter registers 24 volts replace the gas control valve.

- b. If pilot DOES NOT light, measure across the MV/PV and PV terminals (blue and white). If multimeter does not register 24 volts, replace the ignition control module. If the multimeter registers 24 volts replace the gas control valve.

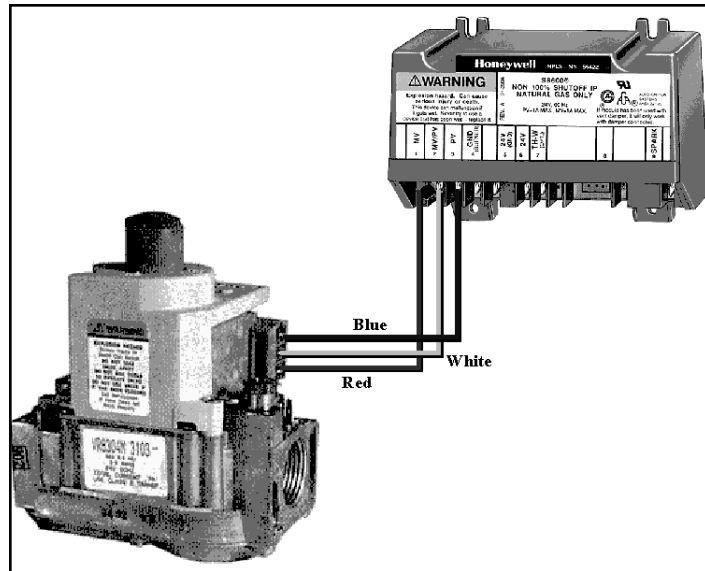


Figure 25 - Checking Gas Valve

HOW TO CHECK HONEYWELL IGNITION CONTROL MODULE

Checking the Ignition Control Module

The diagnosis of a faulty ignition control module is a process of elimination. To properly isolate the control module, all other components of the PowerVent heater must be functioning. Insure there is adequate gas pressure and then perform the check below:

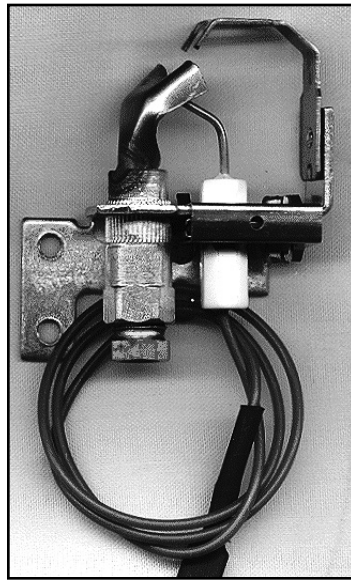
1. Recycle the heater by turning the ON / OFF switch to OFF; wait one minute and turn the heater to ON. Adjust thermostat to its highest setting to demand heat.
2. Using a multimeter, place one probe on the 24V terminal of the ignition control module and the other probe on the 24V (GND) terminal. Measure 24 volts.
 - a. If the multimeter registers 24V, then the thermostat, transformer, blower motor and vacuum safety switch are all functioning normally.
 - b. If the multimeter does not register 24V, then check each component using the How to Check sections of this manual.

3. Next, perform the How to Check Gas Control Valve procedure.
4. Replace the ignition control module if faulty.

HOW TO CHECK IGNITION CABLE AND SPARK IGNITOR

This procedure will expose you to 10,000 volts of electrical energy. When performing these steps do not touch bare or exposed wiring. Make sure the heater is turned off when servicing or inspecting the spark ignition system.

1. Make sure the ignition cable does not run in contact with any metal surfaces, is no more than 36 inches long, and connections to the ignition control module and ignitor are clean and tight.
2. Check ignition system grounding. *Nuisance shutdowns are often caused by a poor or erratic ground.*



- a. Check for good metal to metal contact between the pilot burner bracket and the main burner.
- b. Check the ground lead from the GND (BURNER) terminal on the ignition module to the pilot burner.
- c. Check the ceramic flame rod insulator for signs of cracked or exposure to extreme heat. This can cause a short to ground and will prevent the pilot electrode assembly from sparking. Clean the flame rod with emery cloth if dirty.
3. Check spark ignition circuit. *You will need a short jumper wire made from ignition cable or other heavily insulated wire.*

Figure 26 - Checking the Spark Ignitor

- a. Close the gas valve manually.
- b. Disconnect the ignition cable at the SPARK terminal of the control module. Move the ignition cable out of your way.
- c. Energize the module by turning heater on or adjusting the thermostat to demand heat.
- d. Immediately place one end of the jumper firmly on the 24V (GND) terminal on the control module. Move the free

- end of the jumper slowly toward the SPARK terminal of the control module until a spark is established.
- e. Pull the jumper slowly away from the SPARK terminal and note the length of the spark gap. If the arc is 1/8 inch or more, then the voltage output is okay. If the spark is less than 1/8 inch or there is no spark, then replace the control module.
- f. Remove the jumper, turn heater off, reinstall the ignition cable and turn heater back on.

INSTALLATION OF POWERVENTS

Venting

*Do **NOT** connect this heater to any existing vent or chimney. It must be vented to an outside atmosphere separately from all other appliances.*

Vent the heater to the outdoors using only 3 inch diameter Schedule 40 PVC (Polyvinylchloride), ABS (Acrylonitrile Butadiene Styrene), or CPVC (Chlorinated Polyvinylchloride) pipe and fittings.

The unit may be vented horizontally through a wall or vertically through a roof. The PowerVent system will not operate if there are excessive restrictions (pressure drops) in the venting system. A maximum of 45 feet (see chart below) of vent pipe may be used provided there is only one 90° elbow in the system. For example, a vent connector directly off the blower motor assembly must have a 90° elbow to turn to a horizontal position. You may then vent 45 linear feet to a position outside the building. The termination vent included with the blower motor does not count as an elbow or part of the 45 feet.

Other venting runs may be designed:

40 and 50 gallon models		75 gallon models (commercial or residential)	
90° elbows	Max vent run	90° elbows	Max vent run
1	40 feet	1	45 feet
2	35 feet	2	40 feet
3	30 feet	3	35 feet

Table 8 - Maximum Venting Lengths

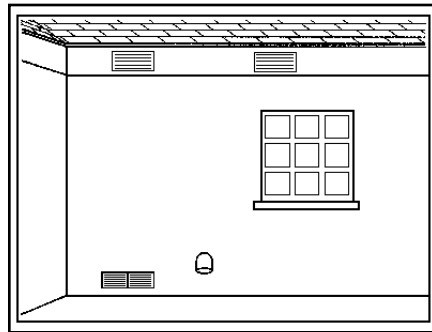
All elbows must be long radius type to minimize vent restrictions. The venting may be as short as necessary, provided the vent termination is outdoors.

VENT TERMINATIONS

Do not locate the termination vent above any walkways, doors, windows, air inlets, gas meters or electric meters. Do not install vent termination under any patio or deck.

Horizontal Vent Termination

1. Twelve (12) inches above ground level and above normal snow levels.
2. Four (4) feet below or four feet horizontally from any door, window or gravity air inlet to the building, other fresh air intakes, gas meters, or electric meters.
3. Ten (10) feet from any forced air inlet to the building.

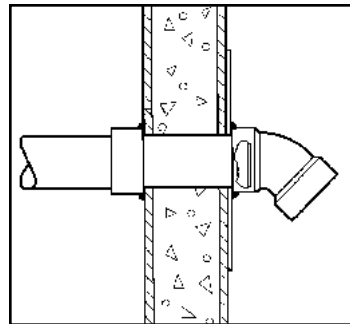


Any fresh or make-up air inlet such as for a dryer or furnace is considered to be a forced air inlet.

4. Six (6) feet from any inside corner formed by two exterior walls.
5. Four (4) feet horizontally from any soffit or under-eaves vent.

Figure 27 - Minimum Clearances

Exterior Wall Termination Vent

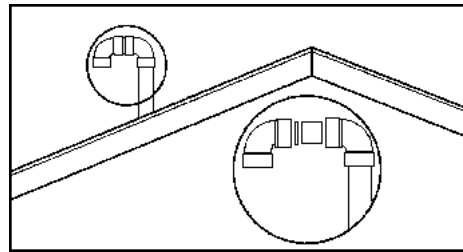


1. Install a 2 foot by 2 foot sheet metal shield on exterior brick or masonry walls.
2. Mortar or silicone caulk all inside and outside seams through the wall.
3. Install the vent termination elbow included with the blower motor with the screen side closest to the exterior wall.

Figure 28 - Exterior Wall Termination Vent

Vertical (Rooftop) Vent Termination

1. Minimum twelve (12) inches above the roof.
2. Minimum twelve (12) inches above the anticipated snow line.
3. Maximum twenty four (24) inches above the roof level without additional support for the vent pipe.
4. Four (4) feet from any gable, dormer, or other roof structure with building interior access (i.e. vent, window, etc.)



5. Ten (10) feet from any forced air inlet to the building. Any fresh or make-up air inlet such as for a dryer or furnace is considered to be a forced air inlet.

Figure 29 - Roof Termination Vent

POWERVERT HOT SURFACE IGNITION

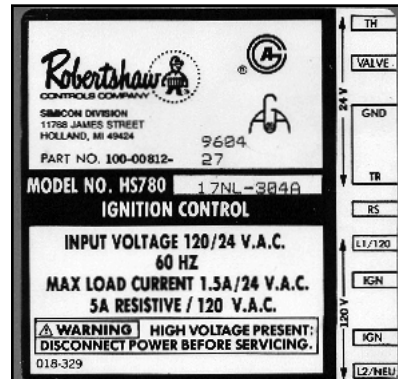
From April 1990 through January 1996, Rheem manufactured a 40 and 50 gallon PowerVent water heater with a hot surface ignitor. The hot surface ignitor is a ceramic assembly with a heating coil located inside the ignitor. When the heater demands heat, the ignition control module delivers 120V to the hot surface ignitor. The ceramic ignitor heats up; glows a bright red and ignites the gas at the main burner.

One of the major differences with the hot surface ignition is the Robertshaw HS 780 Electronic Ignition Module. The module comes in a 'one try' and a 'three try' model. The HS780 ignition control is a direct main burner ignition system that provides the timing sequence, along with the ability to sense main burner flame. The HS780 model number gives specifications of that particular control. Model numbers can be deciphered by:

Assuming all other aspects of the heater are functioning properly, the control module sends 120V to the silicon carbide ignitor. The ignitor heats for 17 seconds and reaches a temperature of approximately 1800° F. After the ignitor has been energized for 17 seconds, the gas valve is energized allowing gas to flow across the ignitor. After one half of the ignition time period a circuit is disconnected to the ignitor, and the ignitor becomes a flame sensor. The ignitor, in its role as a flame sensor, is positioned

sensitive. Care must be taken to assure proper placement for proper ignition and also to allow the ignitor to properly sense the presence of the main burner flame.

Figure 30 - HS780 Hot Surface Ignition Control



The ignitor is used to sense the burner flame. In this case, the ignitor is referred to a local sensor. PowerVent water heaters do not use a remote sensor. The correct position for the ignitor is with the flame covering 5/8" to 3/4" of the ignitor tip. The flame rectification is a safety feature of the PowerVent

heater. If the ignitor is not in the proper position, the control module may lock itself out.

If the flame is not sensed during the 2 second sensing timing period, the HS780 control module enters a lockout stage. The HS780 is available in two different types with respect to the number of ignition cycles before lockout. One model will attempt ignition only once (1 try) and the other model attempts ignition three times (3 try). On the 3 try module, the whole cycle is repeated each time. After the requisite number of tries, the module goes into a lockout. Lockout is controlled by a holding circuit that keeps the module from attempting another ignition sequence. To get the HS780 out of lockout, power must be turned off to the heater for a minimum of ten seconds.

Normal Sequence of Operations

1. Call for heat by thermostat.
2. Control module starts a 17 second ignition event.
3. Ignitor is energized for 17 seconds.
4. Ignitor glows red. Gas valve energized through "TH" and "TR" terminals.
5. Sensor circuit senses flame.
6. Flame sensor continues to monitor presence of flame throughout the call for heat cycle.
7. Call for heat ends; gas valve is de-energized and closes.

