

# **Service Manual**

**for the**

## **RV500 Water Heater**

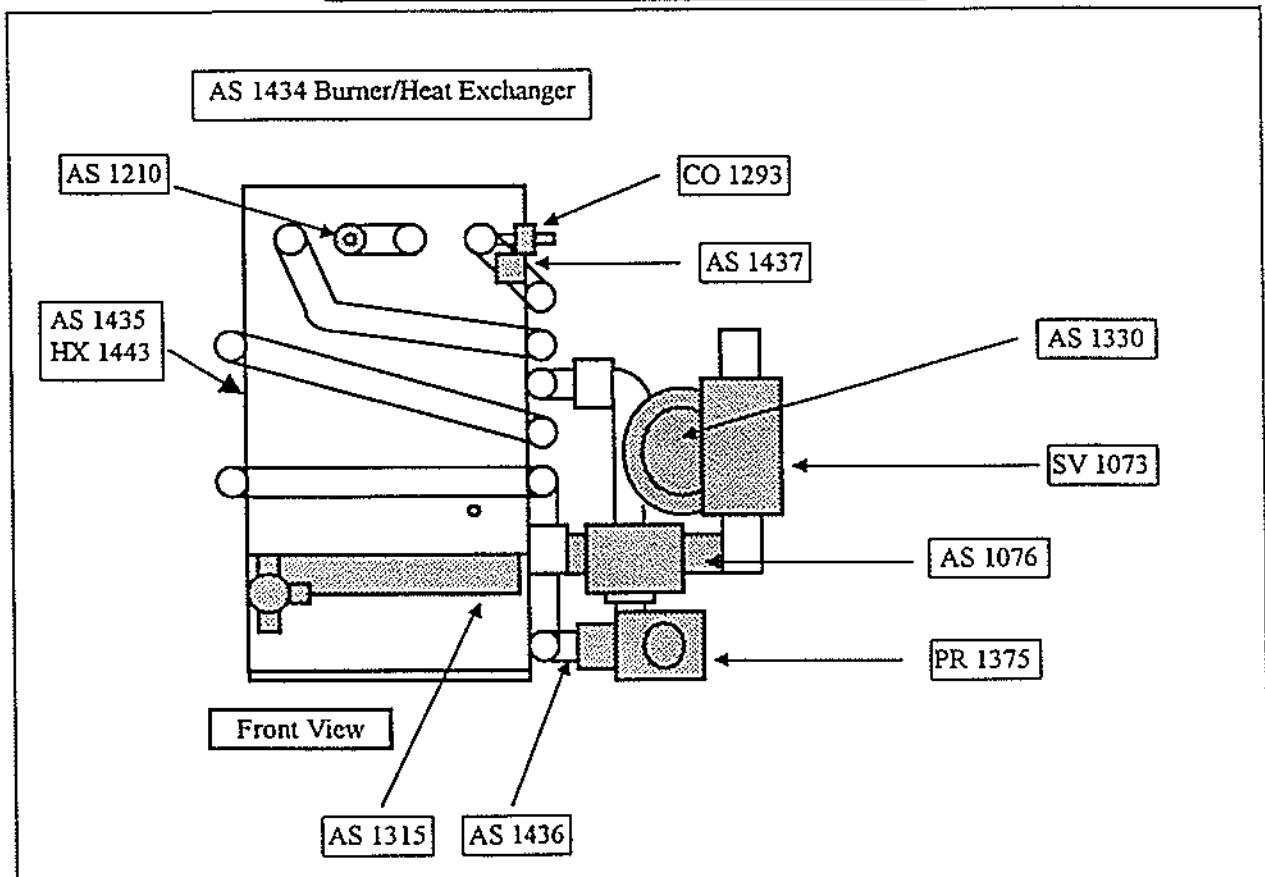
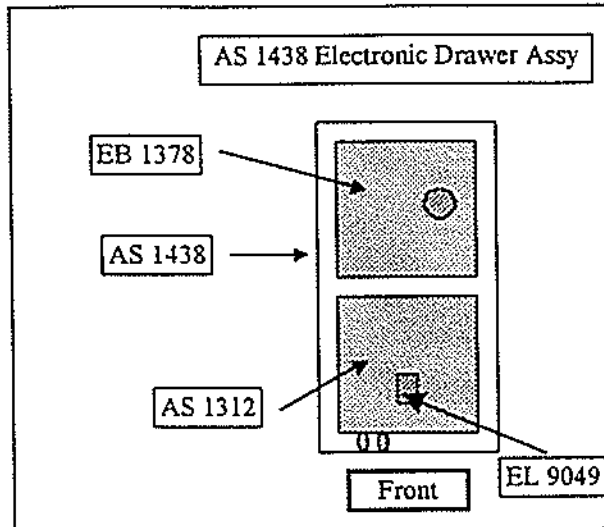
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**Models:**

