

FOR FENWALL DIRECT SPARK IGNITION SYSTEMS  
 05-15 FOR 12 VOLT DC UNITS AND 05-16 FOR 24  
 VOLT AC UNITS AS USED WITH DUO-THERM 659,  
 660, 661 AND 900 SERIES HEATERS.

## DESCRIPTION

In simple terms, DSI (Direct Spark Ignition) is an electronic substitute for the standing pilot and thermocouple used to light the main burner of a gas appliance. The pilot is replaced by a high voltage spark which ignites the main burner directly. The thermocouple, used as a flame sensing device, is replaced by an electronic sensor which detects main burner flame.

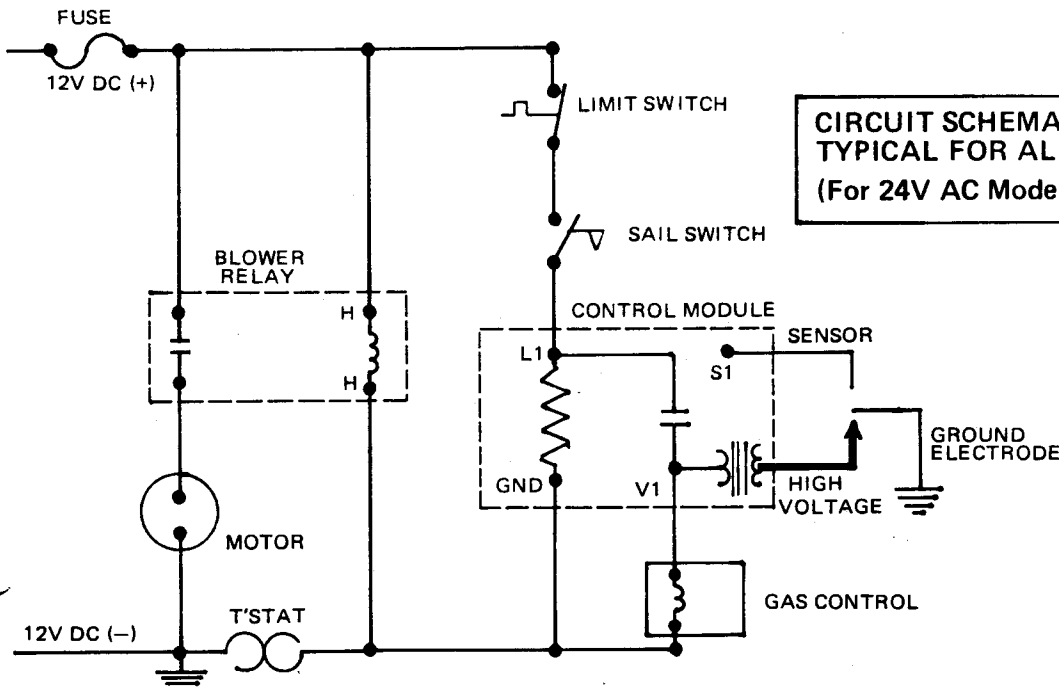
In most ways, the DSI system is simpler to trouble-shoot and service than a comparable pilot model, PROVIDED that the proper equipment and "knowhow" are used.

- D. When the control module receives power it simultaneously energizes three separate circuits:
1. 12V. DC (or 24V. AC on AC systems) is supplied to the gas control, and it opens, allowing gas to flow to the main burner.
  2. Intermittent high voltage is applied to the ignition electrode causing a spark across the ignition and ground electrodes, thus igniting the gas at the main burner.
  3. An AC voltage is applied to the flame sensor. If a proper flame is present between the flame sensor and the ground electrode, a small rectified DC current will flow across this flame path to ground. This current flow signals the control module that flame is present, and the system remains on until the end of the cycle, when the thermostat opens.

## OPERATING SEQUENCE

- When the thermostat contacts close a circuit is completed to the blower relay coil and to Terminal GND of the control module. See Wiring Schematic. (The module does not operate at this time as the sail switch is open - no power to Terminal L1.
- The blower relay contacts close completing the circuit to the blower motor. On some models the relay closes instantly; on other models there is a 10-15 second delay.
- When the blower motor comes up to speed the sail switch closes, completing the power circuit to the module.