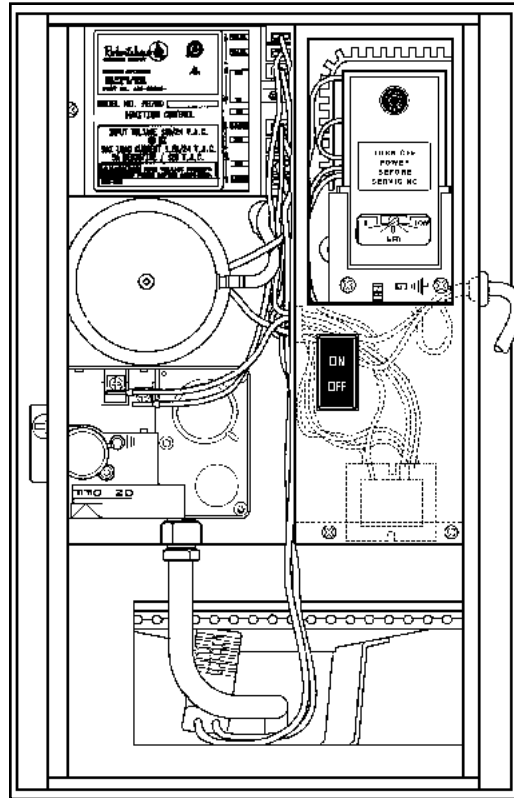


Figure 31 - Hot Surface Ignition Control Panel

HOT SURFACE POWERVENTS AND ELECTRICAL POLARITY

Polarity and Ground	Operational Symptoms
Correct polarity and proper ground	Operations is normal
Correct polarity and no ground	Fires once for two or three seconds; then goes into lockout
Reverse polarity and a ground	No ignition; ignitor will spark; then ignition shuts down
Reverse polarity and no ground	One ignition for two or three seconds; then goes into lockout
Low gas pressure (LP)	Will ignite once and go out immediately; or will not ignite at all

TROUBLESHOOTING POWERVENT HOT SURFACE IGNITION

Troubleshooting the hot surface ignitor PowerVent heaters may be divided into four main categories:

NATURE OF TROUBLE	POSSIBLE CAUSES	SERVICE
Hot surface ignitor does not glow red	No power Ignitor damaged or Control module damaged Unit is in lockout (blower motor runs all the time)	Turn on / off switch to on. Confirm 120VAC-power supply. Turn thermostat to demand heat. Check for 24V at the control module between terminals TH and GND. If 24V not present, check transformer, ECO, thermostat, and vacuum switch. If 24V is present, check for 120V between IGN and IGN terminals. If voltage is present, replace the ignitor. If voltage is not present, replace the control module. Turn heater off; wait ten seconds; turn heater back on.
Ignitor glows red, but main burner will not ignite	No gas supply to heater Polarity reversed Ignitor not positioned properly Gas valve or control module is damaged	Check and open supply gas valves to heater. Check polarity at L1/L2 line. Correct position for the ignitor is with the flame covering 5/8" to 3/4" of the ignitor tip. Check for 24V between terminals TH and TR on the gas valve. If there is <u>no voltage</u>, replace the control module. If there is <u>voltage</u>, replace the gas valve.

Table 9 - Hot Surface Ignition Troubleshooting Table

NATURE OF TROUBLE	POSSIBLE CAUSES	SERVICE
Main burner shuts off before the thermostat is satisfied	Polarity reversed Ignitor not positioned properly Low gas pressure Improper ignition control ground	Check polarity at L1/L2 line. (See check above). Check gas pressure and adjust. Check grounding of ignition control module.
Main burner does not shut off when thermostat is satisfied	Thermostat out of calibration Gas valve or control module is damaged	Check and replace. Check for 24V between terminals TH and TR on the gas valve. If there is <u>voltage</u> , replace the control module. If there is <u>no voltage</u> , replace the gas valve.

NOTES

This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

Pocket Diagnostics Manual (Rev 1)
ELECTRONIC SPARK POWERVENT
TROUBLESHOOTING TABLE

NATURE OF TROUBLE	POSSIBLE CAUSES	SERVICE
No Hot Water	1. Electrical supply turned off 2. Gas supply turned off 3. Pilot not lit 4. Main burner not lit	Check fuse panel and on/off switch Turn on gas supply Check 1 and 2 above. Then see Unable to light pilot and Pilot does not stay lit See Main burner will not stay lit
Not Enough Hot Water	1. Thermostat set too low 2. Burner orifice is clogged 3. Low gas pressure 4. Venting down-draft (or other improper draft) 5. Clogged flue 6. Thermostat out of calibration 7. Defective dip tube 8. Heater is under-sized	Adjust thermostat Inspect and clean Check gas supply pressure and manifold pressure Check for proper up draft venting. Check for other drafts that could blow out the pilot light Inspect and clean flue way. Check for fallen flue baffle. Conduct partial draw test. Reseat thermostat in bracket Check and replace dip tube Adjust Peak Hour Demand
Unable to light pilot (and I don't hear the spark ignitor)	1. Thermostat or ECO is damaged 2. Transformer not producing 24V 3. Vacuum safety switch damaged	Check for both thermostat and ECO; replace thermostat Check transformer and replace Check vacuum switch and replace; check vacuum from blower motor and repair

Table 10 - Spark Ignition Troubleshooting Table

NATURE OF TROUBLE	POSSIBLE CAUSES	SERVICE
Unable to light pilot (but I can hear the spark ignitor)	4. Blower motor does not run 5. Gas supply turned off 6. Ignition control module damaged 7. Gas cock knob dial not positioned correctly 8. Gas control valve damaged 9. Pilot burner orifice clogged 10. Pilot tube pinched or clogged 11. Air in gas line 12. Spark gap too large 13. Spark ignitor damaged	Check blower motor and motor plug; replace if damaged Turn on gas supply Check ignition module and replace Check lighting instructions. Set control knob to ON Check and replace Clean or replace Clean, repair or replace Purge air from gas line Check spark gap and reset to 1/8" Check spark ignitor and replace
Pilot does not stay lit	1. Venting down-draft (or other improper draft) 2. Clogged flue 3. Pilot partially clogged 4. Improper gas pressure 5. Improper ground 6. Spark ignitor is damaged, dirty or has loose connection 7. Poor flame rectification	Check for proper draft venting. Check for other drafts that could blow out the pilot light Inspect and clean flue way Inspect and clean supply tube and pilot burner Check and adjust supply side Check grounding of pilot burner and main burner Check, repair or replace spark ignitor Check that pilot flame covers the flame rod and is steady and blue

NATURE OF TROUBLE	POSSIBLE CAUSES	SERVICE
Main burner will not stay lit	1. Low gas pressure 2. Main burner orifice or plate clogged 3. Main burner supply tube clogged or pinched 4. Improper venting 5. Poor flame rectification	Check gas supply pressure Clean or replace Clean, repair or replace Check venting for proper sizing and down drafts Check that pilot flame covers the flame rod and is steady and blue
Scale on burner and pilot assemblies	1. Condensation 2. Contaminated atmosphere	Excessive condensation caused by undersized heater, poor venting or continuous use Check for contaminant causing chemicals near the heater
Sooting	1. Combustion air inlets or flueway is restricted 2. Not enough combustion or ventilation air supplied to room 3. Improper gas pressure 4. Burner orifice or plate dirty	Remove obstruction or debris from heater or flueway Improve combustion air or ventilation air supply Check and adjust Inspect and clean
Yellow flame	1. Scale on top of burner 2. Burner orifice or plate dirty 3. Flue way clogged 4. Improper gas pressure 5. Not enough combustion or ventilation air supplied to room	Shut off heater; allow to cool; clean burner plate Inspect and clean Inspect and clean Check and adjust Improve combustion air or ventilation air supply

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NATURE OF TROUBLE	POSSIBLE CAUSES	SERVICE
Burner flame noisy -whistling	1. Improper gas pressure 2. Burner orifice dirty	Check and adjust Inspect and clean
Burner flame floats	1. Improper gas pressure 2. Wrong orifice 3. Clogged flue	Check and adjust Install correct orifice Inspect and clean flue way
Burner flame too high	1. Improper gas pressure 2. Wrong orifice	Check and adjust Install correct orifice
Water too hot	1. Thermostat setting too high 2. Thermostat out of calibration	Adjust thermostat to lower setting Check and replace thermostat
Slow hot water recovery	1. Burner orifice clogged 2. Excessive drafts 3. Clogged flue 4. Improper gas pressure	Check and clean Locate and eliminate drafts Clean flue chamber Check and adjust
Noisy water heater (rumbling and sizzling)	1. Scale or sediment build up in bottom of tank 2. Flue baffle loose 3. Condensation on main burner	Clean tank Reseat in hanger bracket and tighten Inspect for condensation (normal) and tank leaks
Excessive relief valve operation	1. Excessive water pressure 2. Excessive temperature	Install proper pressure reducing valve on cold side. Check for open or closed system. Install expansion tank. Check thermostat; lower setting or replace

NATURE OF TROUBLE	POSSIBLE CAUSES	SERVICE
Rusty or black water	1. Anode rod dissolved 2. Excessive sediment build-up	Check anode rod and replace Drain tank; replace tank if sediment build up is excessive
Water heater is leaking	1. Cold in or hot out joints 2. T&P valve 3. Inner tank has a pin hole leak	Check joint and repair Check valve and replace Replace water heater
Smelly water (rotten egg odor)	Sulfate reducing bacteria formation inside water tank	Clean tank using chlorine bleach Replace anode rod if deteriorated Add automatic chlorine feeder to cold water inlet side of tank
Milky water	Aerated water - microscopic air bubbles in the water	Allow a glass of hot water to set for a few minutes. If the water turns clear, the condition is a natural occurrence.

NOTES

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Pocket Diagnostics Manual (Rev 1)
COMMERCIAL ELECTRIC

SURFACE AND IMMERSION THERMOSTATS

Thermostats

A thermostat is a mechanical device that controls the flow of electrical current to various parts of the water heater. First, the thermostat senses the presence of heat. Second, by sensing the presence of heat, the thermostat can control electrical current that is sent to another thermostat or to a heating element. A commercial water heater may contain one surface mounted thermostat or up to three immersion mounted thermostats. With two or more immersion thermostats, each thermostat controls a group of three heating elements.

Surface Mounted Thermostats

Water temperature is maintained by a surface mounted thermostat adjustable from 120° F to 170° F on 85 and 120 gallon models and up to 150° F on 50 gallon models. Over temperature protection is provided by surface mounted high temperature limit controls (ECO) that will suspend power to the heater if the water temperature exceeds 190° Fahrenheit and 170° Fahrenheit respectively.

Immersion Thermostats

Water temperature is maintained by an immersion thermostat adjustable from OFF and ranging from 90° F to 190° F. Over temperature protection (ECO) is provided by an independent immersed high temperature limit control that will suspend power to the heater if the water temperature exceeds 200 degrees Fahrenheit. The immersion thermostat is the only thermostat rated to deliver water temperatures of 180° Fahrenheit. One thermostat is supplied as standard equipment with up to two additional thermostats (optional) to control element staging.

The immersion thermostat system is mounted on the control panel of the heater and comes in two separate parts. The first part is the high temperature limit (ECO). The ECO is mounted on the control panel and the immersion bulb screwed into a spud weld. The ECO has a black plunger to reset the high limit switch. The thermostat is a separate piece and is also screwed into a spud weld on the inner tank. As the water is heated, a signal is sent from the immersion bulb to the thermostat controls. The thermostat, sensing the change in temperature, will

relay or suspend power to the contactors.

Troubleshooting Tip:

When checking the high limit (ECO) switch on commercial heaters, also check the temperature of the water. The ECO will give an audible click when reset. You can check the water temperature by drawing a small quantity from the T&P valve in a bucket and measuring the temperature. Complaints of ECO tripping is a serious problem that needs to be resolved immediately.