**RV500-F-L  
RV500-F-N  
RV501-F-L  
RV501-F-N**

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Model: RV500-F-L / RV501-F-L

SM500-14 Modulating Valve Replacement

Other service documents required:

SM500-04 Hood Change Procedure  
SM500-05 Heat Exchanger / Burner Assembly Replacement  
SM500-16 Testing the RV500

Tools Required:

Basin wrench  
2 Adjustable wrenches  
Phillips screwdriver  
1/4" socket  
9mm open end wrench  
7/8 wrench

1. Turn power OFF, water OFF, and gas OFF.
2. Disconnect the gas, water inlet and water outlet.
3. Remove the hood assembly per SM500-04.
4. Remove the heat exchanger / burner assembly AS 1434 per SM500-05.
5. Place an adjustable wrench on the modulating valve hex and unscrew the gas solenoid and piping from the end of the modulating valve.
6. Use the 7/8 wrench on the modulating valve hex to unscrew the valve and pipe nipple PF 1368 from the burner manifold. Then separate the pipe nipple from the valve.
7. **USE AGA-APPROVED SEALANT ON ALL GAS THREAD CONNECTIONS.** Assemble the pipe unto the new modulating valve and into the manifold. Take care not to get any thread sealant into the modulating valve because this will cause the valve to stick.
8. Re-assemble the heater reversing the procedure of steps 4, 3, and 2.
9. Check the unit for normal operation per SM500-16 'Testing the RV500'. Note: you must call PrecisionTemp for special instructions.

Kit Parts List:

AS 1076 Modulating Valve assembly

Figures:

TS500-3 Frontal View of RV500 with Door Removed  
TS500-4 View of Electronic Drawer

## Section 1. Definition of Terms

**Ignition or minimum burn** – The light off gas flow and the lowest burn that the software will permit, normally 15,000 – 20,000 btu.

**Maximum burn** – The highest burn that will pass through the unit, normally 53,000 btu.

**DSI (Direct Spark Ignition)** – The circuit board that controls the ignition process. Once supplied with 12 vdc by the main circuit board, it opens the gas solenoid, sparks the igniter, and senses the flame. Also, during operation it continues to monitor the flame and will fire the igniter if flame rectification is lost.

**T<sub>in</sub>** – The temperature measured at the entrance to the heat exchanger

**T<sub>mid</sub>** – The temperature measured near the center of the heat exchanger.

**T<sub>out</sub>** – The temperature measures at the exit of the heat exchanger.

**T<sub>set</sub>** – The stabilization temperature set by the pot on the circuit board AS 1478

## Section 2. Description of Operation

With gas and power supplied and no water flow, the RV500 will appear dormant except for the green LED flashing once each second. However, the microprocessor in the RV500 is actively monitoring the three temperature sensors, the set temperature request, and the water flow each half second in anticipation of a request for hot water.

When a hot water faucet is opened and flow is > 0.4 gpm the microprocessor sends ignition voltage to the modulating valve (0.0 vdc) and power the ignition relay on the board which provides 12 vdc to the DSI board.

The DSI:

- Sends 12 vdc to the gas solenoid to open and supply gas to the burner
- Starts sparking the igniter
- Monitors the flame presence. When the DSI senses a flame it grounds (0.0 vdc) the feedback to the circuit board. If the flame is not sensed during the 3.5 second ignition attempt then the DSI will turn off gas and maintain the feedback signal to the circuit board open (12 vdc) for a 3.0 second purge and then repeat the 3.5 second ignition attempt. If there is no flame sensed during the second attempt, then the DSI will lockout and feedback will remain open until the software resets it 45 seconds later and the ignition process is repeated. If the flame is lost during normal burn then the DSI will attempt a re-ignition.

The circuit board monitors the feedback signal from the DSI. When the feedback signal is grounded (0.0 vdc) there is flame. Knowing T<sub>in</sub>, T<sub>set</sub>, and water flow, the software

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Model: RV500-F-L / RV501-F-L

SM500-12 Flowmeter Replacement

Other service documents required:

|          |  |
|----------|--|
| SM500-04 | Hood Change Procedure                        |
| SM500-05 | Heat Exchanger / Burner Assembly Replacement |
| SM500-06 | Heat Exchanger Assembly Replacement          |
| SM500-10 | Burner Assembly Replacement                  |
| SM500-16 | Testing the RV500                            |

Tools Required:

- Basin wrench
- 2 Adjustable wrenches
- Phillips screwdriver
- ¼" socket
- 9mm open end wrench

