

## Magneforce Inc.

### HS2500R2 Induction Heating System Troubleshooting and Service Information

Listed below are possible problems encountered when using the HS2500R2 induction heating system, along with typical causes and potential solutions. If the problem cannot be corrected using this information, the system should be returned to Magneforce Inc. for repair.

## **CAUTION!**

### **HIGH VOLTAGE INSIDE!**

When the system is on, high voltage (300-350VDC) is present inside the power supply, at the output terminals for the power cables and inside the output transformer enclosure. The power supply enclosure and the output transformer enclosure should not be opened or serviced except by trained and qualified personnel.

Turn off and disconnect power to the system prior to servicing this equipment. Even after disconnecting power to the system dangerous voltages may still be present. Allow at least 5 minutes after disconnecting power to allow internal voltage to dissipate! Review Service Procedure SP-1 to check internal voltage before servicing this equipment.

### **POSSIBLE PROBLEMS**

1. Nothing happens when turning on the unit. The Control Panel does not turn on.
2. The On/Off Circuit Breaker switch trips when trying to turn on the unit.
3. The green HEAT ON light does not turn on.
4. The green HEAT ON light turn on but the system does not heat.
5. The yellow COOLANT LIGHT is on and will not turn off.
6. The red FAULT light is on.
7. The Semi-Conductor Fuse inside the unit blows.
8. The system does not heat at the set power or heats very slowly
9. Heating is erratic from part to part.
10. The system makes a loud "buzzing" noise while heating.
11. Operator experiences a shock at the heating coil during heating!!!
12. The KW power display on the Control Panel does not work.
13. The Timer Display(s) on the Control Panel do not work. (HS2500R2C only)
14. The Timer Display(s) on the Control Panel keep looping and do not shut off.

### **EVALUATION AND TESTING PROCEDURES**

1. Measuring voltage inside the power supply.
2. Thyristor/Diode Module Evaluation and Replacement
3. Bridge Rectifier Evaluation and Replacement
5. Output Transformer Replacement
6. Terminal and Coil Block Cleaning
7. Load Capacitor Inspection

## 1. Nothing happens when turning on the unit.

When the power supply is turned on the LED's on the front control panel should illuminate and the fan inside the power supply should start running. If the fan does not turn on, the most likely cause is that the unit is not plugged in or the circuit breaker is defective. If the fan comes on, there is a problem with the +/- 12V power supply, a loose or unplugged connector or there is a shorted component causing failure of the +/- 12V power supply.

### Possible Causes

- 1.1 The unit is not plugged in correctly.
- 1.2 There is a bad wiring connection(s) or a connector is not plugged in.
- 1.3 The on/off circuit breaker switch is defective.
- 1.4 A fuse is blown on the +/- 12V power supply or the power supply is defective.
- 1.5 There is a shorted component or circuit board
- 1.6 Remote on/off connections to the power supply are wrong.

### Possible Solutions

1.1 Check that the unit is plugged into an appropriate receptacle and that the on/off circuit breaker switch on the right side of the cabinet is in the on position. If there are fuses or breakers in the breaker box that supplies power to the receptacle verify that they are OK.

1.2 Disconnect power to the unit. Open up the power supply front door. Visually inspect the interior of the unit, looking for any loose or unplugged wiring connections. In particular, make sure that the connectors to the +/-12V logic power supply (P/N 21700), connector from the logic power supply to the main control board (P/N 21750) and the connector from the logic control board to the front control panel (P/N 21820 or P/N 21920) are all properly plugged in. See Figure 1.

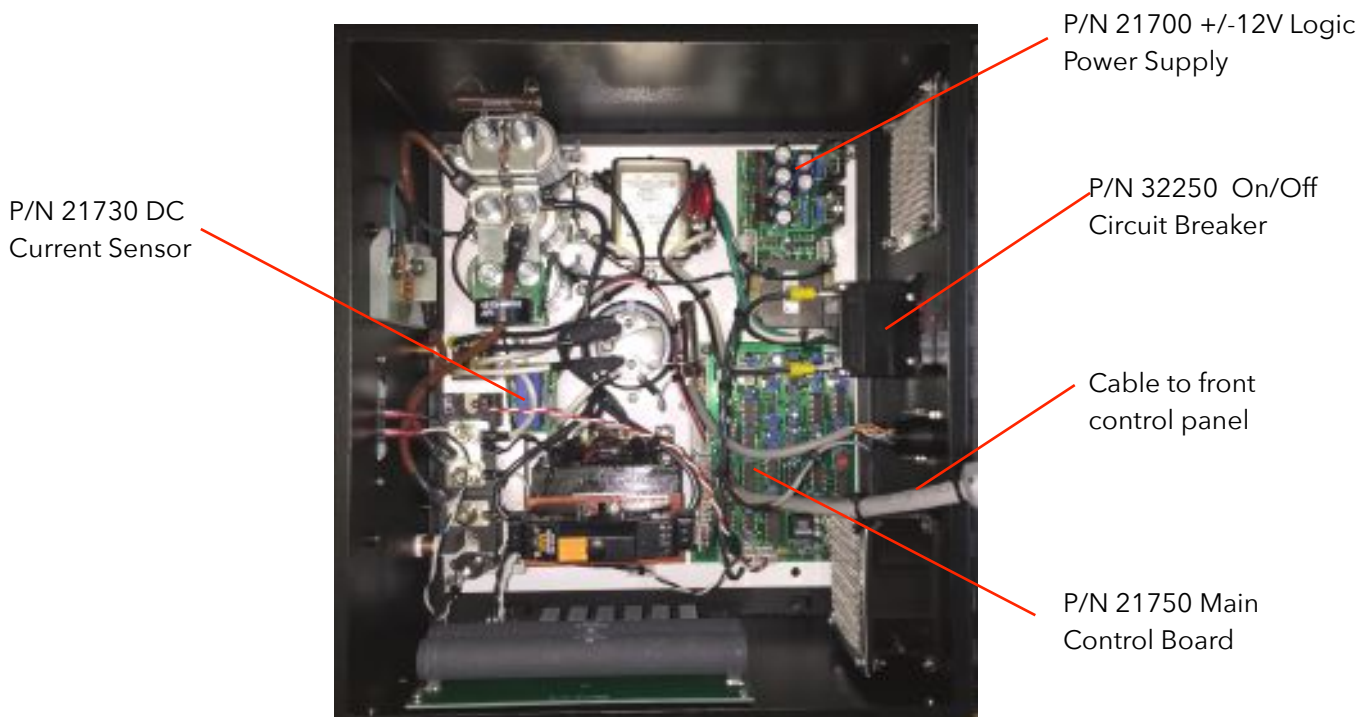


Fig. 1

1.3 Turn on the unit using the on/off circuit breaker switch. Verify that there is power to the unit by measuring the voltage across the bottom 2 terminals of the circuit breaker switch using an AC voltmeter and appropriate test leads. The voltage should be between 208-240 Vac. If there is no voltage present, double check the voltage at the incoming power source. If it is OK, the circuit breaker is defective and should be replaced. See Fig.2.

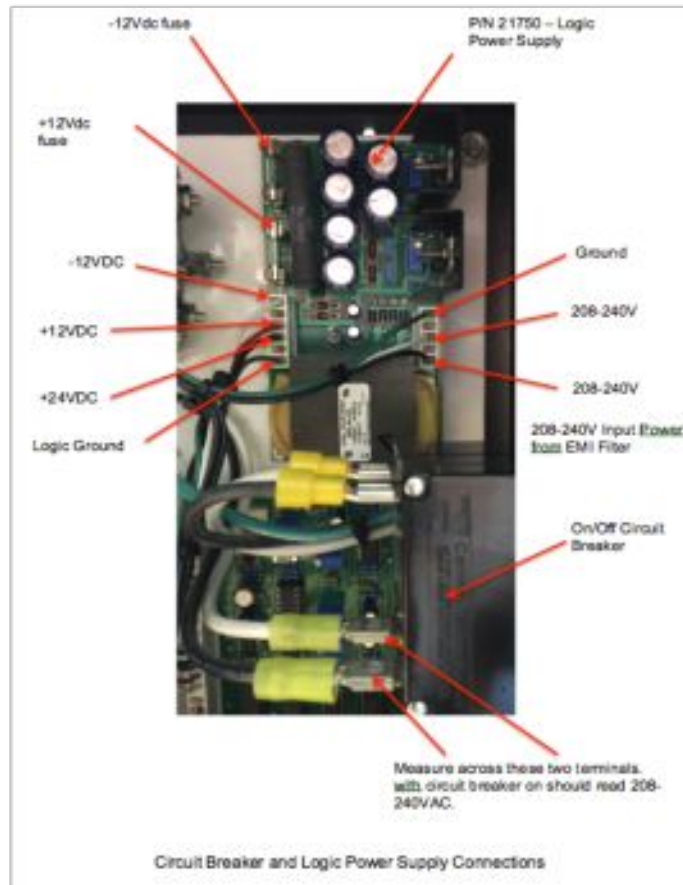


Fig. 2.