HOW TO CHECK LINE VOLTAGE

Why a special section on how to check line voltage? The answer is simple: single phase versus three phase. The other voltage on the water heater is 120V control voltage. The thermostat and the contactors are controlled and actuated by 120 volts. The step down transformer takes the line voltage and steps it down to the 120 volts needed for the thermostat and contactors to operate.

SINGLE PHASE

Phase is a characteristic of electricity. In the United States, single or three phase current supplies nearly all our electrical needs. When one current alternates in a circuit, it is a single phase circuit. When two or more currents are alternating at different time intervals, it is a polyphase current. Generally, the electric utilities generate only three phase (polyphase) current. Single phase current is obtained by connecting to only two of the three phase lines.

A single phase circuit consists of 3 wire 240-120 volt circuitry. It will have two hot conductors (L1 and L2) to ground or a neutral wire. The ground or neutral, from the service panel, is connected to the green grounding screw. Connecting across the two hot wires will supply 240 VAC, single phase. Connecting from either one of the hot wires to ground will supply 120 VAC.



Figure 32 - Single phase

On a single phase heater, the line voltage is introduced

to the field wiring block with only two wires. The combination of these two wires carry the full line voltage specified by the rating plate. This line voltage may be 208, 240, 277 or 480 volts. Line voltage is carried throughout the electrical circuits of the heater by the red wires and the black wires. By looking at the field wiring block, you can instantly tell a single phase heater because all the red wires are bundled into one terminal lug; and all the black wires are bundled into another terminal lug. Verify line voltage by placing the red probe of a multimeter on the field wiring block containing the red wires and the black probe of a multimeter on the field wiring block containing the black wires. The multimeter should read the line voltage specified on the rating plate.

The quick check for proper phase is to verify the phase requirements on the rating plate with a visual inspection of the field wiring block.

To verify line voltage anywhere within the heater, place the red probe of your multimeter on the red wire located on the field wiring block. Next, take the black multimeter probe and place it on any wire terminal containing a black wire. Assuming the heater is functioning properly and the thermostat is demanding heat, the multimeter will read line voltage. (Note: You will always have line voltage at the top of the contactors.) You have now checked the wiring and operation of the black wire side of the heater.

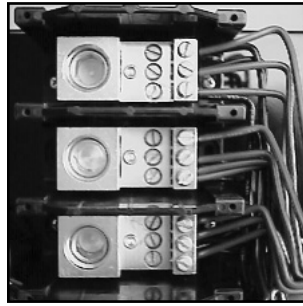
To verify line voltage on the red wire side of the heater, place the black probe of your multimeter on the black wire located on the field wiring block. Next, take the red multimeter probe and place it on any wire terminal containing a red wire. Assuming the heater is functioning properly and the thermostat is demanding heat, the multimeter will read line voltage. (Note: You will always have line voltage at the top of the contactors.) You have now check the wiring and operation of the red side of the heater.

Quick Check: Check the circuits of the heater by measuring line voltage at the element head. If line voltage is present, then both red and black legs are working. Check all elements.

THREE PHASE

Three phase current has three alternating currents equally spaced 120 degrees away from each other. Three phase current is, in effect, three separate single phase currents out of step with each other, but working in unison. There is a ground wire,

from the service panel, connected to the green grounding screw inside the heater. Each conductor of three phase power is a hot conductor. Each conductor of three phase power is also the return side of the circuit for the other two conductors. A combination of any two of the three phase conductors will give you single phase line voltage.



Here is an example of a three phase, 240 volts. A three phase circuit consists of 3 wire 240 volt circuitry. It will have three hot conductors (L1, L2 and L3). Connecting across any two of the three hot wires will supply 240 VAC, three phase.

Figure 33 - Three phase

On a three phase heater, the line voltage is introduced to the field wiring block with three wires. Any combination of two of the three wires carry the full line voltage specified by the rating plate. This line voltage may be 208, 240, or 480 volts. Rheem's commercial electric water heaters are not manufactured to accept 277 volt, 3 phase. Line voltage is carried throughout the electrical circuits of the heater by the red wires and the black wires. By looking at the field wiring block, you can instantly tell a three phase heater because each red wire and each black wire is located at a different position on the field wiring block. The wiring schematic at Figure 7 in this manual shows a three phase heater wiring configuration.

The quick check for proper phase is to verify the phase requirements on the rating plate with a visual inspection of the field wiring block.

Place the black multimeter probe on the bottom (L1) terminal lug of the field wiring block; place the red multimeter probe on the middle (L2) terminal lug of the field wiring block; the multimeter will register line voltage. Next, place the red multimeter probe on the top (L3) terminal lug of the field wiring block; the multimeter will register line voltage. You have just measured (sequentially) the three legs of the three phase line voltage.

Reverse the procedure (black probe on the top (L3) terminal lug) and place the red probe on the middle and bottom terminal lugs and you will still read line voltage every time. If you

place both multimeter probes on the same terminal lug, your multimeter will not register any voltage. Why? Because you are not completing a current path. Remember, you will need to verify line voltage on two of the three legs of a 3 phase heater.

Why is this important? Each contactor and fuse block contains all three legs of the 3 phase line voltage. If you accidentally check one leg and your multimeter does not register, then you may be testing only a single leg and not two of the three legs.

How do we simplify this on three phase heaters? By use of the System Sentinel™ display lights. Remember, the LEDs are energized when the electric elements are receiving current through a completed circuit. An unlit LED pinpoints the exact location of a non-functioning element. This makes diagnostics simple because the problem must be the element, the fuse block, the contactor or the wiring. By working backwards from the heating element you can find the faulty component. With the thermostat demanding heat:

1. Verify element location on the inner tank. It will correspond with the position of the System Sentinel™ display lights. Check for line voltage at the element screws. If you have line voltage, then the element is damaged. (See the section How to Check Open or Grounded Heating Elements).
2. Check the wiring diagram on the inside control panel cover and determine the location of the 'legs' of the red and black wires to the elements.
3. Start with the red wire. Beginning at the bottom of the fuse block, verify line voltage by touching any two red wires, including the 'leg' you are troubleshooting. If you do not read line voltage, move to the top of the fuse block and measure again. If you read line voltage before the fuse, but not after the fuse, then the fuse is damaged. (See the section How to Check Fuse Blocks).
4. If you measure line voltage before and after the fuse, then the fuse and fuse blocks are OK.
5. Measure for line voltage at the bottom of the contactor. If you do not read line voltage, move to the top of the contactor and measure again. If you read line voltage before the contactor, but not after the contactor, then the contactor is damaged. (See the section How to Check Contactors).
6. Repeat steps 3, 4 and 5 for the black wire side.

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SEQUENCE OF OPERATIONS FLOWCHART

For the sake of explanation, line voltage is defined as the amount of voltage applied to the heater. In understanding the sequence of operations, it is not important whether the line voltage is 208V single phase or 480V three phase or any other combination of line voltage supply. The sequence describes how the water heater operates. It operates the same way every time. By following this sequence chart, you can quickly discover the problem component.

Tank is cold and full of water. Line voltage is connected to the field wiring block.	NO	Fill tank to prevent dry firing of elements. Ensure line voltage connections are present.
YES		
Line voltage is applied to the field wiring block.	NO	Check L1, L2 and L3 leg for line voltage at the field wiring block. Replace fuse or reset breaker at service panel.
YES		
Line voltage is routed through transformer fuse block to the transformer.	NO	Check transformer fuse block for presence of 3 amp fuse. Replace fuse if damaged.
YES		
Line voltage also flows to the top of the contactors; but is not passed to the fuse blocks.	NO	Note: The contactors and fuse blocks pass line voltage to the heating elements. Contactors are energized with 120V and controlled by the thermostat. Check for line voltage at top of the contactor.
YES		
Transformer converts line voltage to 120V (also called control voltage) for use by the thermostat and the contactors.	NO	Check the position of the red wire on the transformer screw terminal pad. It should be connected to the same terminal as the line voltage. Black wire should be connected to the common (COM) terminal.
YES		

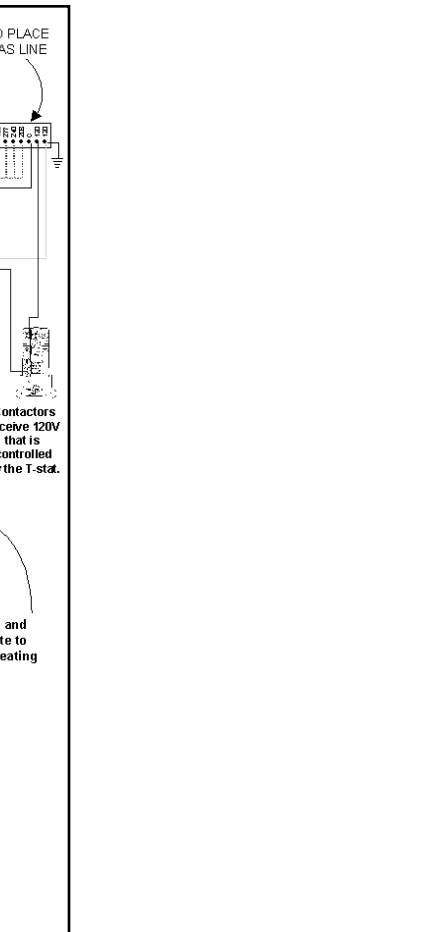
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120V flows along the blue wire from the transformer to the Energy Cut Off (ECO) on the thermostat.			Check red wire and black wire terminal screw location. Check blue wire and white wire location with wiring diagram.
	NO		Check transformer fuse. Check transformer. Rewire according to wiring diagram. Replace fuse. Replace transformer.
YES			
ECO passes 120V to the thermostat.			Reset ECO by pushing the red reset button. Replace thermostat.
	NO		
YES			
Thermostat demands heat . Thermostat closes and relays 120V to the contactors.			Check thermostat. Replace thermostat.
	NO		
YES			
Contactors receive 120V and actuate (close). (120 V power flow stops here). Line voltage is relayed to the fuse blocks.			Note: Contactors - when closed - relay line voltage through the contactor to the fuse blocks. Older model contactor has a square, black manual 'check' button. Check for line voltage at the bottom of the contactor. Check, reset or replace contactors.
	NO		
YES			
Fuse blocks relay line voltage through a fuse and to the heating elements.			Note: Each element requires two legs of the line voltage. The fuse block protects each leg to the element with its own fuse. Check and replace fuses.
	NO		
YES			

Table 11 - Commercial Electric Sequence of Operations

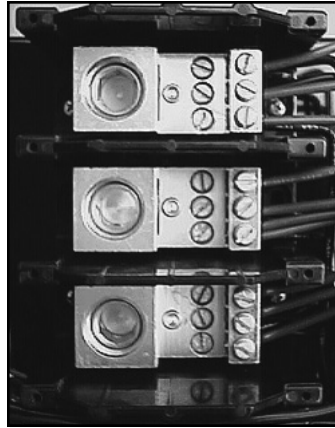
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Heating elements (all of them at the same time) receive line voltage and heat the water.			Check LED panel for red lights. Note: Some models operate on a principle called staging. This involves multiple thermostats. See the section on staging. Check element if LED is not lit. If element is OK, check power to the element.
	NO		
YES			
Water is heated to the thermostat setting. Call for heat ends.			Thermostat is stuck closed. ECO will normally trip due to excessive heating of the water. Check and replace thermostat.
	NO		
YES			
Thermostat suspends 120V to the contactors..			Thermostat is stuck closed. ECO will normally trip due to excessive heating of the water. Check and replace thermostat.
	NO		
YES			
Contactors open and suspend line voltage to the fuse blocks and heating elements.			Contactors may have 'fused' closed. If call for heat has ended, contactors should be open. No power at bottom of the contactor. Check and replace contactors
	NO		
YES			
Heater is fully recovered. Water is hot.			



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Compare the voltage specified on the rating plate of the heater with the terminal screw pad on the transformer and on the electric heating element head. They should all read the same voltage, for example 480 volts. The single or three phase rating does not matter when connections are made to the transformer screw terminal pad or when checking the heating elements; only voltage matters.