1. Turn power OFF, water OFF, and gas OFF.
2. Disconnect the gas, water inlet and water outlet.
3. Remove the hood assembly per SM500-04.
4. Remove the heat exchanger / burner assembly AS 1434 per SM500-05.
5. Disconnect the two compression fittings (see figure SM500-3) and remove the flowmeter assembly.
6. Assemble the new flowmeter assembly.
7. Re-assemble the heater reversing the procedure of steps 4, 3, and 2.
8. Check the unit for normal operation per SM500-16 'Testing the RV500'

Kit Parts List:

|         |                    |
|---------|--------------------|
| AS 1588 | Flowmeter assembly |
|---------|--------------------|

Figures:

|         |   |
|---------|---|
| TS500-3 | Frontal View of RV500 with Door Removed |
| TS500-4 | View of Electronic Drawer               |

### **3.3 No Green LED flash or Green LED stays on, but does not flash**

1. Be sure power is ON and panel breaker is not tripped. With power OFF detach the ¼ inch spade leads of the power supply (see figure TS500-2). Attach multimeter and turn power ON. If there is no power then trouble-shoot the coach.
2. Be sure all electrical connectors are secure. Check polarity of the 12 vdc supply to the RV500. The positive (+) lead must be connected to the red (+) lead on the rear of the RV500. The negative (-) lead must be connected to the black (-) lead. **CAUTION: Supplying the RV500 with reverse polarity will damage the circuit boards.**
3. Do you have a converter. If so, the 12 vdc supply to the RV500 must be from the filtered connection on the converter or connected directly to the battery? Refer to your converter manual to verify hookup. Also, check the AC content on the 12 vdc supply to the RV500. Normally, it should be less than  $\pm 0.3$  vac.
4. Open the electrical drawer and check for indications of water or moisture. If you find moisture turn power OFF and let the drawer dry (a hair dryer may be used if you only use warm air).
5. Check power at the circuit board by placing the multimeter probes on the backside of the 2-pin connector (see figure TS500-4). Voltage should be 10.8 – 14.4 vdc. If voltage is lower than the minimum the ignition board may not function. If voltage is above the maximum it is possible to damage either circuit board. If there is no voltage at the board then the fuse in the power supply cable is blown. Change the power supply cable AS 1331.
6. Examine the micro-controller EL 9049 (see figure TS500-4). Be sure that all pins are in the socket and none appear bent (use thumb to gently press on the chip).
7. If the problem persists then change board AS 1312. Refer to SM500-01 for the change procedure.

### **3.4 Green LED flashes, but no ignition attempt (no igniter, no gas)**

1. Is the water ON and is flow out of the faucet at least 0.4 gallons per minute (2.5 minutes to fill 1 gallon)? Flow must be greater than 0.4 GPM for the unit to turn on.
2. Check T<sub>in</sub>, T<sub>mid</sub>, and T<sub>out</sub> thermistors (see section 4.3 'T<sub>in</sub> / T<sub>mid</sub> / T<sub>out</sub> Thermistor and T<sub>set</sub> readout').
3. Find the RV500 flowmeter (see figure TS500-3) and verify that the black rotor, visible through the transparent cover, is rotating which indicates that there is flow going through the unit. If the flowmeter is not turning or turning slowly so that the rotor spokes are clearly visible there may be cold water leaking into the hot water lines somewhere in the coach. See the description under the problem Section 4.1 'Cold Water Bypass' to learn more about this condition. If your micro-controller EL 9049 is '-D' or later then the flow through the RV500 can be read from the green LED as specified in section 4.3 'Reading flow using the green LED'.
4. Place finger on the ignition relay on the circuit board (see figure TS500-4) and turn on water. Do you feel or hear the relay actuating?
5. If NO, inspect the micro-controller EL 9049 that it is pushed in fully and that no pins appear bent or out of the socket. If the micro-controller is okay then replace circuit board AS 1312 per SM500-01.

Model: RV500-F-L / RV501-F-L

## SM500-10 Burner Assembly Replacement

Other service documents required:

SM500-16 Testing the RV500

Tools Required:

Phillips screwdriver  
1/4" socket  
9mm open end wrench  
3/8" open end wrench  
level

