TROUBLESHOOTING

INTERMITTENT IGNITION SYSTEMS FOR GAS FURNACES AND BOILERS

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These procedures are for the checkout of all systems using an intermittent pilot. It should be noted that some of the checks could also be applied to Direct Spark Ignition Systems. These are things that should be looked at as preliminary checks before proceeding with troubleshooting charts and wiring diagrams. Many of the checks are visual or done with the power off and using an Ohmmeter. In order to understand the principles of many of the checks it is important to understand some of the terms that are used. We include a set of definitions.

The definitions also include two important rules for replacement of existing controls. Under the definition for <u>Timed trial for ignition</u> there is a rule for replacement that says - you can replace a module with one with a lesser time, and for <u>Pre-purge</u> a rule which says when replacing a module you may go to a longer time these two rules give some flexibility when replacing controls.

DEFINITION OF TERMS

<u>Response time</u>: For a thermocouple about 180 seconds IID systems .8 of a second

<u>Lockout</u> - at the end of trial period a safe shut down of all systems. Must shut off then reestablish electrical power for retry.

<u>Non-lockout</u> - also called Continuous Trial for Ignition. The

system just keeps sparking until ignition is established.

<u>Continuous retry</u> - 90 seconds trial for ignition, then 5 minute shut off then retry.

<u>Timed trial for ignition</u> - the time a system will try for ignition, it varies with manufacturer. When replacing always go to the lesser time if module with correct time is not available.

<u>Pre-purge</u> - time when systems is not up and trying for ignition. During this time any residual products of combustion will be forced out of the chamber. When replacing module if time you need is not available go to longer time never shorter.

<u>Post-purge</u> - time after burner operation when blower continues to run to force any residual products of combustion from the chamber.

<u>Interpurge</u> - Thirty second period between trials for ignition when both gas valve and igniter source turn off and the inducer is on allowing unburned gas to escape before the next trial. (Occurs only if ignition was not successful during the previous trail)

<u>Self-Healing</u> - (Special feature on some Integrated Fan Controls) If the system fails to light on the first try because of an open limit; before the second trial the induced draft blower and system fan will come on for 180 seconds then start the ignition sequence again. If the first ignition attempt fails during a normal heating cycle sequence, the control will activate a "self healing" over temperature correction cycle before the next trial for ignition.

<u>"Soft" lockout</u> - if the burner fails to light after three tries the system will shut down; wait 60 minutes (some systems could be longer up to three hours) it will then go through an ignition sequence again, this will repeat indefinitely.

Shutdown - this means that it will retry again without having to interrupt power.

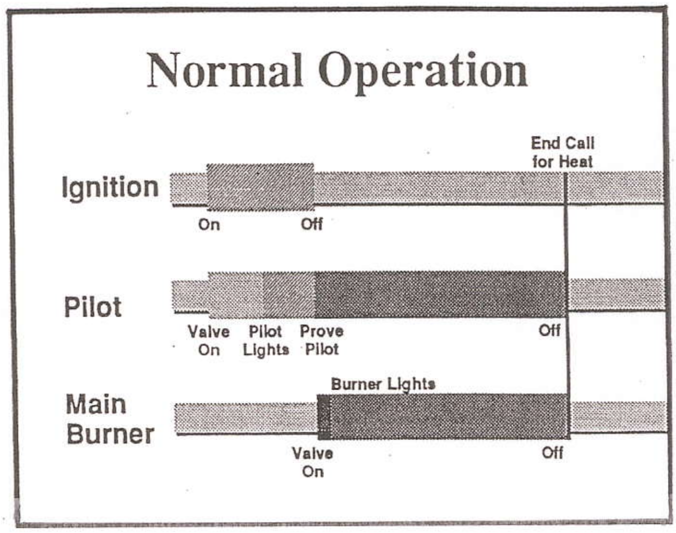


Figure 1

Intermittent pilot sequence of operation illustrated in Figure 1.

- **<u>Pilot Valve</u> and <u>ignition</u> come on together when the thermostat calls for heat**
- **<u>Main burner</u> opens only when pilot is proved and remains open throughout the call for heat**
  - **pilot valve and main valve close together**