Figure 35 - Field Wiring Block

HOW TO CHECK TRANSFORMER FUSE PANEL

Caution: When removing fuses, ensure the power to the heater is turned off.

The transformer fuse block is the first safety on the commercial electric water heater. It contains two 3 Amp fuses and protects the rest of the electrical components from excessive amp draw. Measure line voltage along each wiring path by placing the probes of a multimeter on the two screw terminals after the fuses. Multimeter should register line voltage. You may also check each fuse by verifying continuity through the fuse. Remove the fuse from the fuse panel. Set the multimeter for continuity and check the fuse. If there is continuity, then the fuse is good. If there is no continuity, then the fuse is bad and must be replaced.

When required, the fuse must be replaced with exactly the same fuse type. Look at the fuse carefully before you replace it. Also ensure the clips of the fuse holder are tight. If you can easily remove the fuse with your bare hands, without the use of tools, then the clips are not tight enough. Squeeze the clips of the fuse holder together with a pair of pliers.

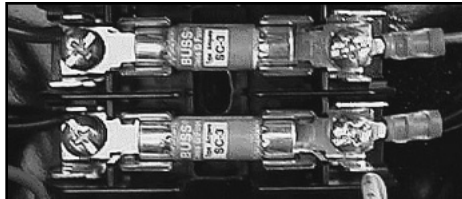


Figure 36 - Transformer Fuse Panel

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HOW TO CHECK TRANSFORMER

Here is the step down transformer used on all of Rheem's commercial electric water heaters from 6KW to 54KW. The transformer takes the line voltage and steps it down to 120V. The 120V is called the control voltage, and is used to operate the thermostat and the contactors. The first check for the transformer is a visual inspection of the wiring. The red wire should be attached to the terminal screw pad and match the line voltage (which should also match the rating plate and the voltage capacity of the heating elements). The black wire should be attached to the COM terminal; the blue wire to the LOAD terminal, and the white wire to the ground terminal (far right hand screw terminal).

Control voltage (120V) for the operation of the thermostat and the contactors is carried by the blue wire and returned through the white (or ground) wire. The transformer either works or it does not work. After verifying the transformer fuses, and line voltage with the rating plate and the terminal screw pad on the transformer, measure for 120V between the blue wire (LOAD) terminal and the white (ground) terminal. If the multimeter does not register 120V, the transformer is bad and needs to be replaced.

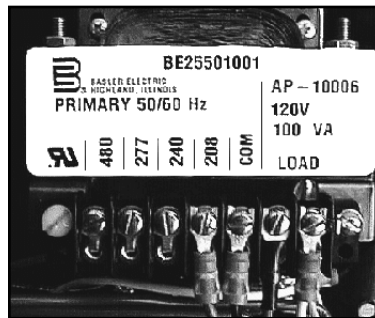


Figure 37 - Step-down Transformer

HOW TO CHECK SURFACE MOUNTED THERMOSTATS

Rheem uses two different surface mounted thermostats in our commercial electric water heaters. Fifty gallon capacity heaters have a thermostat temperature limit of 150° F and a safety (ECO) limit of 170° F. The 85 and 120 gallon models have a thermostat temperature limit of 170° F and a safety (ECO) limit of 190° F. To perform this test you will need a multimeter capable of reading voltage. You may also use a test lamp to verify the presence of voltage only. Ensure the test lamp has a rating equal to or greater than the line voltage of the heater.

Check for voltage to the water heater:

1. Check manual disconnect switch, fuses and service panel breakers.

2. Determine voltage to heater. Check with a multimeter or test lamp across terminal 1 of the ECO and the white (ground) wire terminal of the transformer. If voltage is being supplied, meter will register 120V or lamp will light. NOTE: If you are using a wide spectrum test lamp (50-400V) you may receive a false voltage reading. If there is no voltage supply to the thermostat, the problem may be the transformer fuses, the transformer, the location of the red wire on the terminal screw pad or the line voltage to the heater.
3. Determine voltage through the high limit switch. Place test prongs on terminal 2 of the ECO and the white (ground) wire terminal of the transformer. If voltage is being supplied, meter will register 120V or lamp will light. This means the ECO is not tripped. If the meter does not register 120V, press the red **RESET** button on the thermostat and retest. Replace the thermostat if the meter does not register 120V.

Check operation of the surface mounted thermostat

1. Turn the temperature dial on the thermostat to its highest setting. This forces the thermostat to call for heat. Place the test prongs on terminal 1 (bottom of the bus bar) and the white (ground) wire terminal of the transformer. This test checks for the presence of power between the thermostat and the ECO. If voltage is being supplied, the meter will register 120V or lamp will light.

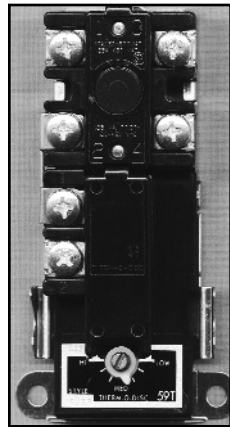


Figure 38 - Surface Mounted Thermostat

2. Move the test prong from terminal 1 to terminal 2 of the thermostat; the other test prong remains on the white (ground) wire terminal of the transformer. This test checks the operation of the switch pole inside the thermostat. If voltage is being supplied, the meter will register 120V or the lamp will light. You may also hear the contactors 'snap' closed. If meter fails to register, make sure the water inside the tank is cooler than the thermostat setting. Recheck the thermostat. If the meter fails to register a second time, the thermostat is defective and should be replaced.
3. Turn the temperature dial on the thermostat to its lowest setting. This forces the thermostat to satisfy. All voltage to the contactors should be suspended. You may hear the contactors snap open. Repeat step 2 and check for voltage on terminal 2 of the

thermostat. *You should not read 120V.* If the multimeter registers 120V, the thermostat is stuck closed and should be replaced.

Check for calibration of the surface mounted thermostat

Turn the temperature dial on the thermostat to its highest setting. Wait for the heater to fully recover. Draw a small quantity of hot water from the T&P valve and measure the temperature of the water. For 50 gallon models, the water temperature should be 150° F (+/- 5 degrees); for 85 and 120 gallon models, the water temperature should be 170° F (+/- 5 degrees).

HOW TO CHECK IMMERSION MOUNTED THERMOSTATS

This section focuses on the 50, 85, 120 gallon immersion thermostats. The 10 gallon booster heater thermostats are a different part number, but are checked using the same sequence.

Check for voltage to the water heater:

1. Check manual disconnect switch, fuses and service panel breakers.
2. Determine voltage to heater. Check with a multimeter or test lamp the top blue wire of the immersion ECO and the white (ground) wire terminal of the transformer. If voltage is being supplied, meter will register 120V or lamp will light. NOTE: If you are using a wide spectrum test lamp (50-400V) you may receive a false voltage reading. If there is no voltage supply to the ECO, the problem may be the transformer fuses, the transformer, the location of the red wire on the terminal screw pad or the line voltage to the heater.
3. Determine voltage through the ECO. Place test prongs on the bottom blue wire of the ECO and the white (ground) wire terminal of the transformer. If voltage is being supplied, meter will register 120V or lamp will light. This means the ECO is not tripped. If the meter does not register 120V, press the black/red **RESET** button on the ECO and retest. Replace the ECO if the meter does not register 120V.

Check operation of the immersion mounted thermostat:

1. Turn the temperature dial on the immersion thermostat to its highest setting. This forces the thermostat to call for heat. Place the test prongs on top blue wire and the white (ground) wire terminal of the transformer. This test checks for the presence of voltage between the thermostat and the ECO. If voltage is being supplied, the meter will register 120V or lamp will light.

2. Move the test prong to the bottom blue wire; the other test prong remains on the white (ground) wire terminal of the transformer. This test checks the operation of the switch pole inside the immersion thermostat. If voltage is being supplied, the meter will register 120V or the lamp will light. If meter fails to register, cool the water inside the tank and recheck. If the meter fails to register a second time, the thermostat is defective and should be replaced. If the heater is multi-staged, continue this process on the remaining thermostats.



3. Turn the temperature dial on the immersion thermostat to its lowest setting. This forces the thermostat to satisfy. All voltage to the contactors should be suspended. Repeat step 2 and check for voltage on the bottom blue wire. You should not read 120V. If the multimeter registers 120V, the thermostat is stuck closed and should be replaced. If the heater is multi-staged, continue this process on the remaining thermostats.

Figure 39 - Immersion Thermostat

Check calibration of the immersion mounted thermostat:

Turn the temperature dial on the thermostat(s) to its highest setting. This forces the thermostat to call for heat. Wait for the heater to fully recover. Draw a small quantity of hot water from the T&P valve and measure the temperature of the water. The water temperature should be 190° F (+/- 5 degrees).

Quick Check: Turn thermostat to demand heat. Listen for the contactors to snap closed or check for 120V at the first contactor. If 120V, then the immersion ECO and immersion thermostat are working.

HOW TO CHECK AN OPEN OR GROUNDED HEATING ELEMENT

See the section in Residential Electric.

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**COMMERCIAL ELECTRIC HEATING ELEMENT
 PROPERTIES**

Watts	Volts	Amps	Ohms	Watts	Volts	Amps	Ohms
2000	208	9.6	21.6	4500	208	21.6	9.6
	240	8.3	28.8		240	18.8	12.8
	277	7.2	38.4		277	16.2	17.1
	480	4.2	115.2		480	9.4	51.2
3000	208	14.4	14.4	5000	208	24.0	8.6
	240	12.05	19.2		240	20.8	11.5
	277	10.8	25.6		277	18.1	15.3
	480	6.3	76.8		480	10.4	46.1
4000	208	19.2	10.8	6000	208	28.8	7.2
	240	16.7	14.4		240	25.0	9.6
	277	14.4	19.2		277	21.7	12.8
	480	8.3	57.6		480	12.5	38.4

Table 12 - Com Electric Heating Element Properties

HOW TO CHECK THE CONTACTORS

The purpose of the contactors is to relay line voltage. Remember, you can find the line voltage rating on the heaters rating plate. Each contactor controls three legs of line voltage; and controls both the black wire legs or red wire legs. Contactors contain an electro-magnet that is energized by 120 volts. The contactors are spring loaded to keep the contact points open (not allowing current to pass) until the coil is energized. When the thermostat demands heat, 120 volts is relayed through the thermostat to the contactors. The electromagnetic coil is energized, the spring tension is defeated and the contact points close. Once the contact points close, line voltage is relayed through the contactor to the fuse blocks.

Due to the wiring configuration, there will always be line voltage at the top of the contactors.

Each leg of the contactor needs to be checked for line voltage. If a contact point fuses closed (due to high heat) then one leg of the line voltage will always be 'hot'. Although not difficult to do, this process is very repetitive. The smallest 3 element, 6 KW water heater will have six legs to check; the largest 9 element heater will have 18 legs.

Assuming the line voltage is correct, the transformer is working and the thermostat is demanding heat -

The electromagnetic coil inside the contactors should now be energized and the contact point closed. Using a multimeter, measure for line voltage at the bottom (lower) screw terminal of each leg of the contactor. Do not forget both the red legs and the black legs. If any one leg does not register line voltage, the entire contactor needs to be replaced. If the heater is three phase, see the section entitled How to Check Line Voltage.

There is a small black spring loaded button in the center of the contactor. This button will allow manual closing of the contactors. To verify the contactor is not working, perform the multimeter check in the previous paragraph. If the multimeter does not register line voltage at the bottom of the contactor, press and hold the black button. This will manually close the contactors and the multimeter should read line voltage. Turn the thermostat to the lowest setting so the contactors are not energized and closed.

With the thermostat satisfied, 120V power is suspended to the contactors. The electromagnetic coil is not energized and the contact points are

'open', preventing line voltage from passing to the fuse blocks. Using a multimeter, check for line voltage at the bottom of the contactor. The multimeter should not read any voltage at all. If line voltage is present the contactors have fused closed and are allowing one leg of the line voltage to pass to the fuse blocks and heating elements.

NOTE: On newer production model heaters, the contactor does not have a button in the center.