1. Turn power OFF, water OFF, and gas OFF.
2. Remove the hood assembly per SM500-04.
3. Remove the heat exchanger / burner assembly AS 1434 per SM500-05.
4. Remove the two 8-32 machine nuts from the left side of the heat exchanger that attach the heat exchanger assembly AS 1435 from the burner assembly AS 1315.
5. Turn the heat exchanger assembly AS 1435 upside down and place on a flat, level table. Assemble the new burner assembly AS 1315 unto the burner so that the high side of the burner is on the outside of the heat exchanger and the heat exchanger other side is resting on the ledge of the burner assembly. See figure TS500-8.
6. Be sure the table is level. Place a level on the burner bracket. Adjust the burner assembly until it is level and then mark the heat exchanger through the two mounting holes in the burner bracket.
7. Remove the burner assembly and drill 1/4" holes at the two marked holes on the heat exchanger.
8. Again place the burner on the heat exchanger. From the inside of the heat exchanger assemble the heat exchanger backup plate through the two holes of the heat exchanger and burner. Use the two new 8-32 self-locking screws FS 1397 and a 3/8" open end wrench to tighten the assembly. Recheck that the upside down assembly is still level as determined in step 6.
9. Reverse the procedure of steps 3, and 2 to complete assembly.
10. Check the unit for normal operation per SM500-16 'Testing the RV500'

Kit Parts List:

|         |                              |
|---------|------------------------------|
| AS 1315 | Burner assembly              |
| FS 1397 | 8-32 self-locking screws (2) |

Figures:

|         |   |
|---------|---|
| TS500-3 | Frontal View of RV500 with Door Removed |
| TS500-4 | View of Electronic Drawer               |
| TS500-8 | Heat Exchanger / Burner Assembly Method |



connector. If there is none then replace the DSI board EB 1378 per SM500-02. If there is a spark then replace the ignition wire AS 1412 and then find where the spark is occurring along the ignition wire.

### **3.7 The unit ignites, but will not rise above minimum burn or water at faucet is cool**

1. Check flow out of faucet by measuring the time it takes to fill a gallon. Water flow, in gallons per minute (GPM) is calculated by dividing 60 by the time to collect one gallon. Refer to figure TS500-1 to be sure that you are in the normal operating range.
2. If your micro-controller EL 9049 is '-D' or later then the flow through the RV500 can be read from the green LED as specified in section 4.3 'Reading flow using the green LED'. If the flow at the faucet is more than 0.25 GPM greater than the flow through the RV500 then read about 'Cold Water Bypass'.
3. Check voltage to the modulating valve AS 1076 by placing the multimeter probes in the 2-pin connector (white and black wires) at the circuit board AS 1312 (see figure TS500-4).
4. If the voltage is greater than 2.0 vdc then the modulating valve likely has been forced out of normal range and needs to be returned.
5. While powered tap on the gas pipe between the gas solenoid and the modulating valve.
6. If this does not free the valve then try running AutoCal.
7. Replace the modulating valve
8. If the voltage is less than 2.0 vdc:
9. The RV500 will not increase the flame above minimum until a flameproof signal is sent to the circuit board by grounding the red lead attached to the spade connector on the DSI board. You can do this manually by touching the metal portion of the red wire to the RV500 steel case. The flame should increase.
10. Check thermisters per the section 4.5 'T\_in / T\_mid / T\_out Thermister and T\_set Readout'.
11. Check DSI harness AS 1333 red wire for continuity between the circuit board and the DSI spade connector (see figure TS500-4).
12. Change the circuit board AS 1312 (SM500-01).
13. Check the heater for air flow obstruction and clean.

### **3.8 Large fluctuation in temperature**

1. Are you operating on the water pump? If yes, then check if the flowmeter (or water flow) is pulsing at a low flow. If YES, then you may need an accumulator. See the section 4.4 'Using the water system pump'.
2. Are inlet and outlet water supply lines hooked up properly? Check all screen strainers and filters are clean and not obstructing water flow. The water inlet connection is the upper and the water outlet is the lower. This is the opposite of hot water tanks. You can also check the direction that the flowmeter rotor is turning. It should turn counter-clockwise.
3. Is the flame cycling between minimum burn and off? If yes, check the water flow through the unit as described in section 4.3 'Reading flow using the green LED'. Then refer to figure TS500-1 to verify that the water flow is above the minimum