1.4 Check the +/- 12Vdc fuses shown in Fig.2 using an ohmmeter. If either fuse is bad replace it. (P/N 32670, 5mm fuse 1.5). Then unplug the 6 position white connector shown on the left side of Fig. 2. Check the +12V, -12V and 24V supply signals from the logic power supply in fig. 2 by measuring with a voltmeter. (Note: The - lead of the voltmeter should be connected to logic ground). The +12 volt should read between 11.8 and 12.2Vdc. The -12V should read between -11.8 and -12.2Vdc. The +24 volt should read between 24V and 30Vdc. If any voltage readings are not correct, replace the P/N 21700 Logic Power Supply or return it to the factory for repair.

If the voltage readings are good, plug the 6 pin connector back in. Turn on the unit and check the Front Control Panel lights. If there are still no panel lights or if they are very dim, there is a short in one of the components that receive voltage from the logic power supply. This could include the main control board, the DC current sensor module, front control panel or the on/off controls connected to the remote jack.

1.5. There is a short in one of the components that receive control voltage from the logic power supply. This could include the main control board, the DC sensor module, the front control panel or the on/off controls connected to the remote jack. Inspect the wiring connections to the DC current sensor and visually inspect for any sign of corrosion or shorting. Replace if required. Visually inspect the main control board for any sign of a burned or shorted component. Replace if required.

1.6. If there are on/off controls connected to the Remote Jack, disconnect them. Turn the power supply on and check the lights. If they are OK, doublecheck all wiring of the on/off controls. See Fig.15.

1.7 If the panel lights still do not come on return the unit to the factory for service.

## 2. The On/Off Circuit Breaker Switch trips when turning on the unit. (Fuse is not blown.)

The on/off circuit breaker will trip at turn on if there is a short circuit in the DC buss section of the HS2500R2 induction heater. This is the part of the primary power circuit that converts incoming AC power to DC. If the circuit breaker trips at turn on, do not keep trying to turn it on. This will result in failure of the breaker.

**Note: The correct semiconductor fuse must be installed in the power supply. (See fig 5.). If for any reason a standard fuse or a slo-blo fuse is used, other problems may be causing the circuit breaker to trip and the information provided here may not apply. Remove the semiconductor fuse and verify that it is the correct fuse. Leave the fuse out for the following checks.**

### Possible Causes

- 2.1 The wrong kind of fuse is being used.
- 2.2 The bridge rectifier is shorted out.
- 2.3 The transformer on the +/- 12V logic power supply is shorted.
- 2.4 The on/off circuit breaker switch is defective.

### Possible Solution

2.1. Remove the semiconductor fuse from the fuse holder. (See Fig. 5). Verify that the correct fuse is being used. The fuse must be a fast trip semiconductor fuse (Magneforce P/N 32620 or equivalent). A standard or slo blo fuse does not provide the required protection and could result in damage or failure of other power supply components.

Check the fuse using an ohmmeter. If the fuse is blown, the problem is most likely in the inverter section of the power supply. See **Section 5. The semi-conductor fuse is blown.** If the fuse is good, the problem is most likely in the DC rectification section of the power supply. Proceed to 2.2.

2.2 Locate the bridge rectifier (P/N 32450) inside of the power supply. (See Fig 3.) Remove the 2 AC wires from the bridge rectifier by gripping the terminal with a needle nose pliers and pulling straight up. (Do not pull directly on the wire.) Attempt to turn on the unit using the circuit breaker. If the breaker turns on, the bridge rectifier has failed and must be replaced. (Reference Service Procedure 4). If it still trips, go to 2.3

2.3 Unplug the AC input connector to the +/- 12V logic power supply as shown in Fig.2 on page 3. This is the 5 pin connector on the right side with the 208-240V designated wires. Attempt to turn on the unit. If it turns on the logic power supply is defective and must be replaced.

2.4. Replace the on/off circuit breaker switch. (P/N 32250)

2.5 If none of the above correct the problem ,return to the factory for service.



Fig 3.

### 3. The green HEAT ON light does not come on when heating is initiated.

In the HS2500R2 system, heating is turned on when a +12V DC signal generated internally in the power supply is connected to the heat on circuit located on the main control board. For the HS2500R2 this is accomplished by a relay connected to the on/off pins of the Remote Jack, via a user supplied control (e.g. PLC, limit switch, temp sensor etc.) or by a timer/power control unit or power control footswitch supplied by Magneforce Inc. For the HS2500R2C this is accomplished by energizing a relay on the front panel (HS2500R2C) using the START pushbutton or a remote START actuator connected to the Remote Jack. This signal simultaneously turns on the green HEAT ON light. If the HEAT ON light does not come on, the problem is usually due to the on/off signal not being connected properly.

**NOTE:** It is possible for the HEAT ON light to turn on but heating does not occur. See Section 4.

#### Possible Causes

- 3.1 The on/off control connected to the Remote Jack is defective or not hooked up properly.
- 3.2 The selector switch on the main control board that indicates what type of control panel is being used is not in the correct position.
- 3.3 The cable from the remote jack to the main control board and/or from the main control board to the front control board is not connected.
- 3.4 The dual timer/power control panel is defective.

#### Possible Solutions

3.1 **HS2500R2** - Make sure that the on/off control is properly connected to the remote jack on the side of the unit. (Fig. 4). As shown the 12V signal is supplied at pin 7. This must be connected to the common pole of the relay. The normally open contact of the relay must be connected to pin 1 (Heat On) and the normally closed contact should be connected to pin 4 (Heat Off). When the contact is closed, the HEAT ON light will be on. When it is open, the light will be OFF.

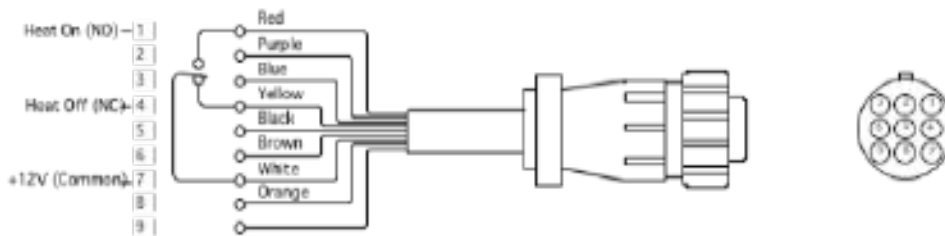


Fig. 4

**HS2500R2C** - Check that the local/remote switch on the control panel is in the correct position. If using the pushbutton switch on the front control panel it must be off. If using an on/off actuator plugged into the remote jack the REM ON light should be on. **Note:** If using an on/off actuator to turn heating on remotely for the HS2500R2C the wiring for the actuator is different than for the HS2500R2. 2 SPST MOMENTARY NO Switches are required. (Fig. 5)

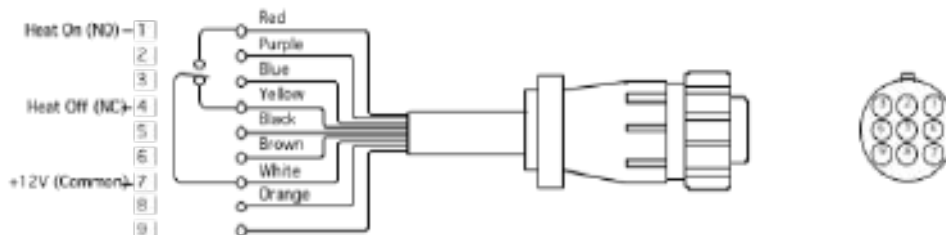


Fig. 5

3.2 The HS2500R2 and the HS2500R2C are the same system. The only difference is the front control panel that is used. To change from one control panel to the other there is a switch on the main control board that must be set for the panel being used. This switch is in the correct position for the panel in place when it is shipped. However, if the panel is changed the switch must also be changed or the controls will not operate properly. (See Fig. 6)

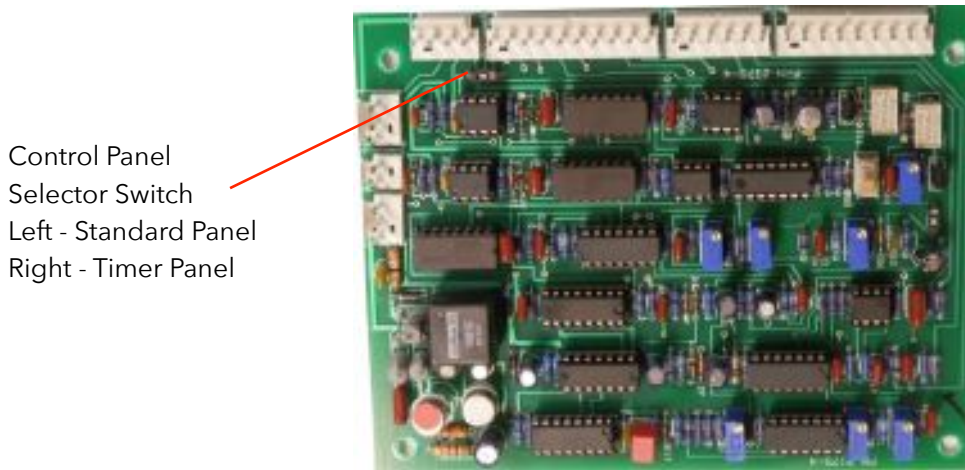


Fig. 6

3.3 Carefully inspect all of the connectors on the main control board. Make sure that they are all plugged in correctly and that there are no loose wires.