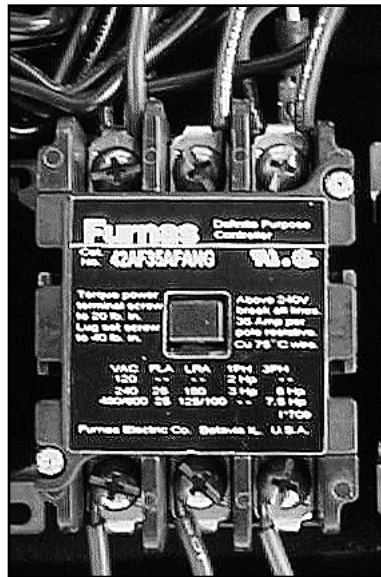


Figure 40 - Contactors

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HOW TO CHECK THE FUSE BLOCKS

Caution: When removing fuses, ensure the power to the heater is turned off.

The fuse blocks are another safety feature of Rheem's commercial electric water heaters. Their purpose is to protect the heating elements from excessive current draw. Checking this fuse block is similar to checking the transformer fuse panel.

Verify line voltage along each wiring path by measuring line voltage at the bottom (lower) screw terminal of each leg of the fuse block. Multimeter should register line voltage. If the heater is three phase, see the section entitled How to Check Line Voltage. You may also check each fuse by verifying continuity through the fuse. Remove the fuse from the fuse block. Set the multimeter for continuity and check the fuse. If there is continuity, then the fuse is good. *If there is no continuity, then the fuse is blown and must be replaced.*

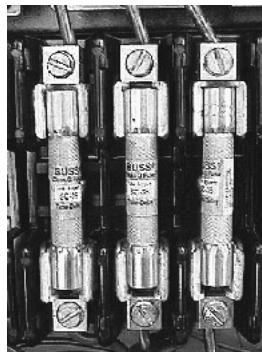


Figure 41 - Fuse Blocks

When required, the fuse must be replaced with exactly the same fuse type. Fuses may be "T" series or "G" series. Look at the fuse carefully before you replace it. Also ensure the clips of the fuse holder are tight. If you can easily remove the fuse with your bare hands, without the use of tools, then the clips are not tight enough. Squeeze the clips of the fuse holder together with a pair of pliers.

UL, ASME, AND NSF PERFORMANCE STANDARDS

Underwriters Laboratories

All Rheem commercial electric water heaters comply with the basic requirements of the "Standard for Electric Booster and Commercial Storage Tank Water Heaters" (UL1453) and are listed by Underwriters Laboratories. Controls, wiring and components are only used when they are listed in the UL Recognized Component Index and are inspected under the Reexamination Service. Good performance of these units is guaranteed because they are constructed of the following UL listed or recognized

components: terminals, internal wiring, contactors, high limit thermostats, operating thermostats and heating elements.

American Society of Mechanical Engineers

Many states have codes that require that water heaters be constructed in accordance with the ASME Boiler and Pressure Vessel Code Section 4, Part HLW. At the present time, the ASME code applies only when the input is greater than or equal to 200,000 BTU per hour (about 58 KW) or when the storage capacity is greater than 120 gallons. All Rheem commercial models with inputs above 200,000 BTU per hour are available with construction in accordance with the ASME Boiler and Pressure Vessel Code. Electric immersion thermostat models of 50, 85 and 120 gallon capacity are available with construction in accordance with ASME Boiler and Pressure Vessel Code. ASME construction may be required if the water heater is installed in an apartment complex that services six or more units. Check your local code requirements.

National Sanitation Foundation

The National Sanitation Foundation (NSF) has established guidelines for the health and safety of employees and customers in establishments such as restaurants and other food service businesses. It is dedicated to the prevention of illness and the promotion of health. All properly equipped Rheem water heaters recommended for food service applications meet the recommendations of the Nation Sanitation Foundation Standard No. 5 (Water Heaters). This assures that the Rheem water heater selected will continuously supply adequate 180° F rinse water to sanitize and air dry dishes. It also provides assurance the heater are constructed in accordance with the NSF recommendations.

N O T E S

Pocket Diagnostics Manual (Rev 1)
MINIMUM BRANCH CIRCUIT SIZING

Based on National Electric Code, ANSI/NFPA 70-1993; Article 422-4(a); Article 240-6(a); Chapter 9, Table 34; and Table 310-16 (based on 75° C type THW wire).

"X" denotes 277v, 3 phase not applicable to Rheem commercial electric water heaters.

Kw	Phase	Recommended Over Current Protection				Wire Gauge							
						C=copper wire; A=aluminum wire							
						208V		240V		277V		480V	
		208V	240V	277V	480V	C	A	C	A	C	A	C	A
6	1	40	35	30	20	8	8	10	8	10	10	14	12
	3	25	20	X	15	12	10	14	12	X	X	14	12
9	1	60	50	45	25	6	4	8	6	8	6	12	10
	3	35	30	X	15	10	8	10	10	X	X	14	12
12	1	80	70	60	35	4	2	4	3	6	4	10	8
	3	45	40	X	20	8	6	8	8	X	X	14	12
15	1	90	80	70	40	3	2	4	2	4	3	8	8
	3	60	50	X	25	6	4	8	6	X	X	12	10
18	1	110	100	90	50	2	1/0	3	1	3	2	8	6
	3	70	60	X	30	4	3	6	4	X	X	10	10
24	1	150	125	110	70	1/0	3/0	1	2/0	2	1/0	4	3
	3	90	80	X	40	3	2	4	2	X	X	8	8
27	1	175	150	125	80	2/0	4/0	1/0	3/0	1	2/0	4	2
	3	100	90	X	45	3	1	3	2	X	X	8	6
30	1	200	175	150	80	3/0	250	2/0	4/0	1/0	3/0	4	2
	3	100	90	X	45	2	1/0	4	2	X	X	8	6
36	1	225	200	175	100	4/0	300	3/0	250	2/0	4/0	3	1
	3	125	110	X	60	1	2/0	2	1/0	X	X	6	4
45	1	300	250	225	125	350	500	250	350	4/0	300	1	2/0
	3	175	150	X	70	2/0	4/0	1/0	3/0	X	X	4	3
54	1	350	300	250	150	500	700	360	500	250	350	1/0	3/0
	3	200	175	X	90	3/0	250	2/0	4/0	X	X	3	2

Table 13 - Commercial Electric Branch Circuit Sizing

Pocket Diagnostics Manual (Rev 1)
**COMMERCIAL ELECTRIC TROUBLESHOOTING
 TABLE**

NATURE OF TROUBLE	POSSIBLE CAUSES	SERVICE
No Hot Water	Manual switch turned off Blown service panel fuse or breaker High limit switch tripped Thermostat faulty Faulty contactors (open) One or both trans- former fuses are blown Thermostat out of calibration Improper wiring a. Shorted or loose wiring b. Undersized service wire	Turn to ON Replace or reset Manually reset ECO button Check and replace Check and replace Check and replace Check and replace Check and rewire Rewire per wiring diagram
Not Enough Hot Water	Thermostat set too low Faulty element(s) Faulty Contactors (open) Faulty fuse on fuse block Improper or loose wiring Improper heating elements Scale formation on heating elements Thermostat not flush with tank Poor grounding of tank Heater is undersized Damaged dip tube (ELDs only)	Increase thermostat setting Check for open or grounded elements and replace Check and replace Check and replace Rewire per wiring diagram; Check and tighten Check wattage/voltage to rating plate and replace Check elements; clean or replace Position thermostat so back touches the tank. Make sure cavity insulation covers thermostat Check grounding and tight- en Resize and compare Check and replace

Table 14 - Commercial Electric Troubleshooting Table

Pocket Diagnostics Manual (Rev 1)

NATURE OF TROUBLE	POSSIBLE CAUSES	SERVICE
Water too hot	Thermostat setting too high Thermostat out of calibration Thermostat not flush with tank Faulty contactors (closed)	Lower thermostat setting Check and replace Position thermostat so back touches the tank Check contactors and replace
Blows fuses and / or trips breaker	One or more elements are grounded Loose terminal screws on heating element(s) Faulty contactors Undersized heater	Check and replace Check and tighten Check contactors and replace Resize and compare
Slow hot water recovery	Heating elements too small Faulty contactors Fuses on fuse block are blown	Check wattage and replace Check contactors and replace Check fuses and replace
Noisy water heater	Scale build-up on elements High watt density elements in the heater Contactors are 'chattering'	Remove, clean or replace Install low watt density elements Check for foreign material in the contactors. Check for broken or weak spring
Excessive relief valve operation	1. Excessive water pressure 2. Excessive temperature	Install proper pressure reducing valve on cold side. Check for open or closed system. Install expansion tank. Check thermostat; lower setting or replace
Rusty or black water	1. Anode rod (s) dissolved 2. Excessive sediment build-up	Check anode rod(s) and replace Drain tank; replace tank if sediment build up is excessive

Pocket Diagnostics Manual (Rev 1)

NATURE OF TROUBLE	POSSIBLE CAUSES	SERVICE
Water heater is leaking (Water heaters produce condensation that may drip on the floor. Condensation will produce only a few drops or small puddles that evaporate.)	1. Cold in or hot out joints 2. T&P valve 3. Immersion thermostat or anode rod is loose 4. Inner tank has a pin hole	Check joint and repair Check valve and replace (Caution: Do not confuse normal T&P operation as a leaking tank. If the puddle dries up, then look for a T&P problem.) Check, tighten and replace Replace water heater (When diagnosing a leaker - you will notice a puddle of water on the floor, next to the heater, that will not go away.)
Smelly water (rotten egg odor)	Sulfate reducing bacteria formation inside water tank	Clean tank using chlorine bleach Replace anode rod if deteriorated Add automatic chlorine feeder to cold water inlet side of tank
Milky water	Aerated water - microscopic air bubbles in the water	Allow a glass of hot water to set for a few minutes. If the water turns clear, the condition is a natural occurrence.

NATURE OF TROUBLE	POSSIBLE CAUSES	SERVICE
No Hot Water	Circulating pump to storage tank is not operating	Check and replace
Not Enough Hot Water	Circulating pump to storage tank is not operating	Check and replace
Water too hot	Check for stacking	Install circulating lines and pump

NOTES

This image shows a single sheet of white paper with horizontal blue or grey ruling lines. The lines are evenly spaced and run across the width of the page. There are approximately 20 lines visible. The paper appears to be a standard notebook page or a sheet of stationery.

COMMERCIAL GAS

ELECTRONIC IGNITION OPERATIONS SEQUENCE

The Universal™ gas series water heaters contain an electronic spark ignition system. The heater is connected to a 120VAC power source required by the transformer. The transformer steps down the 120VAC to 24 volt control voltage. When the heater is turned on (1), a **yellow** wire carries the 24V from the transformer to the thermostat. In a normal stand-by condition, 24V is passed directly to the damper assembly by the **yellow** wire and connected to the **24V** terminal. This terminal controls the closing of the damper after the thermostat is satisfied.

When the thermostat calls for heat (2) , contacts close and pass the 24V through the **blue** wire to the damper assembly **TH** terminal. A microswitch inside the damper does two things. (3) First, the microswitch breaks contact from the **24V** terminal that closes the damper and connects the **TH** terminal. The **TH** terminal provides power to the damper motor that drives the damper blade open. The damper blade, being open, will allow combustion gases to escape through the flueways and vent. Second, when the damper is opened to the correct position, a microswitch passes the 24V control voltage to the **IGN** terminal of the damper assembly. Control voltage follows the **red** wire from the damper to the ignition control module.

Power is now being supplied to the **24V** terminal of the control module by the **red** wire. This is the only wire that feeds power to the control module. The control module now starts a 90 second try for ignition. (4) It may only take a second or two for the pilot burner to ignite. The control module attempts two events simultaneously. The ignition control module generates a 10,000 volt spark at the pilot electrode assembly and attempts to light the pilot. You will hear a distinctive ‘clicking or arcing’ noise. At the same time the control module send 24V from the **PV** (pilot valve) terminal to the ECO along the brown wire. (5)

If the ECO has been tripped due to an overheated tank, the sequence will stop here. The spark ignitor will continue to spark for 90 seconds; then stop. If the ECO is not tripped, 24V is relayed through the ECO to the **PV** terminal of the gas valve along the **brown** wire. This activates the first automatic valve and pilot gas is allowed to flow through the pilot supply tube to the pilot burner. (6)

The pilot gas is ignited by the sparking pilot electrode

and the pilot flame is established. (7) Through a flame recognition of at least one microamp (a very small electrical current produced by the flame), the ignition control module ends the spark generation. After the pilot is lit and recognized by the electronic controls, the ignition control module energizes the main valve.