Figure TS500-7. T\_mid Ferrule Assembly

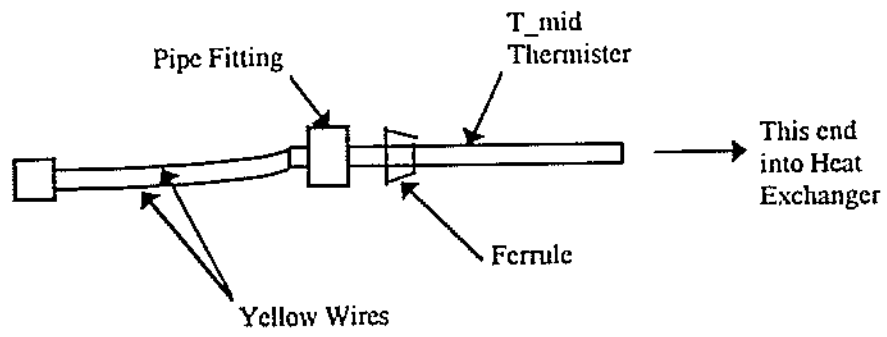
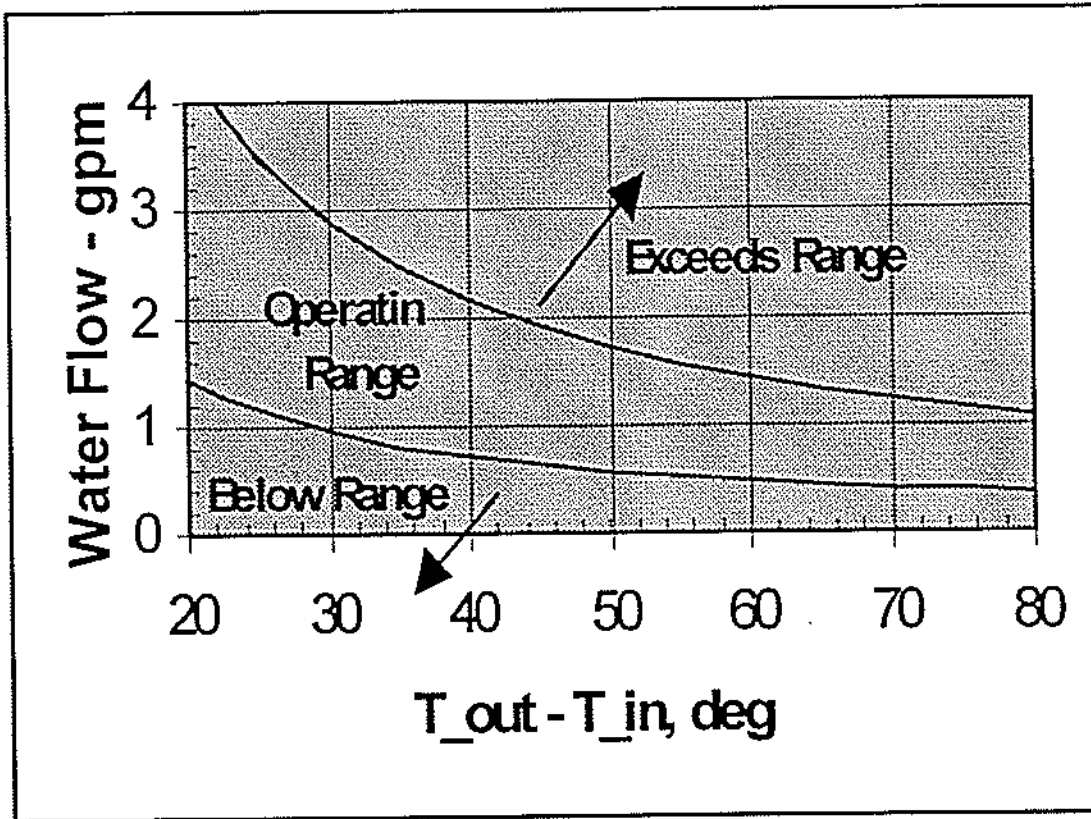


Figure TS500-1. Operating Range of the RV500



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Model: RV500-F-L / RV501-F-L

SM500-07 T<sub>in</sub> Thermister Change Procedure

Other service documents required:

SM500-16 Testing the RV500

Tools Required:

Scissors (or other cutting tool)

1. Remove the wire ties, metal tape, and old thermister. Clean off the old heat sink and be sure copper is wiped clean.
2. Note the depression in the copper tube where the thermister will be placed. Fill the dent with heat sink.
3. Place the thermister into the heat sink with the wire leads going in the direction of the flowmeter. NOTE: We have changed the direction of the leads coming out from the original assembly.
4. Wrap metal tape around the tube and thermister.
5. Take the two wire ties. One goes around the wires as a strain relief. The other goes near the thermister (about ¼" away from the head) to hold the thermister against the tube. **CAUTION: 1) Do not place the tie wrap over the thermister as this may crack the thermister, and 2) Do not over-tighten the wire ties.**
6. Check the resistance across the thermister leads. Under room temperature conditions the value should be between 700 - 1100 ohms. A further check may be to compare the resistance measurement to the other two thermisters. If all thermisters have been exposed to the same temperature they should be within 50 ohms.
7. Route the blue wire leads over the modulating valve keeping the wires away from the burner. Wrap the harness together and connect into the thermister harness that goes back to the control board.
8. Perform a test of the unit. Refer to SM500-16 'Testing the RV500'.