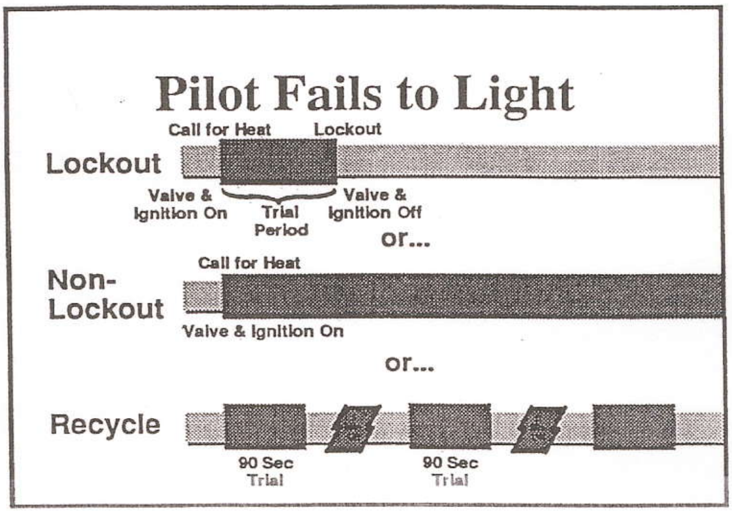


Figure 2

Pilot falls to light

- There are several possibilities as shown in Figure 2 if the pilot fails to light depending on the sequence of operation selected for a particular application

Lockout

- At end of trial period
  - Pilot valve closes
  - Ignition turned off
  - Main valve remains closed
- Typically 90 seconds but can be different
  - Honeywell usually 90 (a few 180)
  - Robertshaw uses 60, 90 or 120
  - White-Rodgers usually 90
  - Penn-Johnson many different timings from 8 to 120 seconds
- Requires manual reset
  - Turn thermostat down or remove power

Non-Lockout

- Also called "Continuous Trial"
- Pilot valve remains open
- Spark ignition continues indefinitely
- Was used for natural gas only; cannot be applied to LP

Recycle

- Timed trial period alternates with waiting period
- For Intermittent pilot ignition this can continue without lockout
  - for either Natural or LP
  - Extensive testing by Honeywell shows that the pilot alone can never accumulate a combustible level of gas outside the furnace or boiler
- Typically 90 second trial and 5 minute wait period
- Advantages of both:
  - Lockout: Flow of gas in interrupted after 90 seconds

- Continuous trial: No lockout to cause nuisance shutdowns

The Recycle or Retry version as it is often called replaces both the lockout and continuous try versions.

Control manufacturers other than Honeywell may have different Trial for Ignition times such as 25 seconds, 45 seconds etc. All however will have the 5 minute shut off.

This by no means concludes the Troubleshooting of these systems. In the next chapter we go into a "Checkout For All Systems" which is a generic troubleshooting process designed to function as a set of preliminary checks to be done on every call. These checks will typically find about 90% of all problems. Many of those checks are done with the power off and using the Ohms scale of the meter.

CHECKOUT FOR ALL SYSTEMS

In establishing a procedure for troubleshooting it is important to first know the operating sequence of the system. In addition a wiring diagram of the system is very helpful. Finally if there are additional diagnostics provided by LED's or any other means surely use them.

In this chapter we go into a "Checkout For All Systems" which is a generic troubleshooting process designed to function as a set of preliminary checks to be done on every call. These checks will typically find about 90% of all problems. Many of those checks are done with the power off and using the Ohms scale of the meter.

It is recommended that these checks be carried out on every call no matter what the complaint.

CHECKOUT FOR ALL SYSTEMS

CHECK OUT FOR IGNITION CABLE

1. **Not touching metal surfaces**

2. **No more than 36" long**

3. **Connections clean and tight. The "kanthal" rod should be cleaned with a soft clean emory cloth.**

4. **Visual Inspection - no cracks, breaks in ceramic. The igniter cable is not dried out or cracked. The boot is in good condition. If there is a white powdery substance on the cable that is the result of ignition cable "outgassing" the cable should be replaced.**

The next set of checks will require a multi-meter set on the OHMS scale. It is very important to understand that these are preliminary checks that should be done on every service call on these systems. The failure to check each item carefully can surely result in a call back. Many of the sometimes difficult to find problems will be isolated by these checks. Those problems, which are erratic by nature, will also many times be diagnosed and corrected by carrying out these checks.