The ignition control opens the second automatic valve by relaying 24V from the **MV** (main valve) terminal to the gas control valve along the **blue** wire. (8) Gas begins to flow to the main burner while the pilot light remains lit. The main burner lights and begins to heat the water in the tank.

When the water temperature reaches thermostat setting, the thermostat contacts will open and suspend power to the damper assembly. Several things will happen. First, without 24V relayed by the **blue** wire, the damper motor closes the damper blade. How does this happen? Remember the microswitch and **yellow** wire connected to the **24V** terminal of the damper? The microswitch reconnects the 24V terminal and relays power to the damper motor to reverse direction and close. Second, without 24V relayed by the **red** wire, the control module will not receive power. The pilot valve and main valve, held open by 24V, are closed. The main burner will shut off and the heater is back into stand-by mode.

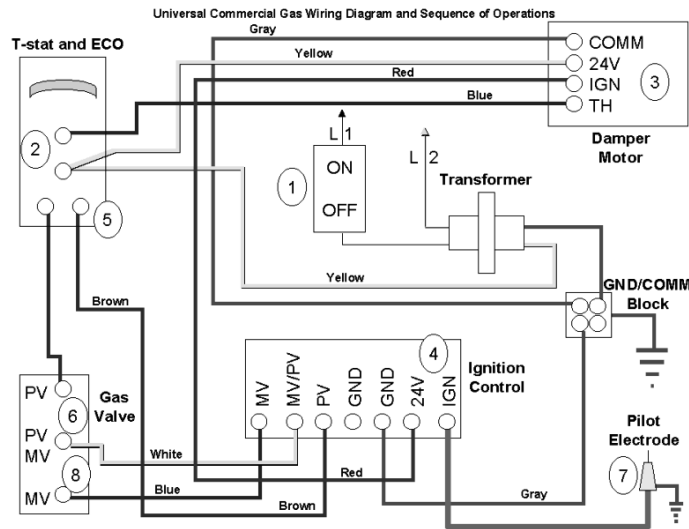


Figure 42 - Universal Com Gas Operations Sequence

Pocket Diagnostics Manual (Rev 1)
SEQUENCE OF OPERATIONS FLOW CHART
ELECTRONIC IGNITION

Tank is cold and full of water. Heater is wired in to a 120 VAC source. Gas supply is connected to heater and valve is set to ON position.	NO	Fill tank Replace fuse or reset breaker at service panel Turn gas valve to ON Turn ON/OFF switch to ON
YES		
120V is extended from the switch to the 24V step down transformer.	NO	Check for 120V at the transformer Replace switch Check wiring to switch
YES		
24V is extended from the transformer to the thermostat.	NO	Check for 24V at the thermostat Check gray grounding wire. Replace transformer
YES		
Thermostat demands heat. 24V is extended through the blue wire to the damper motor.	NO	Check for 24V at the TH and COMM terminals of the damper motor Replace thermostat
YES		
Damper opens. 24V is extended through the red wire to the ignition module.	NO	Check for 24V at the "24V" and "24V GND" terminals of the ignition control module. Check for damper binding or obstruction. Replace damper assembly or remove obstruction
YES		
24V is extended from the ignition control to the ECO (you should also hear the pilot electrode sparking).	NO	Check for 24V at the PV and GND terminal of the ignition module Replace control module
YES		
24V is extended through the ECO to the gas valve.	NO	Check for 24V at the PV terminal of the gas valve. Cool tank to reset ECO Replace ECO
YES		

Table 16 - Com Gas Sequence of Operations Flow Chart

Pocket Diagnostics Manual (Rev 1)

At the same time there is power at the PV terminal of the control module, the pilot electrode should be sparking.	NO	Electric spark generator in the ignition module produces a continuous 10,000V spark pulse through the orange cable. Visually check pilot electrode assembly for a spark. Check ignition control module. Check ignition cable for continuity. Replace control module. Replace ignition cable.
YES		
Pilot flame ignites and remains lit. Spark generator shuts off.	NO	Check gas control valve. Verify 24V at the PV terminal of the gas valve. Check grounding of pilot electrode assembly. Check pilot electrode for cracks. Check gap of pilot electrode. Pilot flame is rectified by the ignition control module. Check gas pressure. Check pilot burner for obstructions. Replace gas valve. Tighten pilot electrode assembly and re-gap to 1/8". Replace pilot electrode. Replace ignition module.
YES		
Main burner ignites.	NO	Check for 24V at the MV terminal of the ignition control module. Check gas pressure. Check main burner supply tube and burner tray for obstructions. Check for 24V at the MV terminal of the gas valve. Replace ignition module. Adjust gas pressure. Replace gas valve
YES		

Main burner ignites.			Check for 24V at the MV terminal of the ignition control module. Check gas pressure. Check main burner supply tube and burner tray for obstructions. Check for 24V at the MV terminal of the gas valve. Replace ignition module. Adjust gas pressure. Replace gas valve.
	NO		
YES			
Water is hot. Thermostat opens and suspends power to damper motor. Damper closes.			Check thermostat. Check damper for obstructions to closing. Check for 24V at the 24V and COM terminal of damper motor.
	NO		
YES			
Main burner and pilot shuts off.			Heater is in stand-by until the thermostat demands heat
	NO		

HOW TO CHECK 24 VOLT TRANSFORMER

The 24 volt (AC) transformer supplies the power to operate the ignition control module, the damper motor and the gas control valve. Assuming the presence of 120VAC power and the thermostat operates -

1. Turn thermostat to highest setting to demand heat.
2. Place the multimeter probe on the gray wire terminal of the grounding buss. Place the other probe on the yellow wire leading from the transformer to the thermostat. Multimeter should read 24 volts (VAC). If not, replace the transformer.
3. Return thermostat to a safe temperature setting.

HOW TO CHECK AN IMMERSION MOUNTED THERMOSTAT

The thermostat performs a number of tasks. Mainly it senses the water temperature in the heater by the use of a capillary bulb mounted in the tank, near the bottom of the heater. This capillary is fluid filled and with the cold and hot water passing through the heater the capillary fluid expands and contracts at a very precise rate. This operates a bellows that opens and closes the thermostat switch mechanism, making and breaking the control circuit to the damper assembly.

Figure 43 - Tank Type Immersion Thermostat



The L8100B thermostat used on the tall models, has a second capillary bulb that is immersed in the upper portion of the tank. This capillary is also fluid filled and connects to the same bellows as the lower capillary. The upper capillary is responsive to temperatures due to stacking or overheating and can also open the thermostat

switch mechanism. The lower immersion bulb contains an ECO (Energy Cut Off) switch. This switch will react in hotter water (200°) and open the circuit to the pilot valve operator. On the face of the thermostat is a rotary dial with temperature markings of 100° through 180°F. Initially, when the dial is rotated clockwise, as far as it can easily turn, it will bring the thermostat to the off position and be in the area below 90°. By rotating the dial plate counterclockwise, the thermostat temperature setting increases. As the dial rotates a click can be heard. This indicates the relative temperature of the thermostat sensing bulb.

With the cover removed from the thermostat you will see 4 screws for electrical connections. The upper 2 vertical screws are for the thermostat portion of the circuit. The lower 2 horizontal screws are for the energy cut off (ECO) portion of the circuit. By rotating the dial past the click point, you will be opening and closing the upper vertical contact connections portion of the thermostat circuit.

Check operation of the immersion mounted thermostat

1. Turn the temperature dial on the immersion thermostat to its highest setting. This forces the thermostat to call for heat. Place the test prongs of a multimeter on the **yellow** wire and the **gray** (ground) wire terminal of the transformer. This test checks for the presence of voltage between the thermostat and the transformer. If voltage is being supplied, the meter will register 24V or lamp will light.
2. Move the test prong to the **blue** wire; the other test prong remains on the **gray** (ground) wire terminal of the transformer. This test checks the operation of the switch pole inside the immersion thermostat. If voltage is being supplied, the meter will

register 24V or the lamp will light. If the meter fails to register, cool the water inside the tank and recheck. If the meter fails to register a second time, the thermostat is defective and should be replaced.

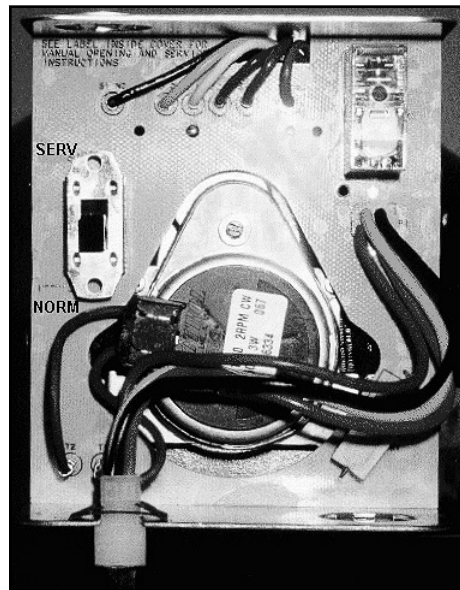
3. Turn the temperature dial on the immersion thermostat to its lowest setting. This forces the thermostat to satisfy. Repeat step 2 and check for voltage on the blue wire. *You should not read 24V.* If the multimeter registers 24V, the thermostat is stuck closed and should be replaced.

Check calibration of the immersion mounted thermostat

Turn the temperature dial on the thermostat to a known setting. This forces the thermostat to call for heat. Wait for the heater to fully recover. Draw a small quantity of hot water from the T&P valve and measure the temperature of the water. The water temperature should be the same temperature as the thermostat setting (+/- 5 degrees).

HOW TO CHECK THE DAMPER ASSEMBLY

As of January 1994, Rheem commercial gas tank type



water heaters with more than 98,000 BTU input must be equipped with dampers. This is due to government energy efficiency standards for standby heat loss. The main purpose of the damper is to prevent stand-by heat loss through the flue tubes when the main burner is not ignited. The secondary purpose of the flue damper is to allow combustion gases to escape when the main burner is operating.

Figure 44 - Damper Assembly

The damper is one of the safety devices designed into the commercial gas water heater. The damper motor rotates in one direction and opens or closes the damper blade. As well as conserving stand-by heat loss, the damper prevents the main burner from lighting if the damper plate is not open. If the heater will not light, take a look at a few simple things. Check to make sure the heater is plugged in to a 120VAC source and the switch is turned ON. Ensure the wires to the damper are securely connected. The connecting plug only goes one way. Check the damper arm is operational and not jammed or stuck in the closed position. Check the small butterfly bracket between the damper motor and the damper arm. It should not be broken or bent.

Assuming the presence of 120VAC power to the heater, switch is ON and transformer is working -

1. Remove the access panel from the damper motor.
2. Measure for 24 volts between the 24V and the COMM terminals of the damper. This connection drives the damper closed when the thermostat is satisfied.
3. Adjust thermostat to demand heat.
4. Measure for 24 volts between the TH and COMM terminals of the damper. This connection drives the damper open when the thermostat calls for heat.
5. Measure for 24 volts at the IGN terminal of the damper. This terminal relays 24 volts to the ignition control module. It is the only source of 24 volt power to the control module.
6. If the damper fails any one of the above tests, the damper assembly is damaged and must be replaced.