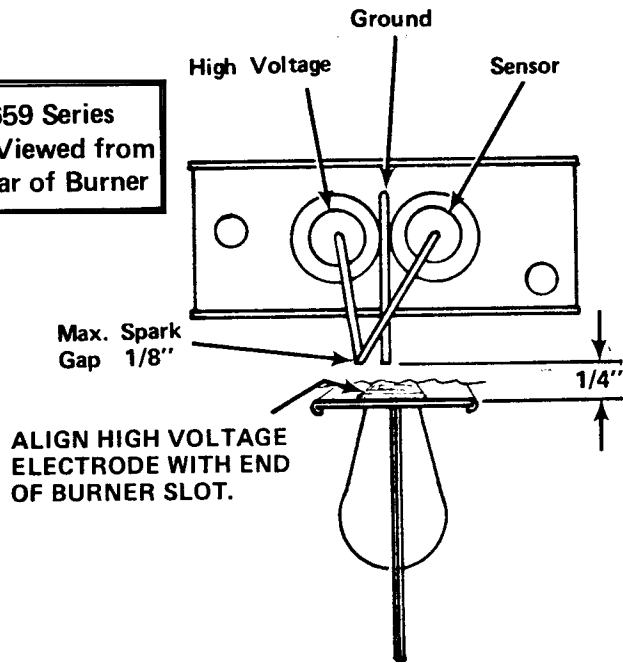
However, if no flame is present there is no current flow in the sensor circuit, and the control module goes into lockout in approximately 7 seconds, shutting off all circuits from the control module. (NOTE: The circulating blower will continue to run after lockout occurs.) To reset a system that is locked-out, simply open the thermostat for about 3 seconds then reclose it. The system will then go through the same sequence as before.



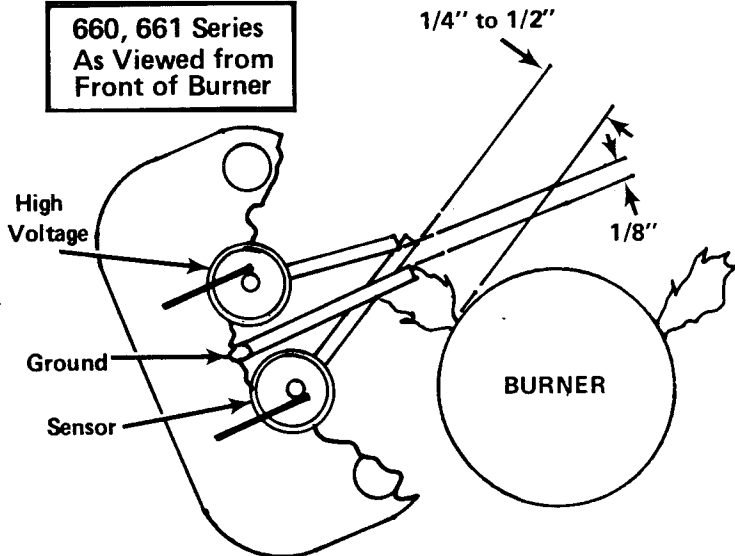
**CIRCUIT SCHEMATIC  
 TYPICAL FOR ALL DUO-THERM 12V DC MODELS  
 (For 24V AC Models, See Page 6)**

# ELECTRODE SETTINGS:

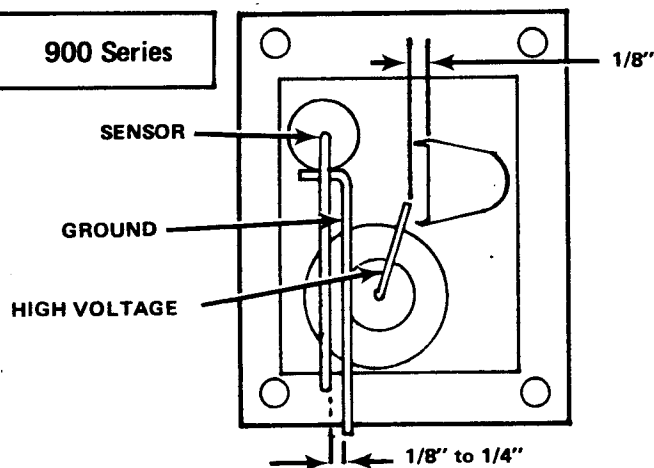
**659 Series  
As Viewed from  
Rear of Burner**



**660, 661 Series  
As Viewed from  
Front of Burner**



**900 Series**



# QUICK-CHECK TROUBLE SHOOTING LIST

## **A** BLOWER RUNS, NO SPARK

1. Check voltage to control module
2. Check control module for spark output

## **B** BLOWER RUNS, SPARK OK, NO BURNER

1. Check manual shut-off valve
2. Check voltage to control
3. Make sure control is opening

## **C** BLOWER RUNS, SPARK OK, CONTROL OPENS, NO BURNER

1. Check electrode settings
2. Check burner pipe, orifices, for restrictions
3. Check gas pressure at control
4. Check gaskets, etc., for air leakage