IGNITER CABLE CONTINUITY

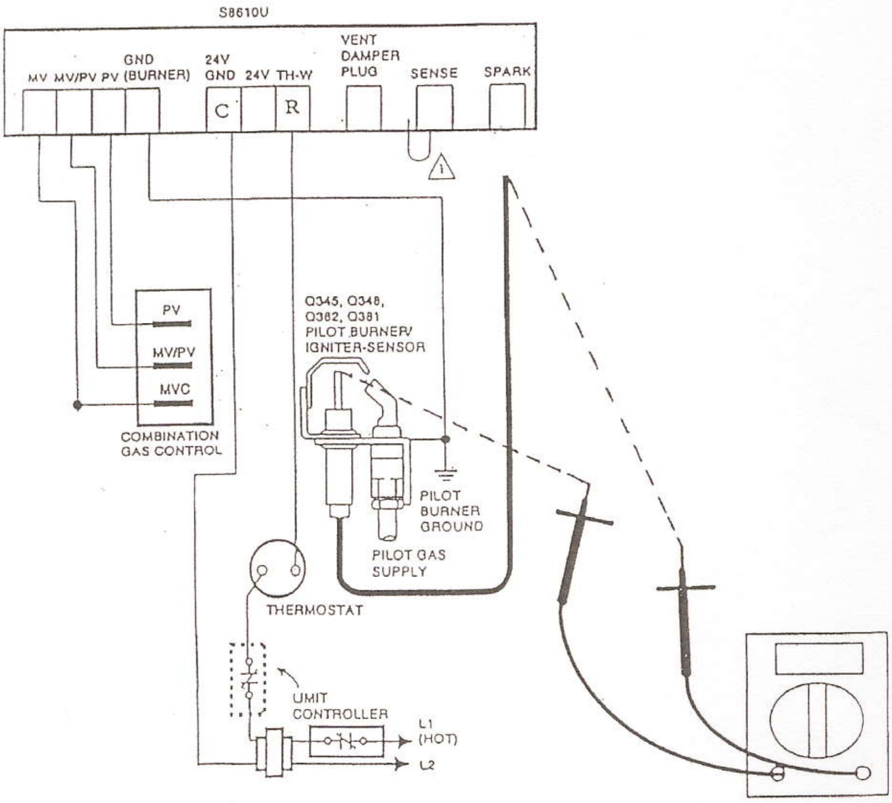
1. **Set the meter on the ohms scale**

2. **You should have continuity from the tip of the igniter at the pilot to the connector on the other end. See the illustration on page 9-a.**

3. **If you do not them replace the cable, keep in mind that on the single rod system the high voltage spark signal (20,000 to 30,000 volts DC) can actually jump across a break in the cable but the very low microamp flame signal cannot.**

4. It is also a good idea to run the meter lead up and down the igniter tip at the pilot looking for an increase in resistance. The normal resistance for cable and igniter should be around .1 to .2 OHMS. While doing this observe also if you break continuity in any case if so replace the igniter and cable.