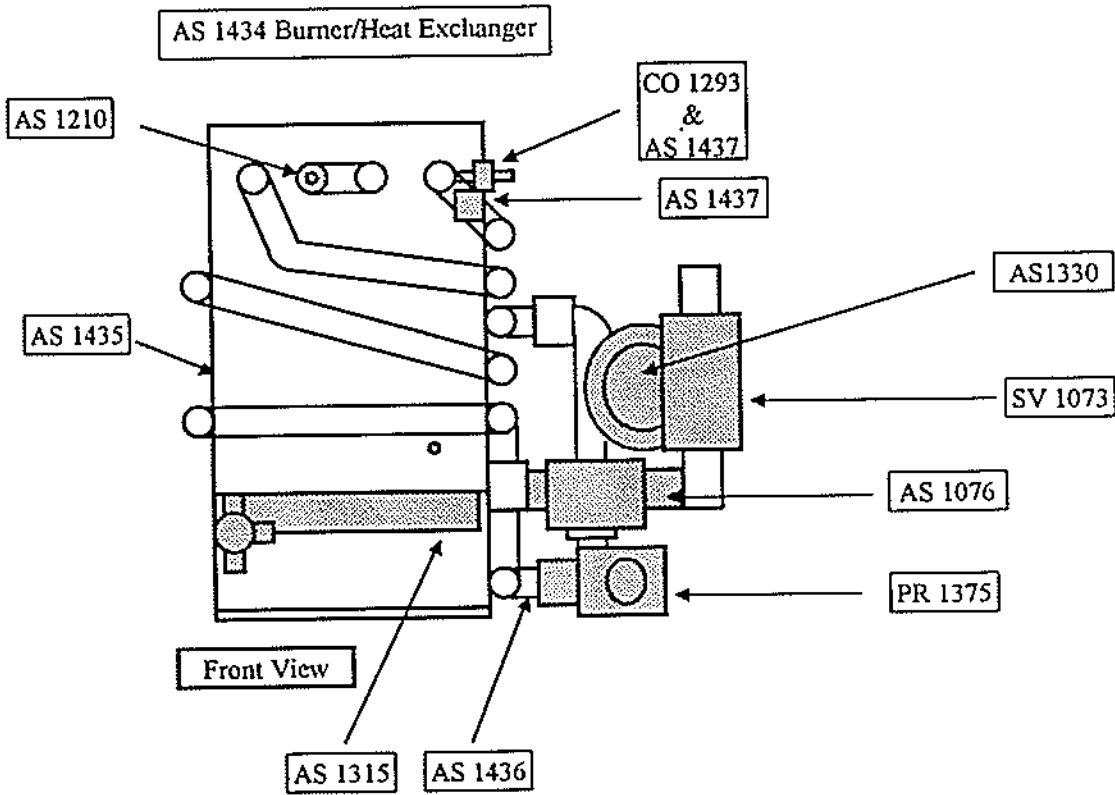
Kit Parts List:

|         |                                     |
|---------|-------------------------------------|
| AS 1436 | T <sub>in</sub> thermister assembly |
| FS 1385 | Metal tape, 2"                      |
| FS 1425 | 2 Wire ties                         |
| EL 1276 | Heat sink                           |

Figures

none

Figure TS500-3. Frontal View of RV500 with Door Removed



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Model: RV500-F-L / RV501-F-L

SM500-05 Heat Exchanger / Burner Assembly Replacement

Other service documents required:

SM500-16 Testing the RV500  
SM500-04 Hood Change Procedure

Tools Required:

Phillips screwdriver  
1/4" socket  
9mm open end wrench  
Side cutters  
2 adjustable wrenches  
7/8 open end wrench

1. Turn power OFF, water OFF, and gas OFF.
2. Disconnect the gas line, water inlet, and water outlet.
3. Remove the hood assembly per SM500-04.
4. Remove the two 8-32 screws on the sides of the burner bracket using the 1/4" socket and 9mm open end wrench. Refer to figure TS500-3.
5. Slide the heat exchanger / burner assembly AS 1434 forward and out of the case.
6. Remove the thermister cable AS 1329 and DSI cable AS 1333.
7. Assemble the thermister cable AS 1329 and DSI cable AS 1333 from step 5 unto the new heat exchanger / burner assembly.
8. Reverse the procedure of steps 4, 3, and 2 to complete assembly.
9. Check the unit for normal operation per SM500-16 'Testing the RV500'

Kit Parts List:

AS 1434 Heat exchanger / burner assembly

Figures:

TS500-3 Frontal View of RV500 with Door Removed  
TS500-4 View of Electronic Drawer

**Figure TS500-5. Thermister Conversion from Volts to °F**

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Model: RV500-F-L / RV501-F-L

SM500-03 Electrical Drawer Assembly Change

Other service documents required:

SM500-16 Testing the RV500

Tools Required:

none

1. Turn power OFF.
2. Remove the door and locate the electrical drawer AS 1438 (see figure TS500-3).
3. Slide the drawer forward to reveal the two circuit boards AS 1312 and EB 1378. Wire harnesses will not permit the drawer to be removed. Disconnect the one connection to EB 1378 and the five (5) connections to AS 1312. All electrical connectors in the drawer should now be disconnected and the drawer can slide out of the guides.
4. Route the wire harnesses through the grommets of the new drawer. Be sure to route the ignition harness separate from the other control harnesses. Then slide the drawer into the guides.
5. Re-connect the nine (9) electrical connections.
6. Perform a test of the unit. Refer to SM500-16 'Testing the RV500'.