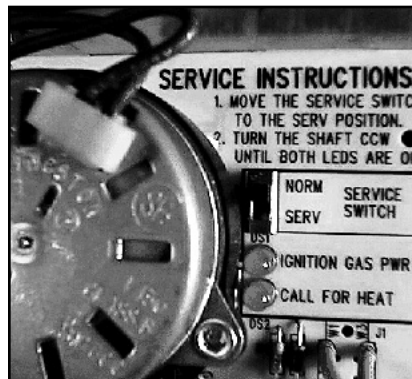
TEMP SOLUTION FOR NON OPERATING DAMPER ASSEMBLIES

1. Turn off power to the heater.
2. Remove damper motor cover and locate the slide switch.
3. Move the slide switch from NORMAL to SERVICE.
4. Using a flat tip screwdriver, rotate the slotted metal knob COUNTERCLOCKWISE until the damper blade is in the open (fully vertical) position.
5. Replace the damper motor cover and turn power on to the heater.
6. The heater should now attempt to light the main burner. Adjust thermostat if necessary to demand heat.
7. Order new damper assembly.

Pocket Diagnostics Manual (Rev 1)
HONEYWELL M896 DAMPER MOTOR
Manufactured effective 12-97

Rheem's Universal™ commercial gas heaters manufactured after Dec 97 will have an improved Honeywell damper motor (model M896). This damper motor contains two green LED display lights to aid in the diagnostics of the heater. It also has a SERVICE switch that allows the main burner to light during service inspections and troubleshooting. If there is a power failure the damper remains exactly where it is, at the moment of failure (open, closed, or somewhere in between). When power is restored, the damper opens if the thermostat calls for heat or closes if the thermostat is not calling for heat.

Figure 45 - Honeywell Damper Assembly



The **CALL FOR HEAT LED** glows when the thermostat is demanding heat. This verifies that 24V power is being passed from the thermostat to the damper motor. The damper motor drives the damper blade to the open position.

The **IGNITION GAS PWR LED** glows when 24V power is being passed from the damper motor to the ignition control module. You can verify this by measuring for 24 volts at the 24V terminal of the ignition control module. You should also be able to hear sparking from the pilot electrode.

All other aspects of checking the damper assembly, damper blades, butterfly arms and damper motor remain the same.

HOW TO CHECK THE IGNITION CONTROL MODULE

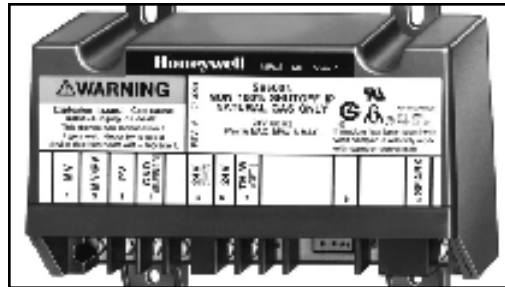
The S8600M provides 100 percent gas shutoff followed by retry for ignition. Operation on ignition failure starts at 90 seconds of continuous try without flame rectification. Six minutes nominal (five minutes minimum) after shutoff, the module restarts the ignition sequence. This time allows the collected gas in the burner compartment to dissipate. The ignition trial, shut-

off, wait sequence and retry continues until the pilot lights, the thermostat is satisfied and the demand for heat ends or the electricity is shut off. The module can be manually reset by turning the ON / OFF switch to OFF for one minute or turning the thermostat down to its lowest setting for one minute.

The diagnosis of a faulty ignition control module is a process of elimination. To properly isolate the control module, all other components of the commercial gas water heater must be functioning. Insure there is adequate gas pressure and then perform the check below:

1. Recycle the heater by turning the ON/OFF switch to OFF; wait one minute and turn the heater to ON. Adjust thermostat to its highest setting to demand heat.
2. Using a multimeter, place one probe on the 24V terminal (red wire) of the ignition control module and the other probe on the 24V (GND) (gray wire) terminal. Measure 24 volts.
 - a. If the multimeter registers 24V, then the thermostat, transformer, and damper assembly are all functioning normally.
 - b. If the multimeter does not register 24V, then check each component using the How to Check..... sections of this manual.
3. Next, perform the How to Check Gas Control Valve procedure.
4. Replace the ignition control module if faulty.

Figure 46 -
Honeywell
Ignition Control
Module



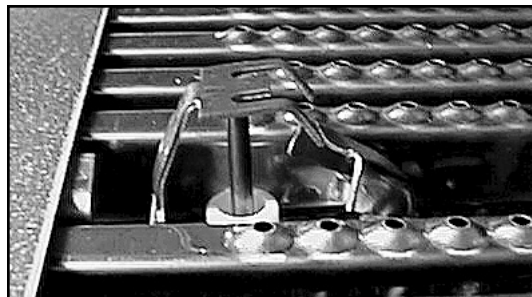
HOW TO CHECK IGNITION CABLE AND SPARK IGNITOR

This procedure will expose you to 10,000 volts of electrical energy. When performing these steps do not touch bare or exposed wiring. Make sure the heater is turned off when servicing or inspecting the spark ignition system.

The pilot and electrode assembly contains a metal rod

that has a ceramic insulator covering. The lower end of the electrode connects to the high voltage ignition cable. Over the upper end of the electrode is a ground strap that provides for igniting and sensing the pilot flame.

1. Make sure the ignition cable does not run in contact with any metal surfaces; is no more than 36 inches long; and connections to the ignition control module and ignitor are clean and tight.
2. Check ignition system grounding. Nuisance shutdowns are often caused by a poor or erratic ground.
 - a. Check for good metal to metal contact between the pilot burner bracket and the main burner.
 - b. Check the ground lead from the GND (BURNER) terminal on the ignition module to the pilot burner.
 - c. Check the ceramic flame rod insulator for signs of cracked or exposure to extreme heat. This can cause a short to ground and will prevent the pilot electrode assembly from sparking. Clean the flame rod with emery cloth if dirty.
 - d. Check and reset electrode for proper gap of 1/8 inch to 5/32 inches.
3. Check spark ignition circuit. You will need a short jumper wire made from ignition cable or other heavily insulated wire.
 - a. Close the gas valve manually.
 - b. Disconnect the ignition cable at the SPARK terminal of the control module. Move the ignition cable out of your way.
 - c. Energize the module by turning heater on or adjusting the thermostat to demand heat.
 - d. Immediately place one end of the jumper firmly on the 24V (GND) terminal on the control module. Move the free end of the jumper slowly toward the SPARK terminal of the control module until a spark is established.
 - e. Pull the jumper slowly away from the SPARK terminal and note the length of the spark gap. If the arc is 1/8 inch or more, then the voltage output is okay. If the spark is less than 1/8 inch or there is no spark, then replace the control module.
 - f. Remove the jumper, turn heater off, reinstall the ignition cable and turn heater back on.



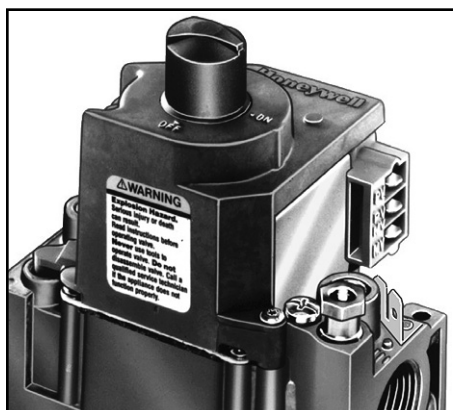
*Figure 47 -
Pilot and
Electrode
Assembly*

HOW TO CHECK GAS PRESSURE - HONEYWELL VR8304

This procedure assumes a maximum supply gas pressure of 10.5" water column for natural gas and 13.0" w.c. for L.P. gas.

1. Turn gas cock knob to OFF.
2. Remove gas pressure check plug using a 3/16" hex key wrench.
3. Connect manometer to 'Press Tap'.
4. Turn gas cock knob to ON. Allow main burner to light.
5. Gauge should read 4" for natural gas or 10" for L.P. gas. If OK, turn gas cock knob OFF, remove gauge and replace 'Press Tap' plug.

HOW TO CHECK GAS CONTROL VALVE - HONEYWELL VR8304



The VR8304 gas control provides ON-OFF manual control of the gas flow. In the OFF position, the pilot and main burner gas flow is prevented. In the ON position, pilot and main burner gas flow is under control of the Honeywell 8600M electronic control module.

Figure 48 - Honeywell Gas Valve

If main burner and or pilot will not light:

1. Check the gas control knob is in the ON position.
2. Verify the presence of a spark at the electrode assembly. You may need to recycle the heater by turning the ON/OFF switch to OFF, waiting one minute and turning the switch back to ON. Also check the wiring harness connections are clean and tight.
3. Adjust the thermostat to its highest setting to demand heat.
4. Using a multimeter check for 24 volts at the gas control:
 - a. If pilot lights, measure across the MV/PV and MV terminals (blue & white wires). If multimeter does not register 24 volts, replace the ignition control module. If the multimeter registers 24 volts replace the gas control valve.

- b. If pilot DOES NOT light, measure across the MV/PV and PV terminals (brown and white). If multimeter does not register 24 volts, replace the ignition control module. If the multimeter registers 24 volts replace the gas control valve.

STANDING PILOT SERIES

R & RF MILLIVOLT SERIES

Manufactured from May 82 through Dec 93

This series of commercial gas water heaters features the millivolt (MV) power pile ignition system. The heat from the pilot on the thermopile produces the electricity that operates the gas control circuit. No external electrical power is necessary.

THERMOPILE

The heart of the electrical system is the thermopile. This mounts on the pilot in the burner tray, and is heated by the pilot flame. the thermopile is specially constructed of two different kinds of metals, so that it will produce an electrical current when heated. The output is termed in millivolts. The thermopile is connected to the gas valve with spade electrical connectors and attaches to the THTP (left) and TP (center) terminal of the gas valve. On heaters manufactured before May '84, you will notice a thermopile with copper tubing and a screw in nut connection. On models manufactured after May '84, you will find a 750 MV thermopile with a braided wire and spaded connections.

GAS VALVE: (millivolt controlled)

This valve has several functions to control the heater gas supply. The gas valve has three possible positions: Off, Pilot, and On (for main burner). It also has an electrical magnet assembly that assists in the performance as a safety for the gas system. With the gas cock in the pilot position and pushed down, gas flows to the pilot orifice lighting the pilot. The pilot will continue to burn when you release the valve, because the thermopile is making a millivolt circuit to energize the magnet coil located inside the gas valve. The main burner can now be lit. If the pilot goes out, the milivolt current the operates the gas valve is not produced. Both the pilot and main gas valves will close and the heater will not operate.

SAFETY FEATURE

If there is an interruption of gas or the pilot flame is extinguished, the pilot flame stops heating the thermopile.

Millivolt current is no longer produced by the thermopile and the gas valve magnet drops out. The gas valve closes, suspending the flow of gas through the valve. The burner cannot come on automatically and the pilot must be re-lit.

MAIN VALVE - ACTUATOR

The main burner will come on when the actuator coil is energized. This is controlled by the immersion thermostat turning on or off. Essentially, the actuator allows the flow of gas to the main burner. The gas flow to the burner will continue until the thermostat is satisfied. The contacts inside the thermostat open, disrupting the millivolt current to the gas valve. Without the millivolt current to hold the main valve open, the main burner shuts off. On heaters with over 400,000 BTU input, the gas valve has another safety feature called 'slow opening'. This valve is staged to partially open on the initial call for heat. This allows enough gas to light the main burner. After a few seconds, the valve fully opens. The slow opening valve impedes the flow of gas the main burner until the burner flame is established. This provides a smooth flame pattern and prevents violent main burner start up.