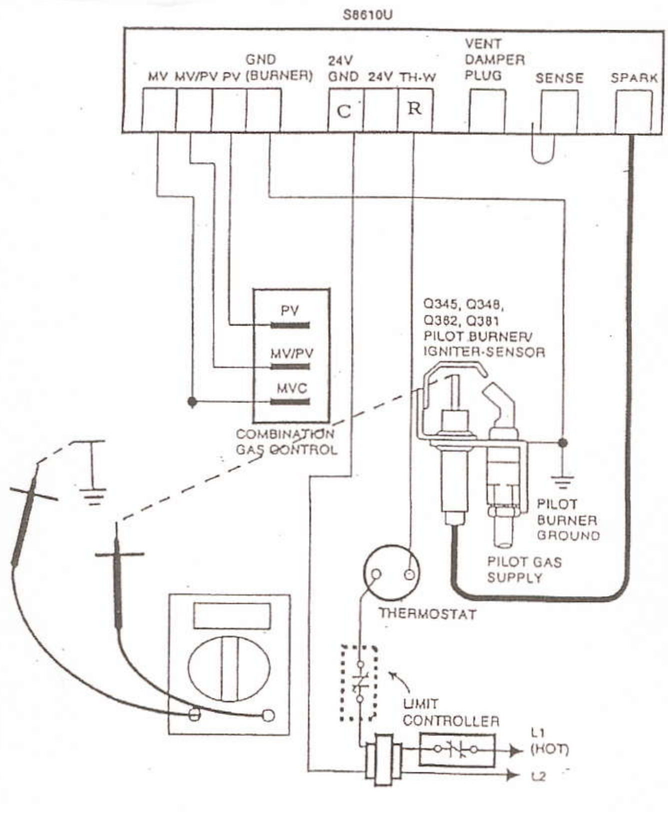
SINGLE ROD SYSTEM



SHORT TO GROUND/GROUNDED IGNITER CABLE

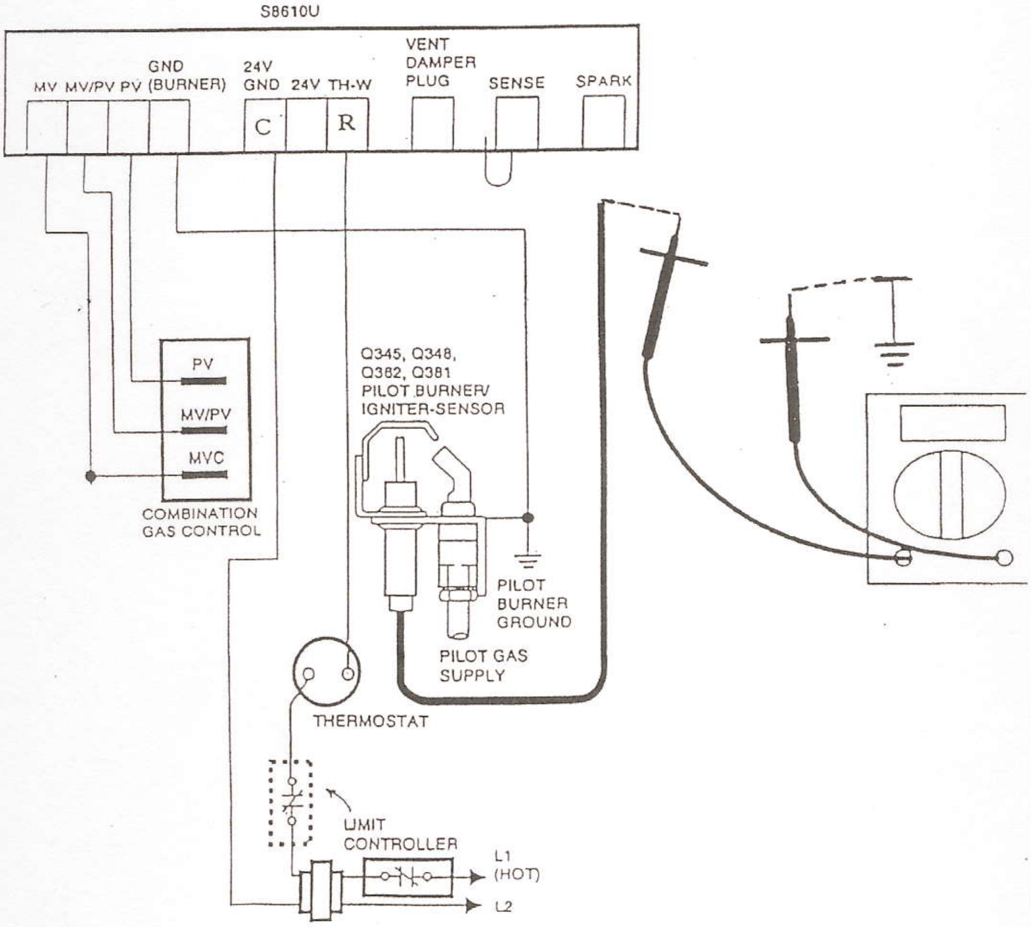
Go from the tip of the igniter to ground - you should not have continuity - if you do it is shorted to ground at some point. This would cause a no spark or weak spark condition. Keep in mind the short could be in the cable or it could be in the module. See page 31 for procedure to check for which is the problem by process of elimination.

SINGLE ROD SYSTEM



In order to narrow down what may be grounded, either cable or somewhere in the module, remove cable from the module and check from the connector end to ground. If it shows continuity then the cable is grounded somewhere. If the previous test showed continuity to ground (a short) and this test does not then the module is suspect for an internal short to ground.

SINGLE ROD SYSTEM



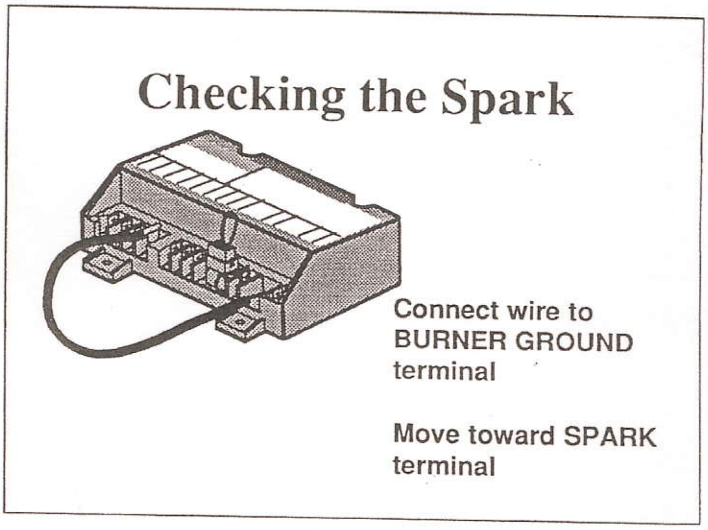
CHECK FOR INTENSITY OF SPARK

1. **Remove igniter cable from the module connection.**

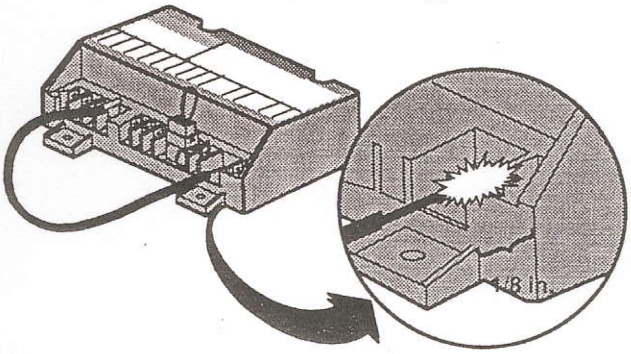
2. **From the module connection to the igniter cable an arc should jump at least a 1/2" gap.**

3. **The spark gap on most systems from the tip of the igniter to the ground connection is 1/8". If the spark will jump across 1/2" with good intensity it should be able to jump across 1/8" with no trouble at all.**

Note: - Hold the igniter cable with insulated pliers and slowly move the connector on igniter cable toward the high voltage connection on the module with the module energized. The spark should jump across the open gap.