## **D** LOCKOUT OCCURS

1. In 7 seconds or less:
  - a. Check sensor for short to ground
  - b. Check sensor circuit for openings
  - c. Check PC Board connection
  - d. Check for proper grounds
  - e. Check micro amp reading
2. After 7 seconds:
  - a. Check micro amp reading and electrode setting
3. Only occasionally
  - a. Check for proper installation, air leaks
  - b. Check for carbon on electrodes
  - c. Check for consistent gas pressure

## **E** SPARKING AFTER IGNITION

1. Re-check electrode setting.

## **F** BURNER CYCLING ON AND OFF

1. Check Limit Switch
2. Check short cycling thermostat

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## SOME POINTS TO REMEMBER

1. Never short across gas control terminals, or from terminals to ground — printed circuit in control module will burn out.
2. Never operate ignitor unless a high voltage wire is attached, and spark gap set at 1/8 inch maximum.
3. Make sure ground connections are tight. This includes the burner itself, the electrode assembly, and the power supply which is connected to GND terminal on ignition control.

Loose ground connections will prevent sensor from providing proper signal — system will lock out.

4. Never attempt to make repairs to the control module itself. Any attempts to make repairs could alter the function of sensitive electronic circuits, and cause unsafe operation.
5. The 12V. DC ignition system can be used only on a negative ground power supply. DO NOT attempt to use with positive ground systems.

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## DETAILED SERVICE PROCEDURES PROBLEMS, CHECKS, CORRECTIONS

### **A** BLOWER RUNS, NO IGNITION SPARK

1. Check for voltage across terminals L1 and GND on control module:
  - A. If no voltage is present, check for open sail switch or limit switch; check wiring connections and leads.
  - B. If voltage is present, check for lockout by resetting thermostat.
2. Check for spark at electrodes during first 5 seconds of cycle. If sparking is evident, check electrode setting (see diagrams). Readjust if necessary. Check for carbon on electrode tip; clean if necessary.

If no spark is seen, check control module for high voltage output. Disconnect high voltage lead from module and temporarily connect another insulated wire to the module. Hold the other end of this wire 1/8 inch from the furnace casing and start the ignition cycle. If no spark is present replace control module.

If spark is present during this check, it indicates a short to ground in the high voltage wire or electrode. Check the high voltage wire for breaks; replace if found defective. Check the electrode insulators for cracks; check high voltage electrode settings, adjust if necessary. (See diagrams for correct electrode adjustment.)

### **B** BLOWER RUNS, SPARK O.K., NO MAIN BURNER

1. Check manual shut-off valve at heater to make sure it is open.
2. Check for voltage across gas control terminals (DO NOT CHECK from terminals to ground) during first 5 seconds of ignition cycle. If no voltage is present, replace control module.

If voltage is present at gas control, check to make sure gas control is opening. Several methods can be used for checking the operation of the gas control. If the unit is being checked on your test bench a strong gas smell can be noticed at the exhaust vent indicating that gas is flowing through the control. On units with General, Robertshaw or Fenwall Controls, a gas pressure check can be made at the pressure tap on the control. Pressure will be indicated only when the control opens.

The Essex control has a pressure tap which shows inlet pressure only, so a different procedure must be used to check this control. Attach the manometer to the pressure tap, open the manual gas valve on the pressure regulator (next to the gas control), then reclose the valve. Close the thermostat circuit to start the ignition cycle, and observe the manometer. If the valve opens the pressure will drop to "0".

If the control does not open with voltage applied to the terminals, replace it.

### **C** BLOWER RUNS, SPARK O.K., CONTROL OPENS, NO MAIN BURNER

1. Recheck electrode adjustment. Spark must be located across the high voltage and ground electrodes only (not to burner, heat chamber, etc.). Model 900 Series must spark to tip of pilot hood.
2. Check gas control outlet, burner pipe, and main orifice for restriction. Check burner ports for corrosion or restrictions which would prevent gas flow to spark area. On 900 models check pilot burner for restrictions in the hood or orifice.
3. Check gas pressure at pressure tap on gas control. Pressure should be 10-11 inches water column. Also, see CHECKING GAS PRESSURE, Section **D** 3.C.

4. Carefully check heat chamber for loose gaskets or other openings which would allow air from the circulating blower to enter the heat chamber and prevent gas from reaching the spark.

Keep in mind that if an air-gas mixture and a spark are in the same place — ignition WILL occur.