Kit Parts List:

AS 1438 Assembly, Electrical Drawer

Figures:

TS500-3 Frontal view of RV500 without door



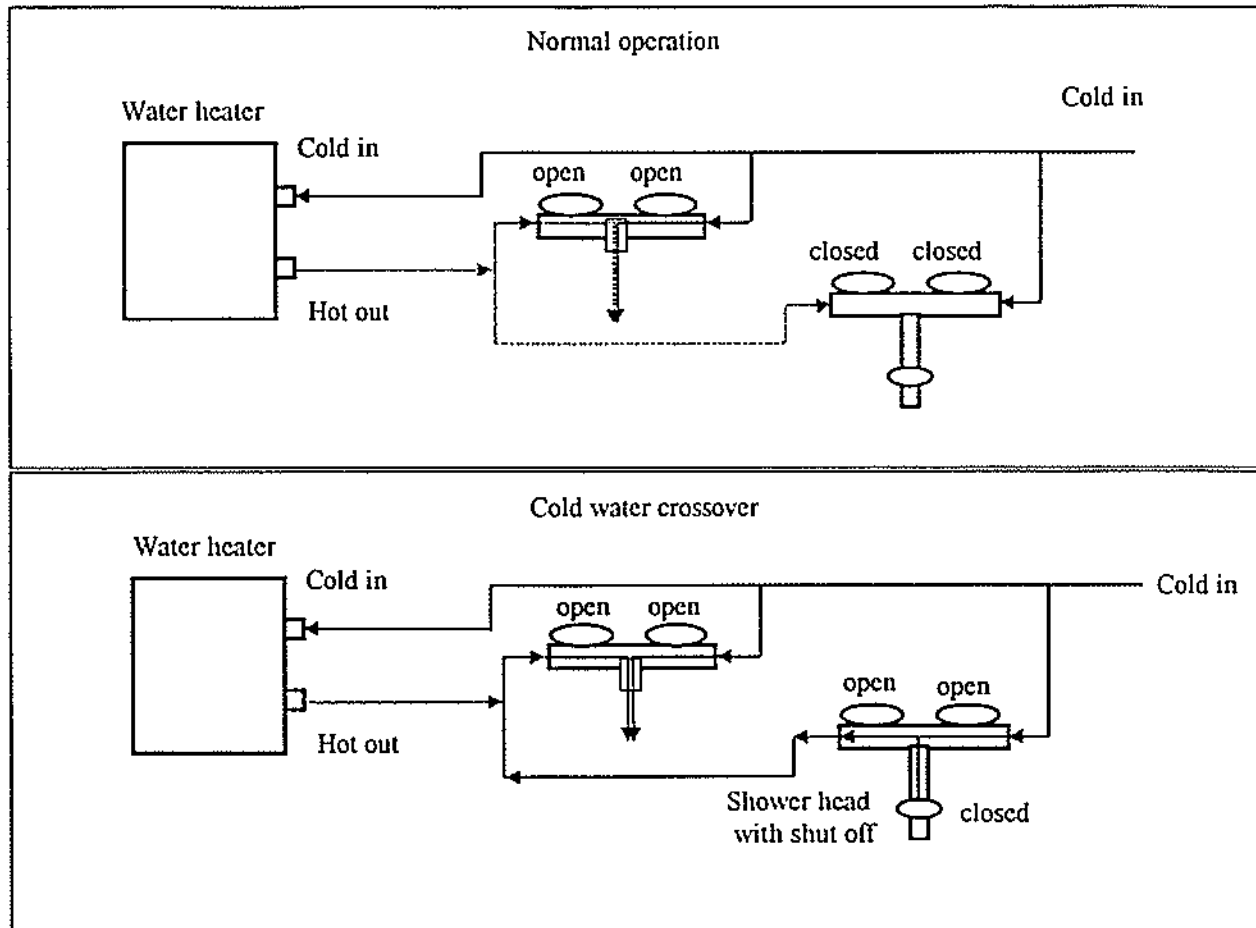


Figure TS500-6. Cold Water Bypass

———— Cold water  
 ————— Hot water

## 4.2 Flowmeter checkout

Find the three-pin connector on the circuit board (see figure TS500-4). Place the ground (-) probe of the multimeter in the back of the connector at the black wire and place the high (+) probe at the red wire. With power ON the multimeter should read 5 vdc. If it does not read properly then replace the flowmeter assembly AS 1588.