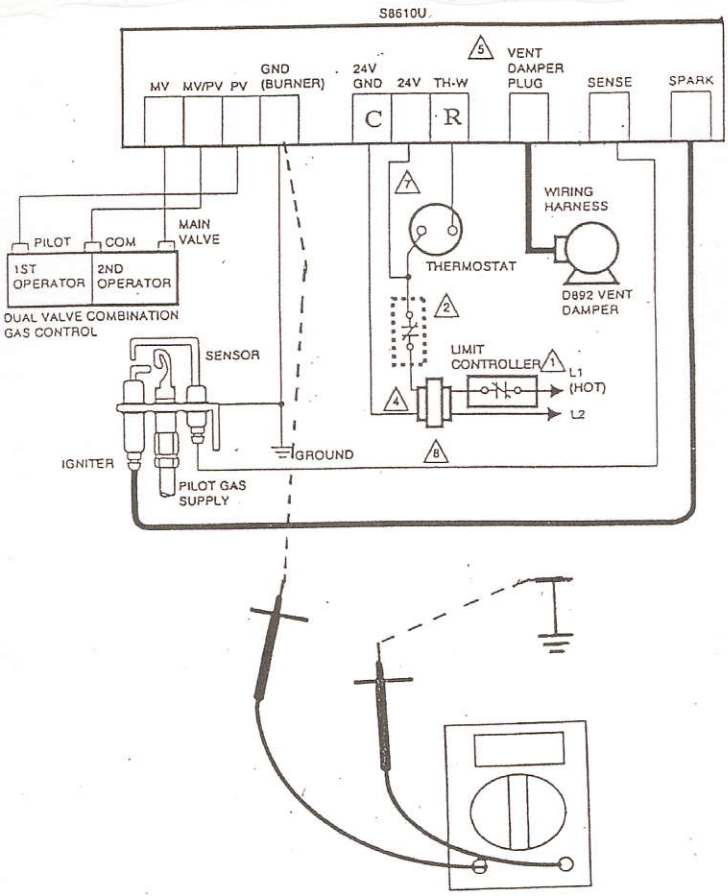
Checking the Spark



IGNITION SYSTEM GROUNDING

Nuisance shut downs or no operation at all can be caused by a poor or erratic ground connection.

1. **From the ground (GND), usually green wire, terminal on the module check for continuity to some portion of the boiler or furnace. It is best to check on an unpainted and clean surface. The gas pipe is a good point. YOU SHOULD HAVE CONTINUITY! ! If you do not then you could experience erratic or no operation at all.**
    a. **It may be necessary to establish a good connection to ground by using a wire with a clamp onto the gas line or equipment chassis and connecting it to the ground terminal of the module. All connections should be clean, unpainted and good metal-to-metal contact. When you look at the wiring diagram for the equipment and see this type of symbol showing the use of a chassis ground be careful that you have a good connection.**



DUAL ROD SYSTEM

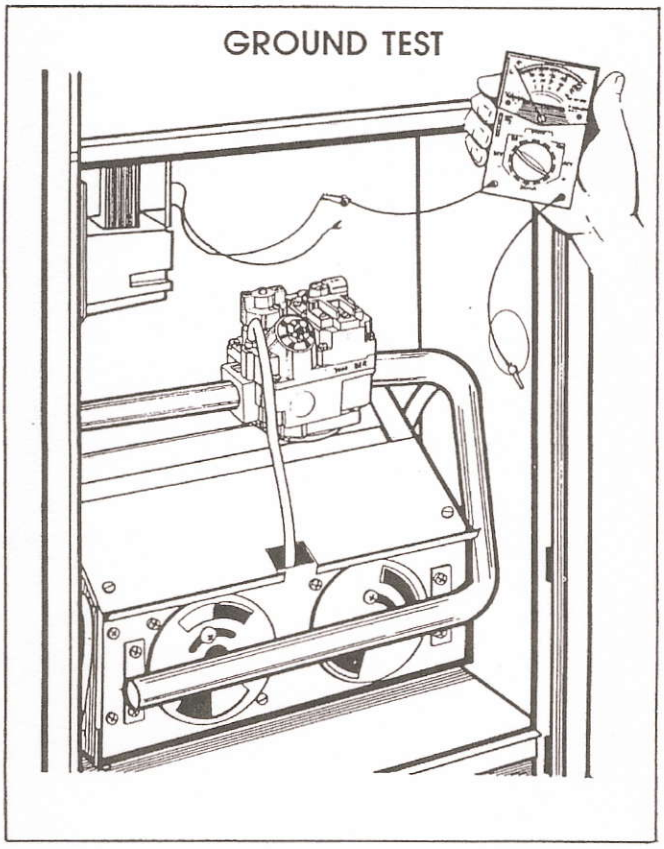
THESE CHECKS ARE GOOD FOR EVERY PIECE OF EQUIPMENT THAT USES ANY TYPE OF IGNITER CABLE.