## **D** IGNITION LOCKOUT OCCURS AFTER BURNER LIGHTS

After the burner ignites, the control module applies a voltage to the sensor. If there is flame present in the gap between the sensor and ground, a small electrical current flows across this gap. The control module senses this current flow, and if the current is more than 5 microamps the control module will allow ignition to continue until the thermostat opens, ending the cycle. However, if the current is less than 5 microamps the control module will shut down the ignition system within 7 seconds.

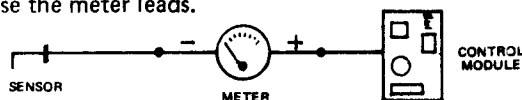
The amount of current flow in the sensor circuit is directly related to the type and amount of flame present in this gap between sensor and ground. By measuring this current it can be determined whether the control module is operating properly, or that the sensor is located in the correct position in relation to the flame.

### — CHECKING MICROAMPS —

To properly check out a Fenwall DSI System, the current in the sensor circuit must be measured, using a DC microamp meter with a 0-50 microamp scale. Some of the more elaborate Volt-Ohm Meters have this type of scale. Also, an inexpensive panel meter is available through Radio Shack stores (Catalog No. 270-1751). Test leads must be attached, and the meter must be mounted in a case of some type. Total cost for meter, leads and case is less than \$20.00.

**CAUTION: DO NOT use a milliamp scale or meter as it will not read a current this low. (1,000,000 microamps = 1 Amp, whereas 1000 milliamps = 1 Amp.)**

To use the meter, connect it in series with the sensor circuit (see sketch). If the meter reads below zero, shut off the unit and reverse the meter leads.



The microamp reading must be taken when the heater is installed in the coach, with all duct work attached, using the coach power supply and gas supply. This is necessary because the reading can be affected by voltage, blower speed, vents being attached, or even combustion air temperature, all of which can affect the burner flame.

For example, on the 659 Series furnace a reading of 10–14 microamps should be obtainable on a bench check, with ducts and vents disconnected. However, when the furnace is installed in the coach, using cold outside air for combustion, the microamp reading will often be lower. Therefore if a unit is checked at 6 or 7 microamps on your workbench test, the reading when the unit is installed may be low enough to cause lockout.

If the sensor is being adjusted during a workbench test try to obtain the highest possible reading, then recheck the reading after the furnace is installed to make sure it is still high enough — minimum 5 microamps.

**REMEMBER—the higher the microamp current is, the less chance there is of lockout occurring.**

1. If ignition LOCKOUT OCCURS IN 7 SECONDS OR LESS check the following:

- A. Sensor shorted to ground. Remove sensor lead wire and check with an ohm meter for short to ground. If short is indicated, re-adjust sensor electrode. Check insulators for cracks. Replace electrode set if necessary.
- B. Check sensor wire lead for continuity and for shorts to ground. Make sure wire lead is not pinched between any metal parts which could cause a break in the wire insulation.
- C. Check PC Board connector at control module for good connections. Remove connector and clean board terminals, using a pencil eraser. If control module uses individual quick-connect terminals check each terminal for tight connections.
- D. Check for proper grounding of the burner to furnace casing. Also, check for proper grounding of the power supply which is connected to the GND terminal of the ignition module. On 12 VDC systems, this lead must be negative polarity. Clean and tighten ground connections if necessary.
- E. Check microamp reading in sensor circuit. If reading stays above 5 microamps while lockout occurs, replace control module.

2. If LOCKOUT OCCURS AFTER 7 SECONDS from beginning of ignition cycle, it indicates that the sensor is passing a "border line" current signal to the control module. A microamp check will show a fluctuating reading, with periods of operation below 5 microamps. In almost all cases this is due to improper location of the sensor electrode. Resetting the sensor according to the diagrams will give the best readings on most units. In some cases a higher reading can be obtained by adjusting the sensor slightly different than shown in the diagram. However, as long as the microamp reading consistently stays above the minimum reading for the entire cycle, no further adjustment should be necessary. See CHECKING MICROAMPS at left.

3. If LOCKOUT OCCURS ONLY OCCASIONALLY it may be difficult to diagnose properly, as the unit may operate properly when being checked-out. Most of these problems can be solved by checking these items:

- A. Air leak in combustion system. Both inlet and exhaust portions of the vent system must be properly connected to the heater. When an RV sealed-combustion heater is properly installed, the air pressure outside the vehicle (wind) should have little or no effect on the operation of the burner. For example, a 20 mph wind blowing against the side of a coach will apply the same pressure against both the exhaust and inlet vents, thus the pressures will balance each other. However, if one of the vents is not properly connected it could cause a leak, thus upsetting the balance within the closed-loop combustion system and causing main burner problems, especially during windy periods.