3.4 Check that the connector at the back of the front control panel is connected.

3.5 When the Start button on the HS2500R2C panel is pressed, the HEAT ON light should turn on and the timer(s) should begin to cut down. If the timers count down but the HEAT ON light does not turn on the panel should be replaced or returned for repair.

#### 4. The green HEAT ON comes on when heating is initiated but the system does not heat.

When heating is initiated, the green heating light turns on and the system sends power to the output transformer and heating coil to heat the part. If the green "Heating" light turns on but there is no heating, the system is receiving the correct ON signal from the operating controls but an internal problem is preventing heating. This procedure discusses the possible causes and solutions.

##### Possible Causes

- 4.1 The yellow COOLANT light is on.
- 4.2 The red FAULT is light on.
- 4.3 The system is heating but at a very low power level.
- 4.4 The gating wire to the thyristor is not plugged in correctly.
- 4.5 Are the power leads properly attached to the output transformer?
- 4.6 No gating signal to thyristor, bad control board.
- 4.7 The gate on the thyristor/diode module is defective.

##### Possible Solutions/Things to Check

- 4.1 Is the yellow COOLANT light on? If the COOLANT light is on, the system will not heat. If the yellow COOLANT light comes on during heating, heating will turn off until coolant flow is OK. Make sure that the coolant source is turned on. See Section 5, The yellow COOLANT light is on and will not turn off.
- 4.2 Is the red FAULT light on? If the red FAULT light is on, the system will not heat. See Section 6., The red FAULT light is on.
- 4.3 Check to see if the unit is heating at all. Is there any audible noise coming from the unit when you turn on heating? Does the KW meter on the front control value display a value greater than 0.1KW? If so, see Section 8. The system does not heat at the set power or heats very slowly.
- 4.4 Checking the gating wire leading from the main control board to the thyristor. Make sure that the connectors are firmly plugged in on both ends the wire colors are oriented as shown in Fig. 7.
- 4.5. Remove the lid from the output transformer. **MAKE SURE POWER HAS BEEN DISCONNECTED FIRST. WITH THE POWER SUPPLY ON THERE IS HIGH VOLTAGE AT THE INTERNAL TRANSFORMER TERMINALS.** Check that the power cables are connected to the terminals and tightened down. (Fig. 8.)

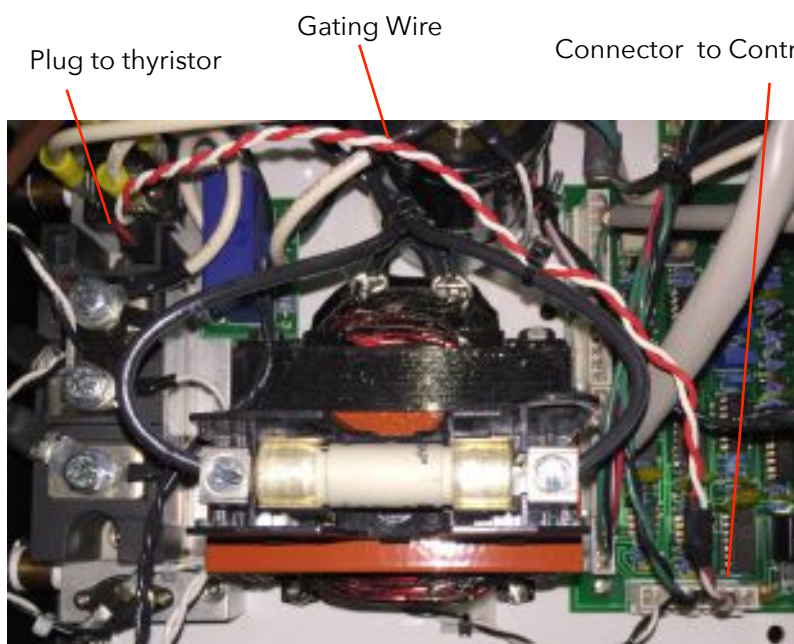


Fig. 7



Fig. 8

4.6 The primary function of the main control board is to send a gating signal to the thyristor/diode module. This signal turns on the thyristor and enables heating. Output power is determined by modulating the pulse frequency of this signal. It is also necessary that the shape of the gating signal waveform is correct or else the thyristor will not turn on.

To check if a gating signal is being generated by the control board, remove the gating connector from the board as shown in Fig. 9. Connect the + lead of a multimeter to the left terminal and the - lead to the right terminal. Set the meter to read Vdc .

Turn on the unit. See the power control to zero and then turn on heating. (Note: Coolant must be turned on and the coolant light must be off. All other checks from the previous items must be OKI)

When HEAT ON is activated, the meter reading should change from approx. 0 Vdc to around 1 Vdc. Turn off heating and increase the power control to 100%. Turn on HEAT ON again. The reading should start at approx. 0.1 volt and then rapidly increase to about 1 volt. If you do not get a voltage reading when HEAT ON is activated, the Main Control Board (P/N 21750) is defective and must be repaired or replaced.

If you get the voltage reading indicated above but the unit still does not heat, the problem is most likely a failed transistor on the main control board in the gating circuit. (The small metal cans by the gating connector. To determine if the transistors are the problem an oscilloscope is required. Contact Magneforce Inc. for assistance.



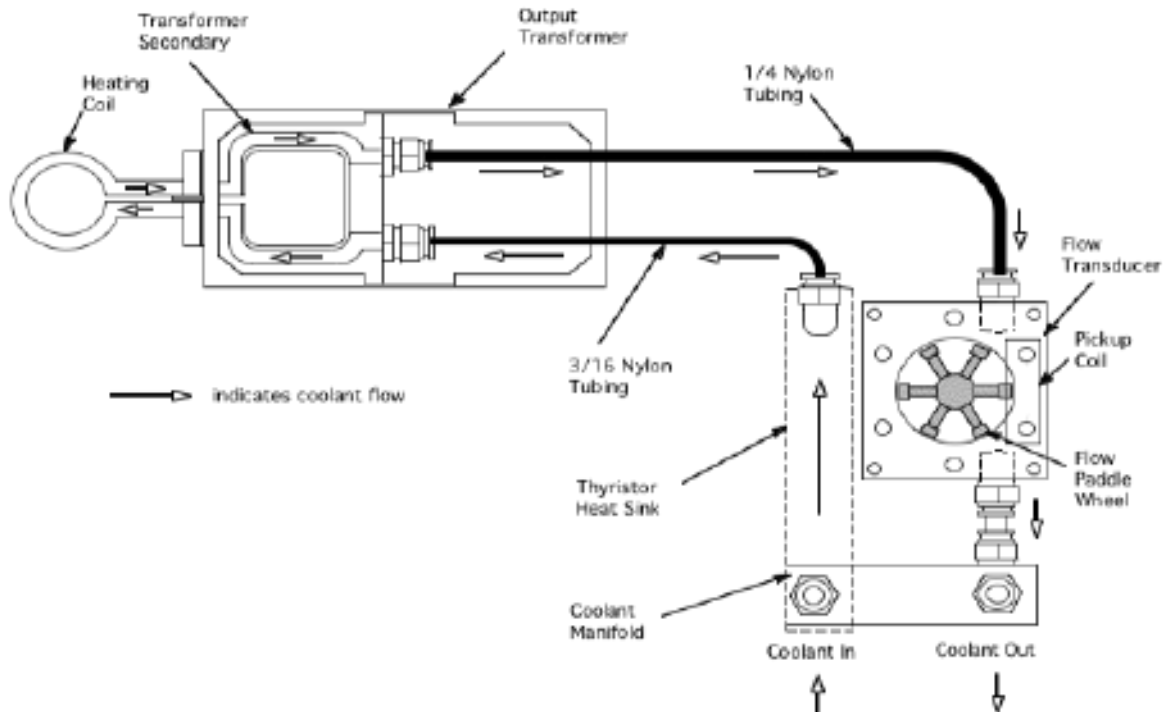
Fig. 9

4.7. If the system still does not heat, the problem could be that the gate internal to the thyristor/diode module is defective. The thyristor/diode module (P/N 32120) must be replaced.

## 5. The yellow COOLANT LIGHT is on and will not turn off.

The HS2500R2 induction heating system requires water cooling for proper operation. Cooling is needed for the semiconductor heat sink located inside the power supply enclosure, the output transformer and the heating coil. Without cooling, these components would rapidly overheat and fail.

Proper coolant flow is indicated by the yellow "Coolant" light on the front panel of the power supply. When the power supply is turned on (and the coolant source is off) the yellow Coolant light will be ON. When the coolant source is turned on, the yellow Coolant light will turn off. The yellow Coolant light MUST BE OFF in order for heating to take place. If the yellow Coolant light is ON, the system will not heat, even if the green "HEATING" light is on.