CHECKING FOR POWER AND PROPER ELECTRICAL POLARITY

This next check is the beginning of your electrical checks and is best done at the secondary of the 24-volt transformer. Many transformers today have the terminals on the secondary labeled "C" and "R" this will assist you with this check. If this check indicates that in fact "R" is 24 volts and "C" is zero (0) volts then the primary polarity is correct. If it indicates the opposite then the primary wiring needs to be corrected: example the black wire on primary side should be hot the white wire neutral (ground) or zero volts.

Once all of these preliminary checks have been completed then the electrical troubleshooting of the system should begin.

The manufacturers sequence of operation, connection wiring diagram, ladder diagram and any trouble "trees" that are available should be used along with a good multimeter.



Power supply

- **Module runs on 24 volts**
- **Modern heating equipment is complex enough so that it's necessary to keep transformer leads identified and properly wired**
  - **C on transformer goes to 24V (GND)**
  - **C is connected internally (in the module) to both Burner GND and MV/PV**
- **If connected wrong transformer can be burned out, because one side of the transformer is grounded somewhere in the control wiring**
  - **You can check this by measuring the voltage from each transformer terminal to ground**

    24 volts = hot side R

    0 volts = ground side C

Polarization and Phasing

Polarization of power supplies and phasing of primary to secondary voltage on transformers is important. Solid-state electronics used in furnaces today demand that the power supply be correctly polarized. Polarization is not a new concept; the three-prong plug used on appliances is for this same purpose. The "hot power leg", or "L 1", from the power supply must be hooked up to its counter part in the furnace junction box. Furnaces that utilize flame rectification for flame sensing must be correctly polarized, or they cannot sense the presence of the flame.

To check for proper polarization of the power supply, check for proper voltage at the supply with a voltage meter. The "hot leg" should read 120 volts to ground when checking as shown in illustration A. The neutral leg should read 0 volts from it to ground. When the proper identity of the power supply leads have been determined, they should be wired to the corresponding points in the furnace junction box (or terminal board).

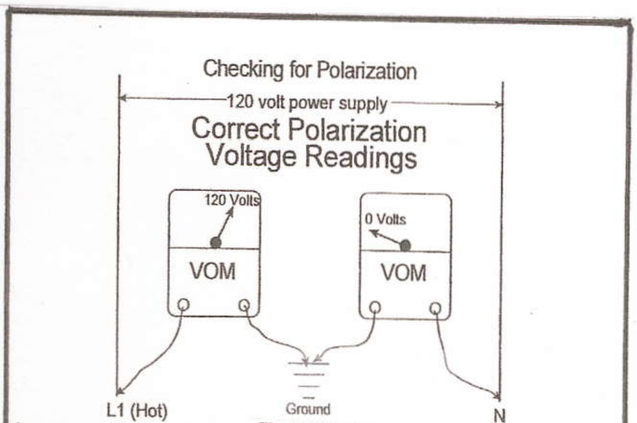


Illustration A

Phasing of the primary winding with the secondary winding of a transformer is required for some solid-state units. While polarization is familiar to most technicians, phasing the windings of a step down transformer is not.

Checking for proper phasing of primary to secondary windings of unmarked transformers can easily be accomplished by using a voltage meter. Units that must have their step down transformer phased have the common from both the primary and secondary windings connected to the cabinet ground. When checking voltage from the "hot leg" (L1) of the primary winding, to the "hot leg" (R) of the secondary winding, the voltage should read the primary voltage minus the secondary voltage or around 96 volts. If the connection were not correct then the reading would be L1 primary plus secondary or 144 volts approximately. Illustration B shows how a typical transformer's primary and secondary is hooked to the cabinet ground. Approximate voltages are shown for each winding.