Also, check all other connections in the combustion system, gaskets, air ducts, etc., for leakage.

- B. Carbon build-up on electrodes. This can be caused by an improper air-gas mixture, due to problems in the combustion air system, or incorrect gas pressure. However, this problem can often be traced to moisture or other impurities in the gas supply.

A complete cleanup of the gas system is required if moisture is present. Disconnect gas piping from all appliances and tank regulator, and blow out with dry compressed air. Add a drying agent (methyl alcohol) to the gas bottles to avoid future problems. If moisture problems persist advise customer to change gas suppliers.

- C. Changes in gas pressure. When properly adjusted, the tank regulator should hold line pressure at 11-14 inches WC (water column). This pressure should not vary more than 1/2 inch WC when the heater (or another appliance) comes on. If line pressure drops more than this it indicates an undersized or defective regulator, liquid fuel getting into the regulator, moisture in the gas supply, or a restriction in the supply line.

If the line pressure goes above the adjusted setting, it indicates a defective regulator, or liquid fuel getting into the regulator. Either of these conditions could be dangerous if pressure continues to build in the system, as most appliance control devices will not withstand more than 2-3 pounds of pressure. If regulator does not hold with all appliances shut off, replace it. Make sure gas bottles are not overfilled, allowing liquid fuel to enter the regulator.

In addition to the tank pressure regulator, all DUO-THERM heaters currently being manufactured have a built-in pressure regulator, either a separate regulator ahead of the control, or as an integral part of the control. These are adjusted to maintain 10-11 inches WC pressure to the burner, to prevent overfiring of the burner because of high line pressure. However, if the line pressure goes extremely high, these built-in regulators will not be able to hold to the pressure they are adjusted for, and the tank regulator must be adjusted to a lower pressure setting.

Built-in regulators used with General and Robertshaw Controls are adjustable; regulators used with Fenwall and Essex Controls are not adjustable. Keep in mind however, that these built-in pressure regulators cannot increase the pressure beyond that supplied to the heater; if line pressure is too low it must be corrected by adjusting the tank regulator, or by eliminating any restriction in the supply line.

### CHECKING GAS PRESSURE

We recommend using only a water-filled U-Tube manometer for checking gas pressure. The standard dial-type pressure gauge used by some servicemen is a sensitive device easily damaged during normal use. If knocked out of calibration, the serviceman often will not be aware of it, and will make incorrect pressure adjustments on each call. If this type of gauge must be used, we recommend that it be compared against a U-Tube manometer often, at various pressures, to make sure it is reading properly.

Due to the built-in pressure regulator on a Duo-Therm heater, the pressure tap in the gas control cannot be used to check line pressure. The line pressure can be checked at another appliance without a built-in regulator. However, this method will not find a restriction in the heater branch line. To check this a temporary tee must be installed at the heater ahead of the gas control, and a pressure reading taken while the heater is operating.

Correct line pressure, with heater OPERATING, is 10-14 inches WC. Correct manifold pressure (between gas control and main orifice) is 10-11 inches.

## E SPARKING AFTER BURNER IGNITION

In some cases the high voltage spark will continue during main burner ignition. This continued sparking is not harmful, and will not damage the control module.

If this sparking is objectionable to the customer it can be lessened or eliminated by proper adjustment of BOTH the sensor electrode and the high voltage electrode. If EITHER of these electrode tips are not immersed in the burner flame properly, the sparking may continue.

## F BURNER CYCLING ON AND OFF

This condition does not indicate a problem with the ignition system, but rather an interruption of power coming to the control module. Check for:

1. Limit Switch opening due to excess temperature rise in furnace. Check for blocked or restricted discharge ducts. Check for minimum number of ducts as recommended:

Models	Min. Ducts Recommended
65917, 65925	2
65925, 65930	3
65940, 65941	4
90020	2
90025, 90030	3

2. Short cycling Thermostat. Thermostat should be located where it will not be exposed to warm air from a register or any other source of heat, as this will cause the thermostat to open before the room air temperature reaches the set temperature. If necessary, relocate the thermostat, or direct air from the register away from the thermostat.

Also, check the heat anticipator setting in the thermostat. If the setting is too low it could cause thermostat to short-cycle. Refer to the Owner's Manual for the correct anticipator settings for each model. If a longer heat cycle is desired, set anticipator to a higher setting.

**CIRCUIT SCHEMATIC**  
**For 120V. AC Models with 24V. AC Control Circuit**