### Coolant Flow Description

- Coolant is brought into the power supply at the COOLANT IN port of the coolant manifold located on the bottom left side of the exterior of the power supply enclosure.
- Coolant flows into and through the Thyristor Heat Sink inside the power supply. Mounted on this heat sink are the P/N 32120 Thyristor/Diode module and the P/N 21450 Bridge Rectifier. Both of these components produce heat during operation and they must be cooled to prevent them from failure due to overheating.
- Coolant exits the heat sink and then flows out of the power supply enclosure to the output transformer. Inside the output transformer coolant circulates through the left side of the transformer secondary, through the heating coil and then back through the right side of the transformer secondary.
- The returning coolant then flows through the P/N 31650 flow transducer causing the paddlewheel to spin. This measures the total flow of coolant through the system. The paddlewheel MUST spin in a clockwise direction.
- Coolant then exits through the COOLANT OUT port returns to the coolant source.
- The rate of spin of the paddlewheel is read by the pickup coil that is a part of the flow transducer. This coil generates a voltage that is proportional to the rate of spin. The voltage is then read by circuitry on the main control circuit board inside the power supply. If the rate of spin and corresponding voltage is high enough, the yellow Coolant light will turn off and the system will be permitted to heat.
- A temperature switch on the thyristor heat sink inside the power supply monitors the temperature of the coolant. If the temperature is too high, the switch will cut off the signal from the flow transducer and the coolant light will not turn off.

## Possible Causes

- 5.1. The coolant supply and return lines are hooked up backwards.
- 5.2. There is a clog or sediment buildup in the system.
- 5.3. There is low coolant flow or pressure.
- 5.4. The paddlewheel inside the flow transducer is stuck.
- 5.5. The pickup coil on the rear of the flow transducer is bad or is not connected.
- 5.6. The coolant is too hot or the temperature switch is bad.
- 5.7. The flow rate circuitry on the main control board is defective

## Possible solutions/Things to Check

5.1. The coolant tubing must be connected to the ports as shown in Fig 10 . If the supply lines are reversed, the paddlewheel will spin counterclockwise and the Coolant light will not turn off.

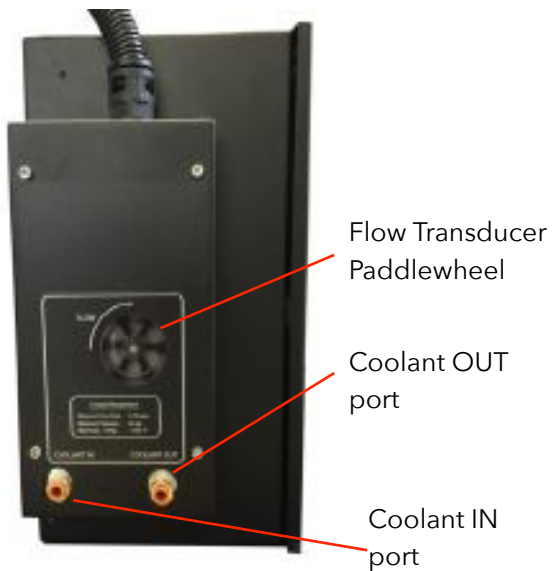


Fig. 10

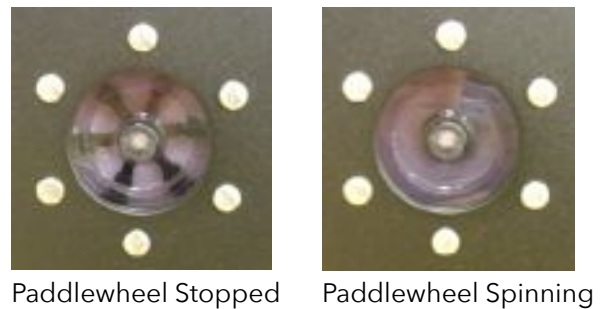


Fig. 11

5.2. Sediment can build up in the system over time. The sediment can come from mineral buildup from the coolant water that is being used. It can also occur through electrolytic action of the coolant flowing through the copper tubing and other metals in the system. This buildup can restrict or even stop the flow of coolant. Clogs can also occur if dirt particles or other particulate matter get into the system. This typically occurs when water is added to the reservoir of the coolant system. Sediment can build up in the bottom of the tank and adding coolant stirs up the sediment. A filter should be used between the coolant out port of the coolant system and the coolant in port of the induction heater.

The most likely area for buildup to occur is in the output transformer and/or the heating coil. This is because these components are typically constructed from small diameter copper tubing bent into a variety of configurations with many bends and corners.

Methods for cleaning these parts include:

### 5.2.1 Heating Coil

- Remove the coil from the output transformer. Inspect it for any signs of kinks that could prevent coolant flow. Blow compressed air through the coil in one direction and then again in the other direction. Try and flow water through the coil, again, first in one direction and then the other.
- If another coil is available, put it on the transformer and see if the flow improves.
- Before replacing the coil, make sure that the coil and transformer terminal blocks are clean.

### 5.2.2 Power Supply and Output Transformer

- Reverse the Coolant In and Coolant Out hoses leading to the power supply. Turn on the coolant source to back flush the system. In many cases if there is a clog in the system, back flushing will remove it.
- Remove the heating coil from the output transformer. Attach a source of clean water to the COOLANT IN port on the power supply. If possible, use a continuous flow of fresh water, e.g. from a city water supply. If not, use a recirculating system with clean water. Allow water to pump through the system for a few minutes. Water should exit from one side of the output transformer. Switch the hose to the COOLANT OUT port and repeat. Water should come out the other side of the output transformer. Re-attach the heating coil. Flow coolant through the entire circuit for a few minutes. Repeat as required.
- If the flows does not improve, replace the 1/4" nylon tubing in the power lead assembly. If this does not improve the flow, there is probably a solid clog inside the aluminum thyristor heat sink inside the power supply, at the aluminum coolant manifold or inside the output transformer. Return the system to Magneforce Inc. for repair.

### 5.2.3 Recirculating Coolant System

- Empty the coolant in the system by disconnecting the coolant out hose and pumping it out.
- Fill the coolant system with clean tap water. Rock the system back and forth to free up any sediment buildup on the bottom.
- Pump out the newly added water. Repeat this a couple of times until the water comes out clean.
- Re-fill the coolant system with a mixture of 75% deionized water and 25% inhibited ethylene glycol. Defense coolant from Dynaflux Inc. and sold by Magneforce Inc. can also be used. (Do not use automotive antifreeze. It contains additives tht can gum up the coolant paths.)

### 5.2.4 Coolant Filter

- Replace the cartridge in the filter assembly P/N 32620 Coolant Filter Cartridge

5.3 If the coolant flow through the system is low it may be due to the coolant source that is being used. A coolant source with a minimum pressure of 50 psi at a minimum flow rate of 0.5 gpm is recommended.

If using a recirculating system, such as the Dynaflux system supplied by Magneforce, make sure that it is filled with coolant and that it is hooked up correctly. Measure the output pressure of the recirculator by connecting a pressure gauge to the Coolant Out port on the recirculator. The gauge should read at least 50 psi when the system is turned on. If it does not, the rotary vane pump may require adjustment or replacement. To adjust the pressure, take off the nut shown in Fig.12. Turn the screw beneath it clockwise to increase pressure.

If using another type of water source, check its' flow and pressure characteristics. Most centrifugal style pumps do not operate at the pressure required to circulate coolant through the system.

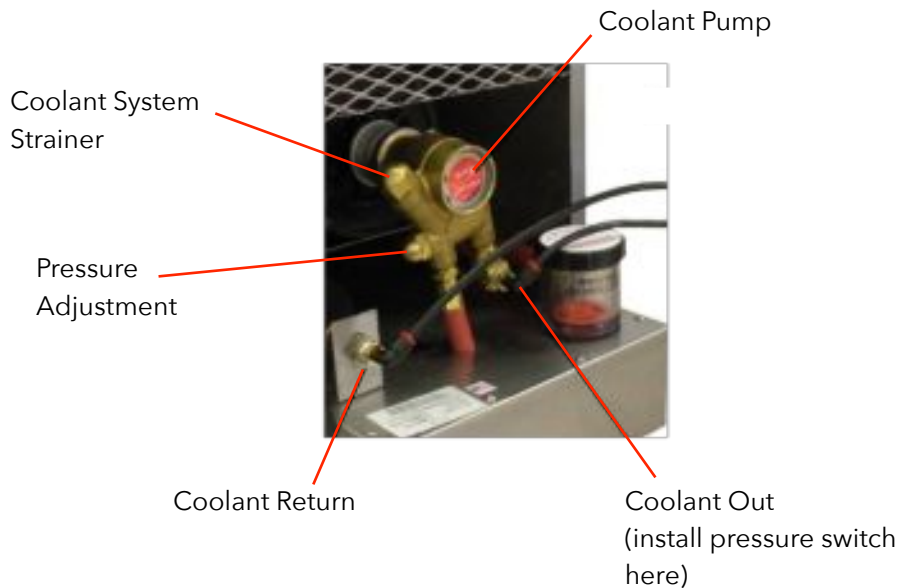


Fig. 12

5.4. The paddlewheel inside the flow transducer should be spinning in a clockwise direction and a rate fast enough where you can not make out the individual vanes. If you can see the vanes turning the coolant flow rate is not fast enough to turn off the yellow COOLANT light. If the paddlewheel is stuck and cannot turn, due to sediment buildup or a bad paddlewheel, the COOLANT light will not turn off.