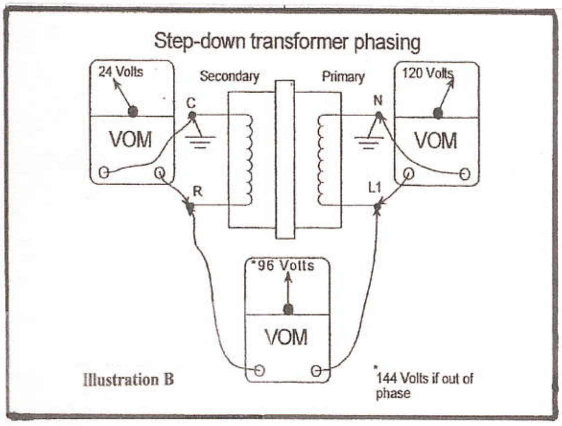


Illustration B

Transformers that are not phased have a voltage that equals the primary voltage plus the secondary voltage. Illustration C shows electrically what is taking place when this reading is found. To correct

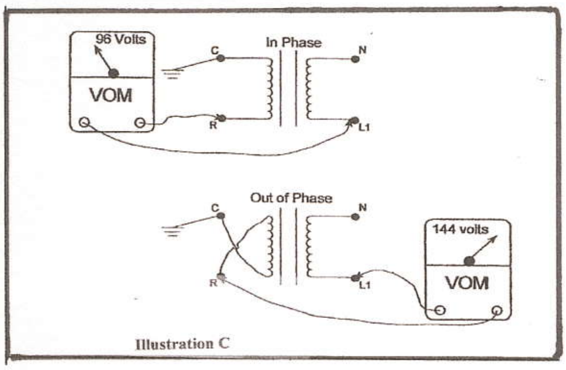


Illustration C

an out of phase transformer, reverse only the secondary winding leads.

Caution: If both the primary and secondary leads are reversed, the transformer remains out of phase.

After switching the secondary leads check for proper voltages again.

Note: When identifying a transformer that is not installed, it is important to have the common of the primary winding and the common of the secondary winding connected for testing purposes.

Manufacturers are starting to identify transformers that must be phased. Furnace manufacturers are using transformers with identifying markings on them and schematics are starting to use the phasing symbol shown in illustration D. Supply houses will be slow to replace their stock of unmarked transformers. Technicians must become aware of the importance of phasing and check for proper phasing as a normal service routine.

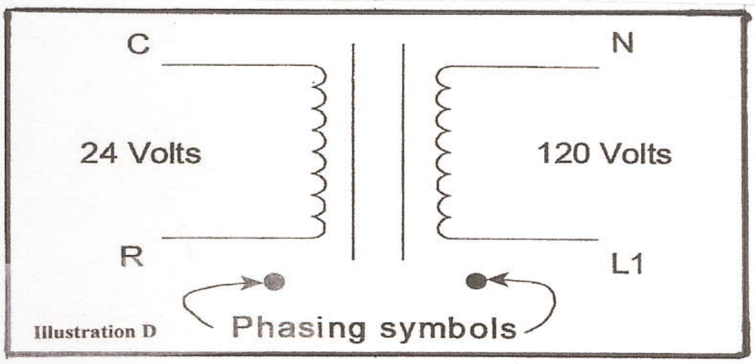
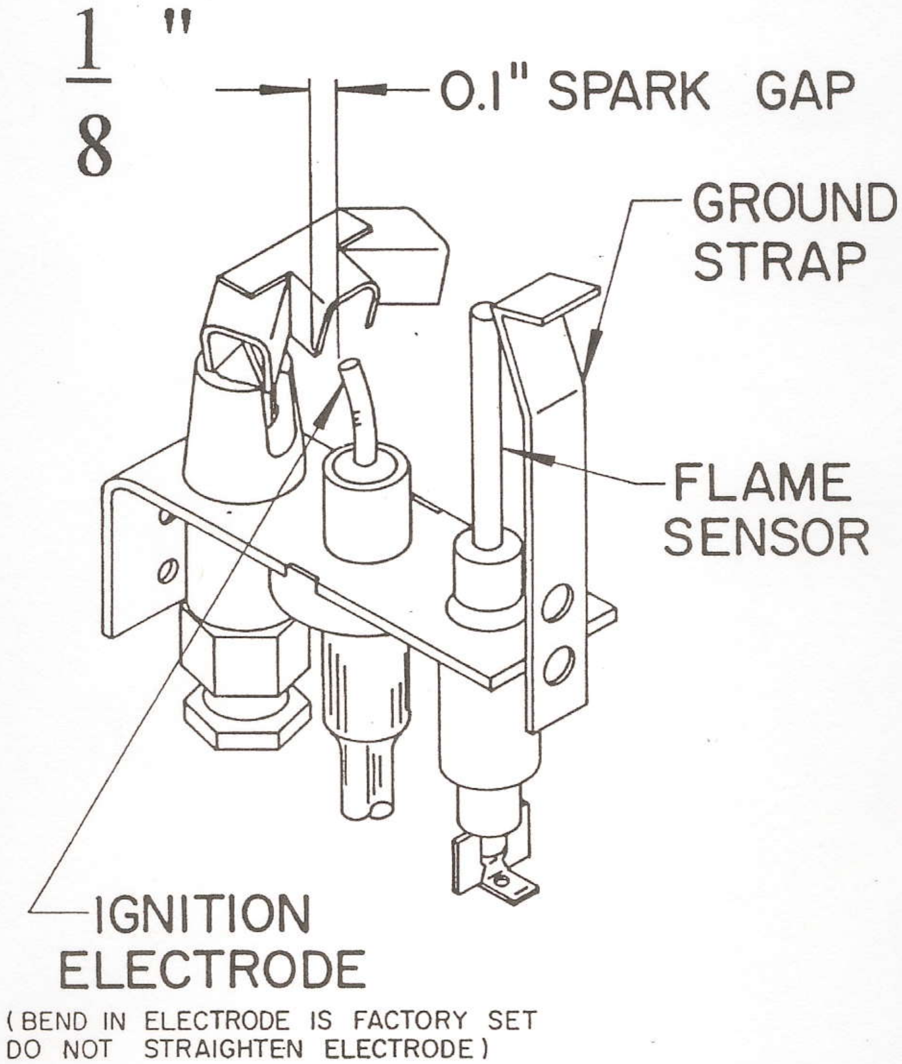