Now move the high (+) probe to the middle or white wire of the flowmeter. Turn water flow ON (greater than 0.5 GPM). You should see the multimeter jumping to values between 0 and 5 vdc. If you have a multimeter with frequency measurement go to that scale. The frequency is proportional to flow with 27 hertz  $\approx$  1 GPM. If it does not read properly then replace the flowmeter assembly AS 1588 per SM500-12.

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Model: RV500-F-L / RV501-F-L

SM500-01 Circuit Board Replacement

Other service documents required:

SM500-16 Testing the RV500

Tools Required:

Needle-nose pliers

1. Turn off power. Disconnect all electrical connectors at the circuit board.
2. Remove the circuit board. A needle-nose pliers can be used to remove the circuit board standoffs.
3. Remove the two black LED holders so they will not interfere with the installation of the new board.
4. Install the new board with the LEDs located at the front of the drawer. Reconnect all connectors to the board. CAUTION: there are two two-pin connectors. Be sure that the power supply connector (red and black wire) goes to upper left corner and the valve connector (white and black wire) goes to upper right (see figure TS500-4).
5. Put the LED holders in.
6. The set temperature is already at 115°F. Refer to manual if a further adjustment is desired.
7. You must call the factory for special instructions at this point.
8. Perform a test of the unit. Refer to SM500-16 'Testing the RV500'.

Kit Parts List:

|          |  |
|----------|--|
| EL 9049D | Micro-controller chip (already installed in board) |
| EL 1325  | Standoffs (already installed in board) (4)         |
| AS 1412  | Circuit board                                      |
| SL 1379  | LED holder (2)                                     |

Figures:

TS500-4 View of the Electronic Drawer

If the red LED is flashing, then turn power OFF for 5 seconds and then turn power ON.  
Does the problem remain?

Prior to checkout run water through the unit for at least 30 seconds with the power OFF and then turn water off. The output of the thermister can be checked with power ON using a multimeter. Plug the ground (-) probe into the black test connector (TP1) on the circuit board AS 1312 and the high (+) probe into:

T\_out orange test connector (TP4)  
T\_mid yellow test connector (TP3)  
T\_in back of 6 pin connector on AS 1312 at right blue wire  
T\_set blue test connector (TP2)

The output of the T\_in, T\_mid, and T\_out thermisters will read close to the curve shown in figure TS500-5 if the thermister is okay. You can also compare the three thermister outputs and all should be close to one another.

Turn power OFF. Unplug the 2-pin connector (figure TS500-4) and, using a multimeter, check the resistance across the each thermister. If the suspect thermister is more than 75 ohms from the other thermisters then replace the thermister. Otherwise, replace the thermister cable (AS 1329) first. If that does not fix then replace the thermister.

T\_set is set to 1.570 vdc (115°F) at the factory. The T\_set pot output will change about 0.44 vdc (7°F) per turn of the pot. For example, to adjust T\_set to 122°F turn the pot until the readout is  $1.570 + 0.44 = 2.010$  vdc.

## Section 5. Service Code Service

All red LED flashes can be reset by cycling power OFF for 5 seconds and then ON.

### Red double flash / second

Indicates that the T\_mid thermister has failed. The heater will not operate without maintenance action.

Check that the 2-pin and 6-pin connectors are all plugged in and inspect the wiring for any indications of a problem.

Unplug the T\_mid thermister AS 1210 at the 2-pin connector and check the thermister cable AS 1329 for continuity on the two red wires. If either wire shows a break then replace the cable AS 1329. Otherwise, replace the T\_mid thermister AS 1210 per SM500-08.

### 6 Red flashes

$T_{in}$  is larger than  $T_{mid}$  and  $T_{mid}$  is larger than  $T_{out}$ . This indicates that the water is flowing through the unit backwards. Check the water inlet and outlet connections because they must be reversed. The water inlet is the upper connection and the water outlet is the lower connection. This is the opposite of RV hot water tanks.

### 7 Red flashes

The direct spark ignition (DSI) has timed out (two 3.5 second ignition attempts) and the DSI board EB 1378 has locked out. After 45 seconds the software on circuit board AS 1312 will reset the DSI board and the ignition sequence will be repeated. The DSI can also be reset by turning off water a few seconds and then on. The red LED will continue to flash even though the unit is now operating. The red LED can be reset by cycling power OFF, then ON. If the unit frequently locks out then refer to section 3.6 'Green LED flashes, but no ignition (no igniter sparks, gas flows/smells)'.