The paddlewheel can be removed and the inside of the transducer cleaned as follows: See Fig.13)

- Remove the 4 screws attaching the coolant cover to the power supply. Remove the coolant cover.
- Take off the 6 screws retaining the plexiglass cover on the flow transducer.
- Remove the paddlewheel from the housing by pulling straight back on it. Note the front side of the paddlewheel as you pull it out. It must be replaced in the same direction. (The front side has numbers stamped on it.)
- Clean the paddlewheel and interior of the flow transducer. Reassemble it by replacing the six screws. Be careful not to overtighten the screws or you will crack the housing.
- Replace the coolant cover.

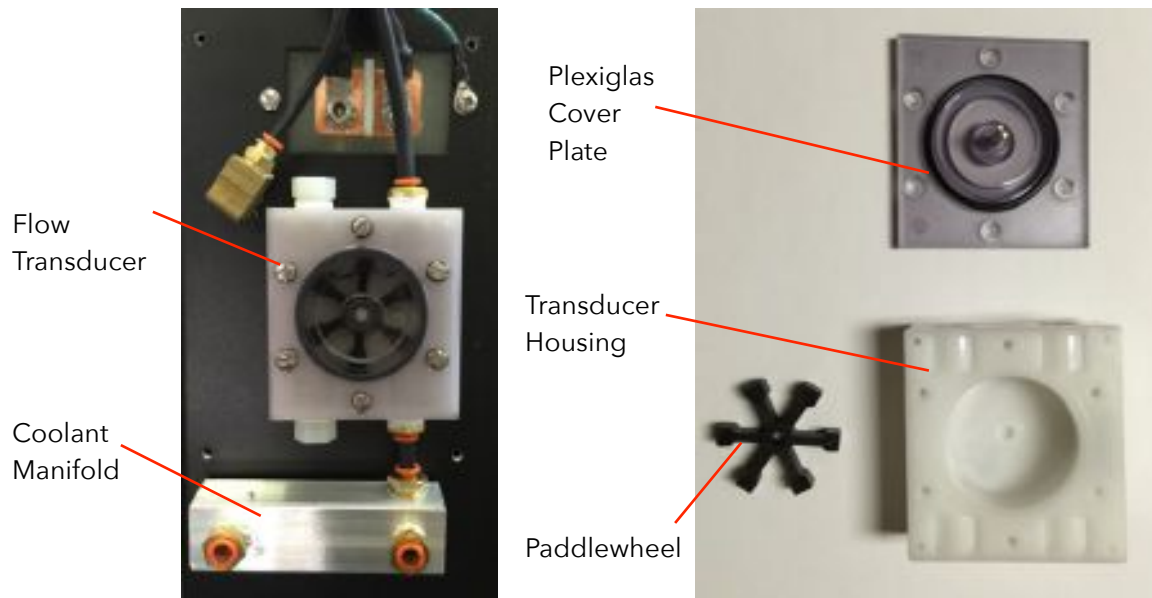


Fig. 13

5.5 The pickup coil (located on back of transducer housing) picks up the signal from the spinning paddlewheel and converts it to a low level DC voltage signal that is sent to the main control board. If it fails, no signal is produced and the yellow Coolant light will not turn off. Check that the wiring leading from the pickup coil to the main control board is connected properly. (Fig. 14) To check the pickup coil, proceed as follows:

- Turn off and disconnect power to the unit. Wait 5 minutes for internal voltage to drop.
- Open the power supply door and locate the pickup coil on the left side on the cabinet.
- Remove the white and black wires. Connect a voltmeter across the leads of the pickup coil. Set meter to read AC voltage.
- Turn on the coolant source (the power supply does not have to be on. The meter should read 0 mv.
- When coolant is turned on, the reading should be approximately 50 mv AC. The actual reading will depend on flow rate.
- If there is no reading, the pickup coil or the flow transducer assembly should be replaced.

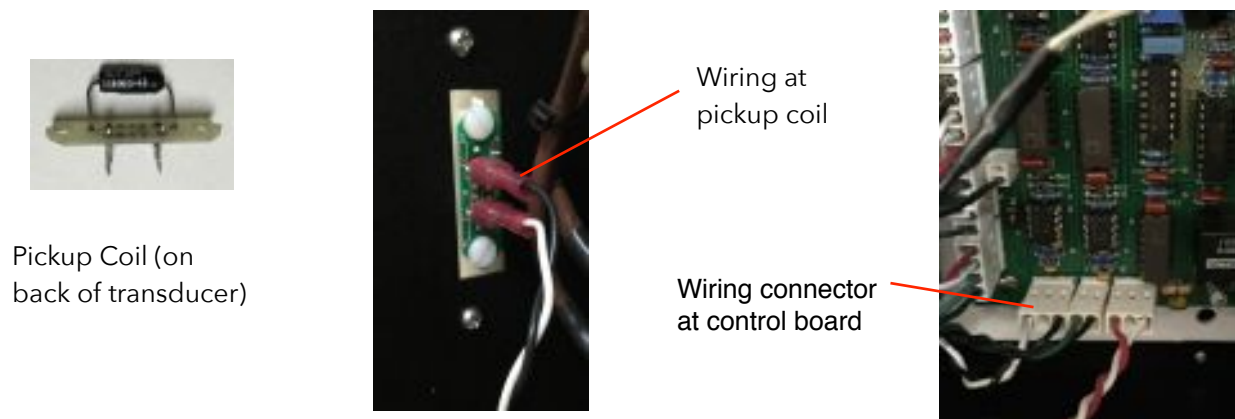


Fig. 14

5.6 The temperature of the coolant should not exceed 100°F. If the coolant is too hot the performance of the thyristor/diode module inside the power supply will be reduced. A normally closed temperature switch is mounted on the thyristor heat sink inside the power supply. If the coolant is too hot this switch will open, the yellow COOLANT light will turn on and the system will stop heating, even when the green "Heat On" light is on. Over temperature conditions usually occur when the ambient temperature exceeds 90°F.

The switch will self reset when the coolant temperature drops. This will typically take about 20 minutes after the power supply has been turned off. If the yellow Coolant light turns on during operation but then shuts off after 20-30 minutes, the problem is most likely that the coolant is too hot.

To check if the temperature switch is defective or not, connect an ohmmeter across the terminals of the temperature switch. This should be done when the system has been shut down for at least 30 minutes and the coolant has cooled down. The ohmmeter should show continuity across the temperature switch. (less than 20Ω). If it does not the temperature switch should be replaced.



Temperature Switch  
(located at bottom left  
corner on top of the  
thyristor heat sink)

Fig. 15

5.7. If the flow transducer paddlewheel is spinning at a fast rate in a clockwise direction, the pickup coil is OK, the temperature switch is OK and the wiring connections are OK, the problem may be in the flow rate circuitry that is located on the main control board. The control board or the complete power supply should be returned to the factory for evaluation and repair.

## 6. The red "FAULT" light on the front control panel is ON.

The red FAULT light on the control panel will illuminate when the DC buss voltage inside the unit is too low. It will also turn on when there is a short circuit or a shorted component in the inverter output portion of the HS2500R2 power supply, causing the semiconductor fuse to blow. When the FAULT light is on, the system will not heat, even if the green HEAT ON light turns on. The fault condition must be corrected before heating can take place.

### Possible Causes

- 8.1 The semiconductor fuse is blown
- 8.2 The current limiters inside the power supply are bad
- 8.3 The AC voltage supply to the system is too low
- 8.4 There is a problem with the Main Control Board voltage sensing circuit

### Possible Solutions/Things to Check

6.1 The most likely reason for the FAULT light to be on is a blown semiconductor fuse. (See Fig. 4) The semiconductor fuse is a very fast acting fuse that will blow if there is a shorted component in the power supply output circuit or if a temporary short has occurred at the heating coil.

To check if the fuse is blown, disconnect power to the power supply and wait at least five minutes for internal capacitors to discharge. Locate the fuse at the bottom of the power supply. Fig. 16. Remove the protective cover over the fuse and then remove the fuse using a fuse puller. Check the fuse for continuity using an ohmmeter. If the fuse checks OK, continue to the next step. If the fuse is blown, go to **9. The Semiconductor Fuse is Blown.**

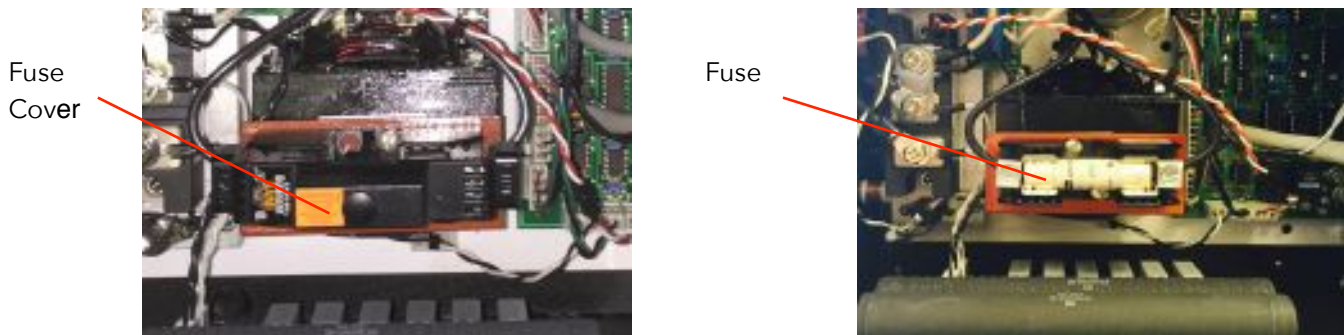


Fig. 15

6.2 Check the incoming AC voltage. The HS2500R2 power supply operates on 208-240V AC power. If the power supplied to the unit is too low, less than 150V, the FAULT light will turn on and the unit will not heat. Low AC power can occur if there is a blown fuse or breaker in the AC source or if the unit has incorrectly been hooked up to 115V AC power.