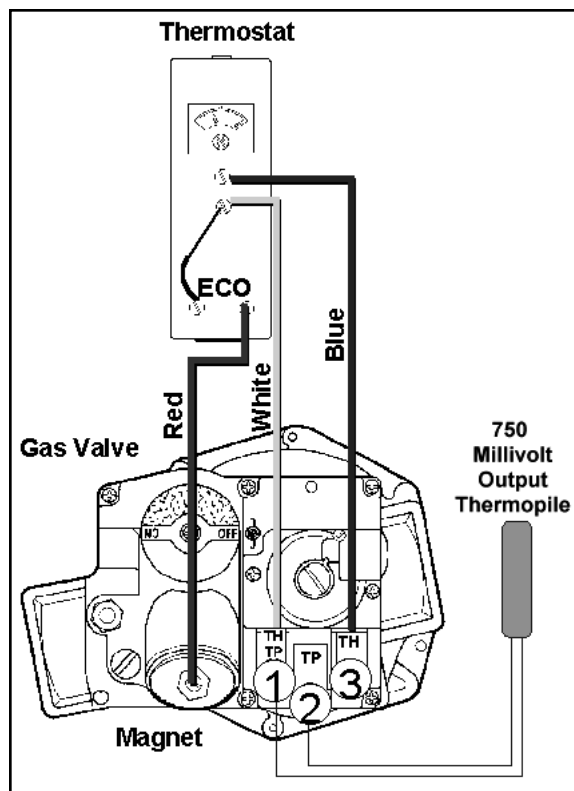
THERMOSTAT

The thermostat is immersed into the tank about midway up the heater to directly sense the water temperature. The thermostat temperature range is from 100° to 180° and can be set with a screwdriver. Electrical connections consist of four (4) wiring terminals on the thermostat face. The upper and center terminals are to turn the thermostat On and Off. A microswitch inside the thermostat reacts to the temperature of the water inside the tank. The upper thermostat terminal is wired to the gas valve (TH) right terminal. This terminal provides millivolt current to open the main burner gas valve.

The two lower terminals are for the energy cut off (ECO) switch, (a jumper connects the lower left terminal to the center terminal). This provides a millivolt circuit through the ECO for a hi-temperature safety. Should the water temperature exceed 200°, the ECO will open and the millivolt circuit that is holding the pilot magnet open is suspended. The pilot will go out and must be re-lighted.

Pocket Diagnostics Manual (Rev 1)
R & RF OPERATIONS SEQUENCE

1. With the gas valve gas cock depressed in the pilot position - Light the pilot.
2. The thermopile, being heated by the pilot flame, produces a millivolt current to terminals 1 & 2 of the gas valve.
3. Terminal #1, via the white lead, connects to the center terminal of the thermostat.
4. The circuit continues through the jumper, then through the ECO bulb, immersed in the waterway, to the right lower terminal of the thermostat.
5. The circuit continues via the red lead to the gas valve magnet assembly.
6. The magnet assembly is energized by the millivolt circuit to ground - thereby locking the pilot in the OPEN position.
7. The circuit continues through ground to terminal #2, to the other side of the thermopile.
8. The pilot remains "ON".
9. Turn the gas cock valve from "Pilot" to "On" and increase the thermostat temperature setting so the contacts close. This contin-



ues the millivolt circuit from the top thermostat terminal to the "TH" right terminal #3 of the gas valve. 10. The main gas valve opens, allowing gas to flow to the main burner to light and heat the tank to temperature.

Figure 49 - R & RF Milivolt Series

11. When the water is heated to the thermostat setting, the thermostat top and center contacts open and the gas valve shuts off the main burner.

Test Information - Using a Milivolt Multimeter -

* To perform this test, light the pilot. Place the millivolt meter leads on terminal 1 & 2 until maximum MV output is obtained (approximately 325 MV). Blow out the pilot. Do not remove the meter leads. Watch the millivolt meter drop until the magnet disengages. You will hear an audible click. This should be between 120 MV - 30 MV.

Troubleshooting

Pilot goes out - occasionally

- (A) Check for poor corroded connections. Clean. Be sure they are tight.
- (B) Be sure thermopile is embedded in the pilot flame for greatest temperature.
- (C) Weak thermopile output. (Do Thermopile Output test.)
- (D) Weak Magnet assembly. (Do Auto Pilot Drop-out test.)
- (E) Thermostat contacts dirty - rotate dial (numerous times.)

Pilot will not light

- (A) Poor flame impingement.
- (B) Weak magnet assembly in gas valve. (Do Auto Pilot Drop-out test.)
- (C) Weak thermopile - low output. (Do Thermopile Output test.)
- (D) ECO Open on thermostat.
- (E) Thermostat contacts dirty - rotate dial numerous times.

Main Burner will not light

- (A) Thermopile may have corroded terminals.
- (B) Thermopile output too low. (Do Auto Pilot Drop-out test.)
- (C) Gas Valve actuator not operating properly.
- (D) Thermostat contacts dirty - rotate dial (numerous times.)

ECO activates (tank overheats above 200°)

The ECO microswitch opens to shut off the gas valve. This may have been due to stacking. Draw cold water through the heater to cool down the ECO. If it continues, check temperature at which the ECO opens. Verify thermostat calibration.

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To Test:	Turn Gas Cock	Main Burner Should Be:	Thermostat Contacts are:	Meter leads on Terminals:	MV reading should be:	Service
Complete System	ON	ON	Closed	2 & 3	100 MV or more	Check gas valve
Thermopile Output	PILOT	OFF	Open	1 & 2	325 MV or more	Check thermopile
System Resistance	ON	ON	Closed	1 & 3	80 MV or more	Check thermostat and thermostat wiring connections
Auto Pilot Dropout *	PILOT	OFF	Open	1 & 2	Between 120 - 30 MV	Check thermopile

Table 17 - R & RF Test Information

DASH ONE MODEL AUTOMATIC FLUE DAMPER

Automatic Vent Damper: (redesigned 10-94)

Commencing with first usage in October, '94, the commercial gas water heater product line complied with energy upgrade standards that became effective January 1st, 1995. Commercial gas water heaters were equipped with the latest version of Automatic Flue Damper assembly. This damper assembly has a Honeywell drive motor which is equipped with a series of micro switches. Although still a standing pilot water heater, this product requires the use of 120VAC for the transformer; and 24V to operate the damper motor and gas control valve.

In a stand-by condition, 24V is extended through the yellow wire to the damper assembly. The yellow wire causes the damper motor to rotate and close the damper blade. Other switches are activated as the motor rotates turning the shaft to open on a call for heat. When the thermostat operates calling for heat, power is extended through the blue wire, to the damper.

The blue wire is also connect to a microswitch that energizes the damper motor and begins to open the damper blade. When the damper blade is upright, a third microswitch extends 24V along the red wire to the TH terminal of the gas valve. At this point the damper blade is fully open, allowing for positive vent drafting and verification for the main burner to ignite. The TH terminal of the gas valve controls the main valve. When the TH terminal receives 24V, the main valve opens allowing the burner to ignite.

The main burner remains lit until the thermostat is satisfied. After the thermostat is satisfied, power is suspended through the blue wire. Microswitch relays power from the yellow wire to the damper motor. The damper motor rotates closed. At the same time power is suspended through the red wire, closing the main valve of the gas valve.

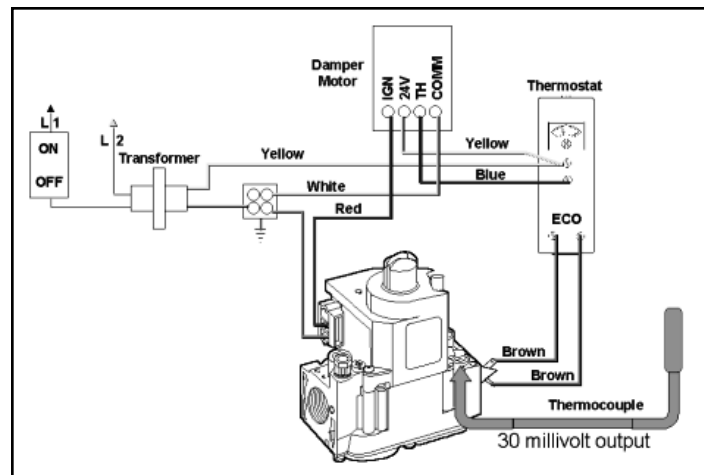


Figure 50 - Dash One Automatic Flue Damper

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COMMERCIAL GAS TROUBLESHOOTING TABLE

NATURE OF TROUBLE	POSSIBLE CAUSES	SERVICE
No Hot Water	Manual switch turned off Blown service panel fuse or breaker High limit switch tripped Thermostat faulty Thermostat out of calibration Improper or loose wiring	Turn to ON Replace or reset Cool tank by turning on a hot water faucet Check and replace Check and replace Check and replace
Not Enough Hot Water	Thermostat set too low Improper or loose wiring Thermostat not seated in tank Heater is undersized Improper gas supply	Increase thermostat setting Rewire per wiring diagram Reseat thermostat Resize and compare Check gas pressure
Water too hot	Thermostat setting too high Thermostat out of calibration Thermostat not seated in tank	Lower thermostat setting Check and replace Reseat thermostat
Slow hot water recovery	Improper gas supply	Check gas pressure
Noisy water heater	Sediment build-up on the bottom of the tank	Clean tank
Excessive relief valve operation	1. Excessive water pressure 2. Excessive temperature	Install proper pressure reducing valve on cold side. Check for open or closed system. Install expansion tank. Check thermostat; lower setting or replace

NATURE OF TROUBLE	POSSIBLE CAUSES	SERVICE
Rusty or black water	1. Anode rod dissolved 2. Excessive sediment build-up	Check anode rod and replace Drain tank; replace if excessive sediment build up
Water heater is leaking (Gas water heaters produce condensation that may drip on the floor. Condensation will produce only a few drops or small puddles that evaporate.)	1. Cold in or hot out joints 2. T&P valve 3. Immersion thermostat or anode rod is loose 4. Inner tank has a pin hole	Check joint and repair Check valve and replace (Caution: Do not confuse normal T&P operation as a leaking tank. If the puddle dries up, then look for a T&P problem.) Check, tighten and replace Replace water heater. (When diagnosing a leaker - you will notice a puddle of water on the floor, next to the heater, that will not go away.)
Scale on burner and pilot assemblies	1. Condensation 2. Contaminated atmosphere	Excessive condensation caused by undersized heater, poor venting or continued use Check for contaminant causing chemicals near the heater
Yellow flame	1. Scale on top of burner 2. Burner orifice(s) dirty 3. Flue way clogged 4. Improper gas pressure	Shut off heater; allow to cool; clean burner Inspect and clean Inspect and clean Check and adjust

Table 18 - Commercial Gas Troubleshooting Table

TROUBLESHOOTING - PARALLEL INSTALLATION & STORAGE TANKS

Check the heaters with the previous troubleshooting table; then check...

NATURE OF TROUBLE	POSSIBLE CAUSES	SERVICE
No Hot Water	Circulating pump to storage tank is not operating	Check and replace
Not Enough Hot Water	Circulating pump to storage tank is not operating	Check and replace
Water too hot	Check for stacking	Install circulating lines and pump

Table 19 - Commercial Gas Specialty Applications

TROUBLESHOOTING - SYSTEM SENTINEL™ SYSTEM



Introducing the simplest gas commercial water heater diagnostics ever. With the System Sentinel™ panel on large volume commercial gas water heaters, you can quickly verify sequence of operations and focus in on the problem component. Here is what the LED lights on the diagnostics panel mean: Use the System Sentinel troubleshooting table below to diagnose defective components. See the Use and Care Manual for a comprehensive diagnostics flow chart.

Figure 51 - System Sentinel

NATURE OF TROUBLE	POSSIBLE CAUSES	SERVICE
If the POWER LED is not illuminated -	No power to heater No power to transformer Transformer is damaged	Turn ON/OFF switch to ON Check circuit breaker Replace ON/OFF switch Replace transformer
If the THERMOSTAT LED is not illuminated -	Thermostat set too high Thermostat defective or out of calibration	Lower thermostat setting and check for LED Replace thermostat
If the IGNITION LED is not illuminated -	Damper assembly did not open Ignition control module is defective Wiring harness is defective	Inspect and test damper Replace ignition control module Replace wiring harness
If the PILOT VALVE LED is not illuminated -	Pilot electrode (spark ignitor) is defective Orange ignition cable is defective Ignition control module is defective Gas control valve is defective	Check for proper gap. Check for cracks. Replace spark ignitor Replace ignition cable Replace ignition control module Replace gas control valve
If the ECO LED is not illuminated -	Water in tank is too hot ECO is defective	Cool tank down by drawing off hot water Replace ECO
If the MAIN VALVE LED is not illuminated -	Ignition control module is defective Gas control valve is defective	Replace ignition control module Replace gas control valve

Table 20 - System Sentinel Troubleshooting Table

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NOTES

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