**6.3** If the semiconductor fuse is OK, visually check the current limiters. (See Fig. 16) The current limiters inside the power supply (the black discs) control the inrush of current into the system when the unit is first turned on. The current limiters can fail after extended use, typically after several thousand hours of operation. Visually inspect the current limiters for any sign of burning or cracking. Any problem with the limiters will usually be easily seen. Replace the current limiters if defective. (Note: There are two current limiters in the unit. Even if only one is defective, they should both be replaced.)

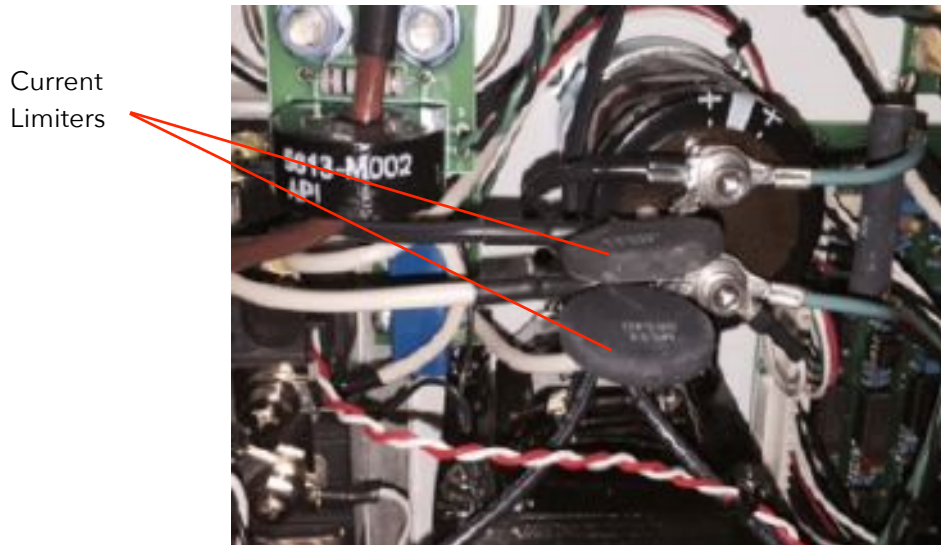
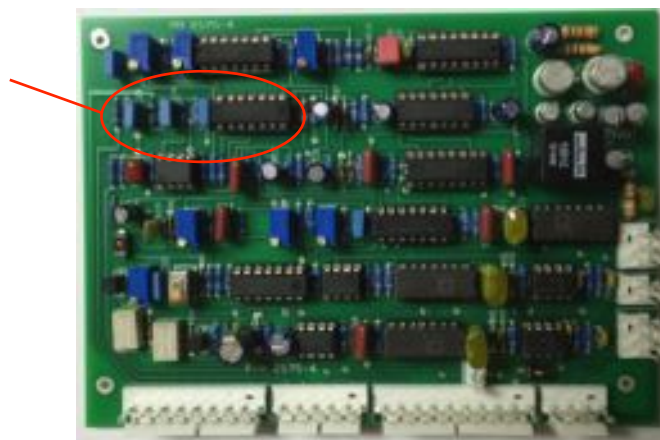


Fig. 16

**6.4** A voltage surge or spike in the power supply can damage the DC volts circuit located on the main control board. Inspect the control board in the area shown below. Fig. 17) If there is any sign of overheating or burning in the area indicated, return the control board or power supply to Magneforce Inc. for repair.

Inspect resistors and IC chip in this area for any sign of overheating



## 7. The Semi-Conductor Fuse is Blown.

The semiconductor fuse in the unit protects the power supply in the event that a fault or a short circuit condition should occur in the inverter/output portion of the HS2500R induction heater. A blown semiconductor fuse will be indicated by the red FAULT light on the control panel.

The primary purpose of the semiconductor fuse is to protect the thyristor/diode semiconductor module in the power supply from failure due to a fault. The thyristor module is the primary switching device in the system and is very susceptible to failure due to voltage spikes and overamperage operation. The semiconductor fuse will blow almost instantly, protecting the thyristor from failure in most, but not all, fault conditions.

**NOTE: Only a fast trip semiconductor fuse can be used, Mersen A30QS20-1 or or equivalent. (Magnefroce P/N 32620). A standard fuse will offer no protection. A slo-blo fuse will offer no protection and can result in the failure of other components.**

There are many possible causes, ranging from a failed component to a momentary short or arc at the heating coil. In order to determine and correct the cause of the failure, it is important to identify at what point in the process that the fuse fault occurred. These include:

- 7.1. When the power supply is first turned on using the on/off circuit breaker.
- 7.2. Immediately when HEAT ON is activated.
- 7.3. At some time during the heating cycle.

Each of these possible conditions are considered separately below.

### 7.1. The semi-conductor fuse blows when the power supply is turned on.

#### Possible Causes

- 7.1.1. A load capacitor has failed.
- 7.1.2 The thyristor/diode module is defective.

7.1.1. Visually inspect the grey load capacitor cans as indicated in Fig 18. If any of the cans appear swollen or are leaking fluid, the capacitor(s) should be replaced.

Load Capacitors

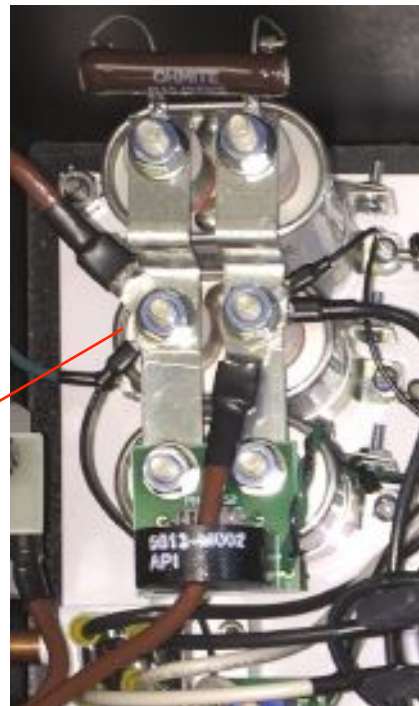


Fig. 18

7.1.2 If the thyristor/diode module is shorted, this will cause the semiconductor fuse to blow immediately at turn on. To check the thyristor/diode module, disconnect power to the unit and wait five minutes for internal capacitors to discharge. Locate the thyristor module in the bottom left corner of the power supply.

Remove the power lead and snubber wire going to the anode of the thyristor module as shown in Fig. 19. With the power lead removed, measure the resistance between the anode and cathode using an ohmmeter. If the meter shows continuity, the thyristor module is defective and must be replaced.

If the meter shows some resistance and not continuity, it is still possible that the thyristor is defective. To check this, it is necessary to install a new semiconductor fuse. With the power lead still disconnected, turn on the power supply. (Note: Make sure to tape off the terminal on the end of the power wire that was removed from the thyristor anode with electrical tape to prevent a possible short circuit.) If the fuse does not blow, the problem is most likely the thyristor and it needs to be replaced. If the fuse does blow at turn on check the load capacitors.

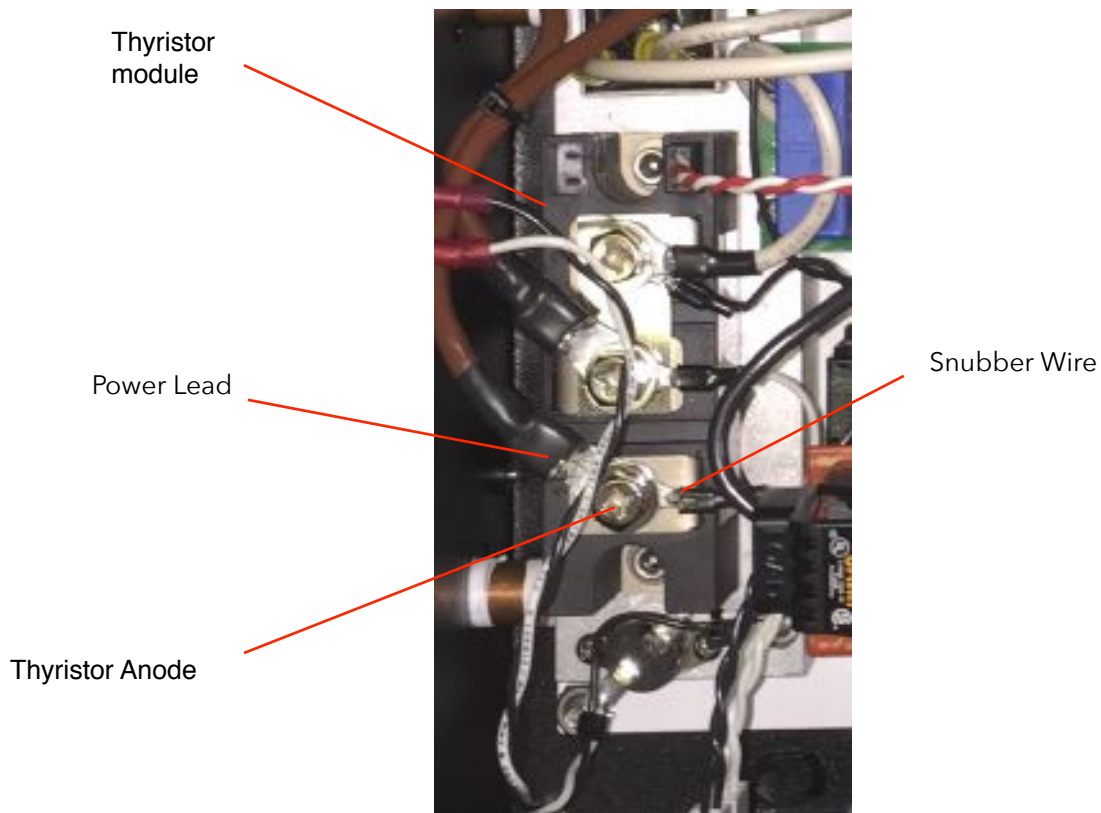


Fig. 19

## 7.2. The semi-conductor fuses blows IMMEDIATELY when HEAT ON is activated

### Possible Causes

- 7.2.1 The coil/output transformer connection is loose or the terminals are dirty and corroded.
- 7.2.2 The heating coil or heating coil leads are uninsulated and shorted out.
- 7.2.3 The -12V supply of the +/- 12V logic power supply is defective.
- 7.2.4 The power lead connection to the output transformer is shorted.
- 7.2.5 The thyristor/diode module is defective
- 7.2.6 The main control board is defective

### Possible Solutions/Things To Check

7.2.1 If the coil is not connected properly or the terminal blocks are dirty or corroded, the semi-conductor fuse can blow at heat on due to the poor connection. The correct fasteners must be used and the terminal blocks on both the coil and the output transformer must be clean. (Fig. 20)

Remove the heating coil from the output transformer. Inspect the terminal blocks on both the base of the heating coil and on the output transformer. Make sure that they are clean and free of any corrosion. If necessary, clean them with a Scotch-Brite pad, fine emery cloth or a steel wool pad. When reattaching the heating coil, make sure to use the correct length screws along with a washer. Use 10-24 x 1/2" screws only,



Fig. 20

7.2.2 Inspect the heating coil. The insulation on the heating coil must be intact and no bare copper should be visible. Make sure there is no mechanical damage to the coil and the coil loops are not touching each other.

If there is bare copper showing and you are using a multiturn heating coil, the coil loops touching each other or if the coil leads can touch each other, this will affect the operating characteristics of the unit and could cause the fuse to blow on Heat On.

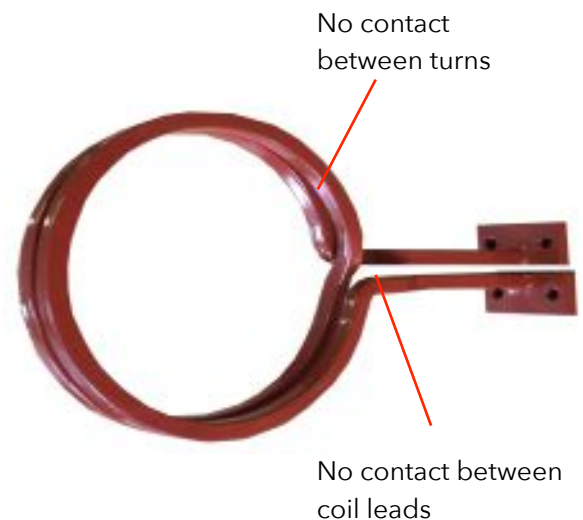


Fig. 21

7.2.3 Check the -12V fuse on the +/- 12V logic power supply located in the top right corner of the unit. . (See Fig. 22). If the -12V supply is bad the “ramp to power” function of the control circuitry will not work, causing the thyristor/diode module to short out and the semiconductor fuse to blow. Measure the voltage at the -12V DC pin on the connector shown by attaching a voltmeter between -12V and logic ground. It should read between -11.8 and -12.2Vdc.

If the -12V fuse is blown, replace it. Measure the voltage at the -12V pin again before proceeding.

7.2.4 Remove the lid on the output transformer and inspect the power cable connections for any sign of shorting. Fig. 23

7.2.5. The thyristor/diode module (P/N 32120) has failed and must be replaced.

7.2.6. There is a problem with the Main Control Board (P/N 21750). It must be returned to the factory for repair or replaced.

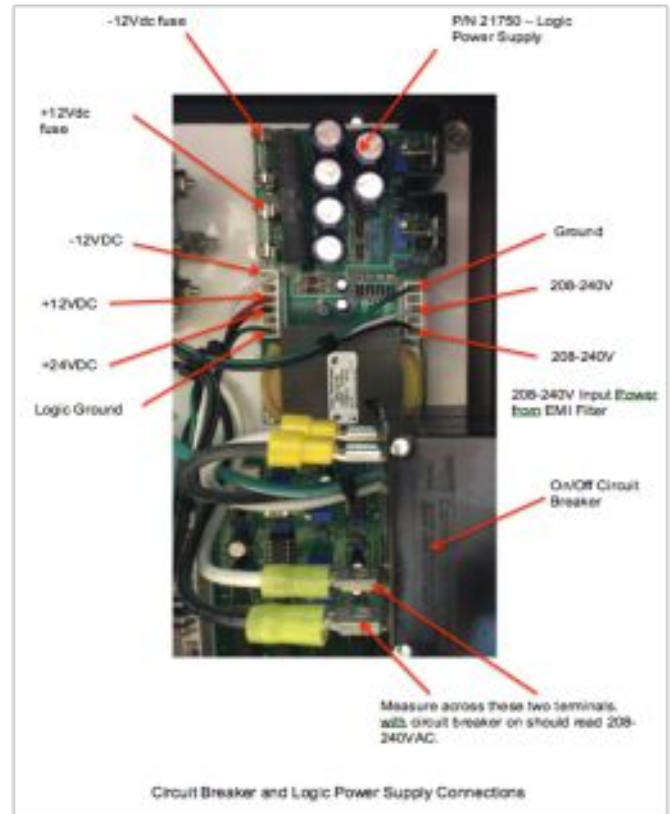


Fig. 22

Check for shorted or loose connection



Fig. 23

### 7.3. The semi-conductor fuses blows a few seconds after HEAT ON is activated.

#### Possible Causes

- 7.3.1 There is no part in the heating coil or it is too small for the coil being used.
- 7.3.2 There is bare copper exposed on the heating coil and the part contacts the bare copper during heating.
- 7.3.3 The part is removed from the coil during heating.
- 7.3.4 The coil is dirty, covered with flux, damaged with missing or no insulation.
- 7.3.5 The settings for max operating power or output amperage on the main control board have been changed.
- 7.3.6 The wrong coil/output transformer is being used.
- 7.3.7 The snubber board inside the power supply is not connected.
- 7.3.8 The thyristor/diode module has been weakened by previous faults.
- 7.3.9 Coolant flow to the main heat sink in the unit is low or coolant temperature is too high.

#### Possible Solutions/Things to Check

7.3.1 Make sure that the part is in the heating coil before initiating heating. Make sure that the coil is properly sized for the part that is being heated. If the coil is much bigger than the part, it will cause the system to operate at high amperage and voltage. In most cases control settings for maximum power and amperage will protect the system from faulting. However, if the mismatch is extreme they may not. This is particularly true if the part is non-magnetic, such as aluminum, brass, copper or some stainless steels. If there is a question about the heating coil/part setup, contact Magneforce for assistance.

7.3.2 The part should not contact the heating coil during heating, especially if there is bare copper exposed. Inspect the heating coil. There should not be any exposed copper showing through the coil insulation. If the part contacts exposed copper during the heating cycle this will create a high voltage arc that will cause the fuse to blow. Reinsulate the coil using electrical epoxy coating or return the coil to Magneforce Inc. to be recoated.

**Note:** Different coil insulation types are used on the heating coils depending on the application and the final part temperature required. For applications below 600°F or where there will be sufficient space or fixturing to insure there is no contact between the hot part and the heating coil, coils are powder coated with electrical epoxy. For applications where the part will be very hot, up to 2000°F, coils are ceramic coated with a special plasma spray ceramic coating process.

7.3.3 The part inside the heating coil establishes the load resistance required for proper operation of the power supply. If the part is removed from the heating coil while the system is on and heating the output amperage and voltage of the power supply will instantly increase in order to maintain constant power to the output. This sudden increase could result in blowing the semiconductor fuse and in some cases could result in failure of the thyristor/diode module. **DO NOT REMOVE THE PART FROM THE HEATING COIL DURING HEATING!**

7.3.4 If the turns, or loops, of the heating coil are not insulated and bare copper is exposed, dirt or flux can build up between the turns and result in a short circuit between them. This can alter the inductance of the coil and change its' operating characteristics. It can also affect heating times. **THE COILS SHOULD BE CLEANED REGULARLY AND REINSULATED IF REQUIRED.**

7.3.5 The main control board P/N 21750 (see fig 11) includes several potentiometers that are adjusted by the factory at the time of testing and tuning the unit. These pots set critical parameters essential to the operation of the power supply. Turning these pots with knowing what you are doing can change the maximum operating power of the unit, maximum output amperage of the unit, pulse frequency, power control setting and more.

**THESE POTS MUST NOT BE TURNED. CHANGING THESE SETTINGS WILL RESULT IN FAILURE OF THE SYSTEM**

7.3.6 The size of the heating coil that can be used with the HS2500R2 heating system is dependent on the turns ratio of the output transformer supplied with the system. Standard transformer ratios used are 7:1, 10:1 and 14:1. The primary purpose of the output transformer is to match the coil to the electrical requirements of the induction heater.

A wide range of heating coils can be used, but only if properly set up. Small coils require a higher turns ratio e.g. 14:1. Large coils require a lower turns ratio e.g. 7:1. If a small coil is used on a 7:1 transformer the operating frequency can be too high, exceeding the operating characteristics of the thyristor/diode module. If a large coil is used on a 14:1 transformer, the operating frequency can be too low, resulting in saturation of the transformer core and affecting performance. If the frequency is too high or too low, this could cause the fuse to blow.

A chart of acceptable coil sizes/transformer ratios is given in Fig. 24. The sizes shown are for circular type coils and can vary depending on the length of the coil, power level, material being heated and coupling. Sizes for U type coils, pancake coils and custom shapes can also vary.

Contact Magneforce Inc. for application assistance and to determine if the coil/transformer combination is OK.

# COIL TURNS	Size I.D."	Transformer Ratio		
		7:1	10:1	14:1
1	Min	2.0	1.0	.50
	Max	5.0	4.0	3.0
2	Min	1.38	.75	.38
	Max	3.0	1.75	1.12
3	Min	1.0	.50	.25
	Max	2.25	1.12	.88
4	Min	.88	.25	.25
	Max	1.5	.88	.62

Fig. 24

7.3.7 The snubber board attenuates voltage spikes across the thyristor module as it turns on and off during operation. If the snubber board is damaged or not properly connected this will result in very high voltage spikes, causing the fuse to blow and possibly damaging the thyristor.

7.3.8 The operating characteristics of the thyristor/diode module are reduced each time the fuse blows, during heating, due to a fault condition occurring. The level of reduction depends on the type of fault but it would typically be around 1%. If repetitive faults occur the thyristor may be weakened to the point that it affects operation. This can be offset by turning down the operating power level. If this is not acceptable the thyristor module should be replaced.

7.3.9 The thyristor/diode module, output transformer and heating coil must be water cooled for during operation. If the coolant flow is too low or if the coolant temperature is too high, this will result in a reduction of the power handling capability of the thyristor/diode module. There are coolant flow and temperature protections built into the power supply. If these protections are overridden for any reason this could result in overheating and cause the fuse to blow.

## 8. The system does not heat at the set power level.

The heating power of the system is set using a 0-10Vdc signal supplied by the POWER knob(s) on the control panel or by auxiliary controls connected to the remote jack. In general, the operating power will be linear to 2500 watts depending on the power control signal. For example, if the power control signal is 5Vdc, or 50%, operating power will be approximately 1250 watts, or 1.25KW. If the power control signal is 10Vdc, or 100%, operating power will be approx. 2500 watts, or 2.5KW. The actual operating power is displayed on the KW meter on the control panel. It is also available as a voltage signal on pin 6 of the remote jack.

There is a minimum operating power level. If power is set at 0 and heating is turned on, the system can not heat at 0 power. The minimum power level will depend on the coil used and the part being heated. Minimum power level can vary from about 50 watts to over 300 watts depending on the setup.

Maximum operating power level also depends on the coil and part. The combination of the coil and the part inside it represent the load, or electrical resistance, of the output. If the load is poor, i.e. very low resistance, excessive internal voltage and amperage may be required to heat at the set power level. This could result in damage to the power supply, particularly failure of the semiconductor fuse and/or the thyristor/diode module.

There are protection circuits built into the power supply control circuitry that limit the operating power if the load is not very good. These circuits and other possible causes and potential solutions are listed below.

### Possible Causes

- 8.1 There is no load in the heating coil.
- 8.2 The maximum output amperage circuit is limiting power.
- 8.3 The load sensor circuit is limiting power.
- 8.4 The heating coil being used is not the best design for the application.
- 8.5 There is no power control signal to the Main Control Board inside the unit.
- 8.6 The heating coil is damaged or coil turns are shorted together.
- 8.7 There is a problem with the Main Control Board.

### Possible Solutions

- 8.1. There must always be a part in the heating coil. Do not operate the system unless there is a part in the coil and do not remove the part from the coil during heating.
- 8.2. The HS2500R2 power has a maximum output amperage of 100 amps. If the resistance of the load required to draw 2500 watts at 100 A is not high enough, the output will "limit" and not permit any increase in power, even if the power knob setting is increased. For example, if the load resistance is  $0.2\Omega$ , the maximum power output at 100amps is  $P=I \times I \times R = 100 \times 100 \times 0.2 = 2000$  watts. At a power setting of 8v (80%), the expected power output is 2000 watts. When heating this load, power will increase linearly until you reach 80%. Any additional increase in the knob setting will have no effect.  
A modification in the coil may improve the maximum power output. It is also possible that 2000w is the maximum power that can be achieved heating the part.  
**(Note: For most materials, as the part gets hotter its' resistivity will increase. If a load is running in limit you may notice that the power draw increases as the part heats up.)**
- 8.3. The HS2500R2 power supply incorporates a load sensor circuit. The purpose of this circuit is to prevent the unit from increasing in power unless there is a part in the heating coil. See Section 10 for more information.

## 9. Heating is different or erratic from part to part.

If the same part is fixtured the same way in the same heating coil and heated at the same power level, the heating time should be very consistent from one part to the next. If it is not, check the following:

### Possible Causes

- 9.1. The part is not positioned in the heating coil the same way each time.
- 9.2. The part is touching the heating coil during heating.
- 9.3. The heating coil is bent, damaged or covered in flux or other material.
- 9.4. The fixture used to hold the part is affecting the heating.
- 9.5. The limit circuit is holding back power.
- 9.6. The load sensor circuit is holding back power.
- 9.7. Coolant flow is variable and heating is being turned on and off during the heating cycle.
- 9.8. The power control input is variable.

### Possible Solutions/Things to Check

9.1. If the part is not positioned the same way in the heating coil each time it can affect the heating. For example, if a cylinder is being heated in a circular coil the cylinder should be centered. If one side is closer to the heating coil than the other, that side will heat faster. This also applies to U type coils and pancake, or surface heating coils. If a pancake coil is being used, the distance between the surface of the part and the surface of the coil is very important. As the part is moved away from the coil, heating will drop off rapidly. Position is particularly important when heating two areas simultaneously. For example, if a shaft is being brazed to a hub and both parts are being heated together, moving the coil up and down will change the heat pattern. The heating of each part will change. (Fig.25).

9.2. The heating coils are water cooled. If the part contacts the coil during heating the area of contact will heat more slowly. It is being cooled by the coil. This could also result in deterioration of the insulation coating, or, if bare copper is exposed, arcing and blowing the semiconductor fuse.

9.3. The fixture holding the part can affect heating in two ways. The first is by heat sinking the part and drawing heat away from it into the fixture by conduction during heating. The second is when the magnetic field actually heats up the fixture at the same time it is heating the part. This can happen if the wrong fixture material is being used or if it is too close to the coil. In general, 304 and 316 stainless steels and ceramics are good materials to be used for fixtures. Aluminum can be used as long as it does not suck heat away from the part. Carbon steel and ferritic stainless steels should not be used unless they are kept well away from the heating coil. For more information, contact Magneforce Inc. for application assistance.

9.4. If the output amperage is being limited during heating, this can result in an increase in power during the heating cycle, even if the power control setting does not change. This could cause variability in part to part heating. To get more consistent results, reduce the heating power so the limit is not reached. See note.

9.5. Similar to 9.4, if the load being heated is not that good, the load sensor circuit could be affecting the power output. See Section 10.

9.6. If coolant flow is intermittent due to low coolant level in system, a bad pump or a restriction in the coolant path, this could cause heating to turn off and then back on in the middle of a heating cycle. Check the coolant system. Also, observe the yellow Coolant light during the heating cycle. Does it come on at all?