Illustration D



CORRECT SPARK GAP SETTING ELECTRIC IGNITION

CHECKING

MICROAMPS

CHECKING MICROAMPS

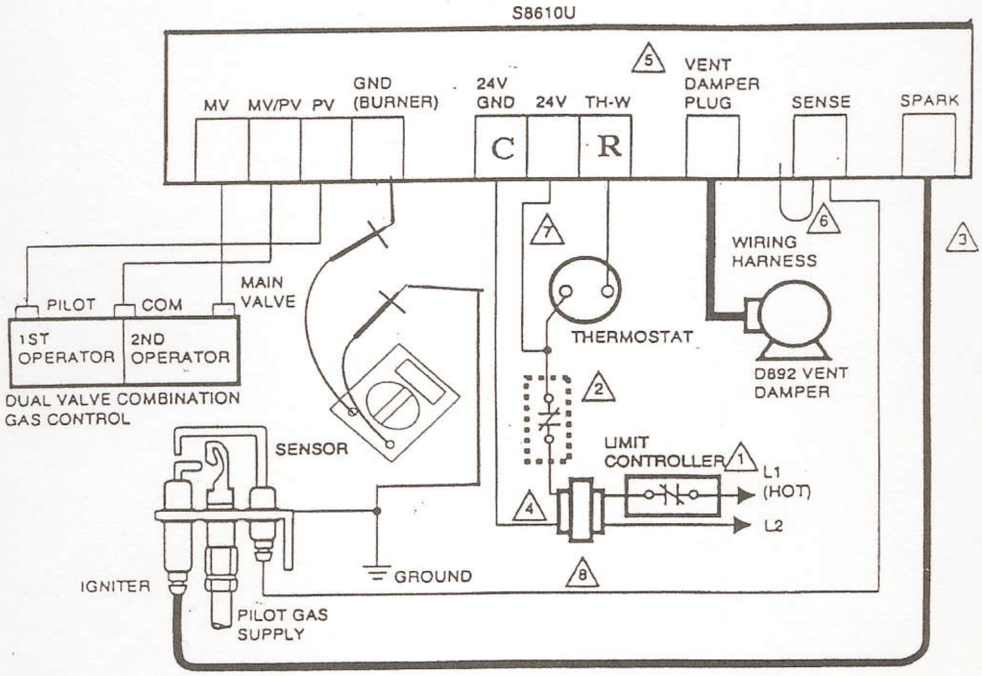
The following section is to illustrate what is required when measuring microamps. The microamp signal is developed through the process of Flame Rectification.

Rectification requires that the pilot flame be a soft blue flame enveloping the upper ½ to 3/8 of the flame rod. Systems are either single rod systems (proprietary to Honeywell) or they are dual rod systems. Single rod systems are also described as local sense or direct sense. Dual rod systems are often called remote sense or indirect sense systems. In either case the microamp signal is measured by placing the multimeter set to the microamp measuring scale in series with the output from the flame. This is accomplished by breaking in the "burner ground" or "sense" wires (in series) with the pilot lit and operating to measure this very small signal. Normal range is 2 to 10 microamps on most systems. Normal is around 3 to 5 microamps.

If the microamp signal strength is below the readings defined here then it may be necessary to clean the pilot or clean the flame rod with some soft clean emory cloth. If the microamp signal is being produced by the pilot flame as specified and the main burner is not coming on then check the voltage output from the module to the gas valve, if no voltage is present then the module must be replaced. If the voltage is present then check to see if voltage is getting to the gas valve if so and the valve does not open then the valve is bad and will need to be replaced. Assumption made here are that the gas is on, pressures are correct and the gas system is functioning correctly as to pressure at the outlet and inlet of the gas valve if that is able to be measured.

In Figure 39 we show the procedure for measuring microamps with a dual rod pilot. The multimeter can be placed in series with the burner ground wire or the sense wire, either one gives the same reading.

DUAL ROD SYSTEM

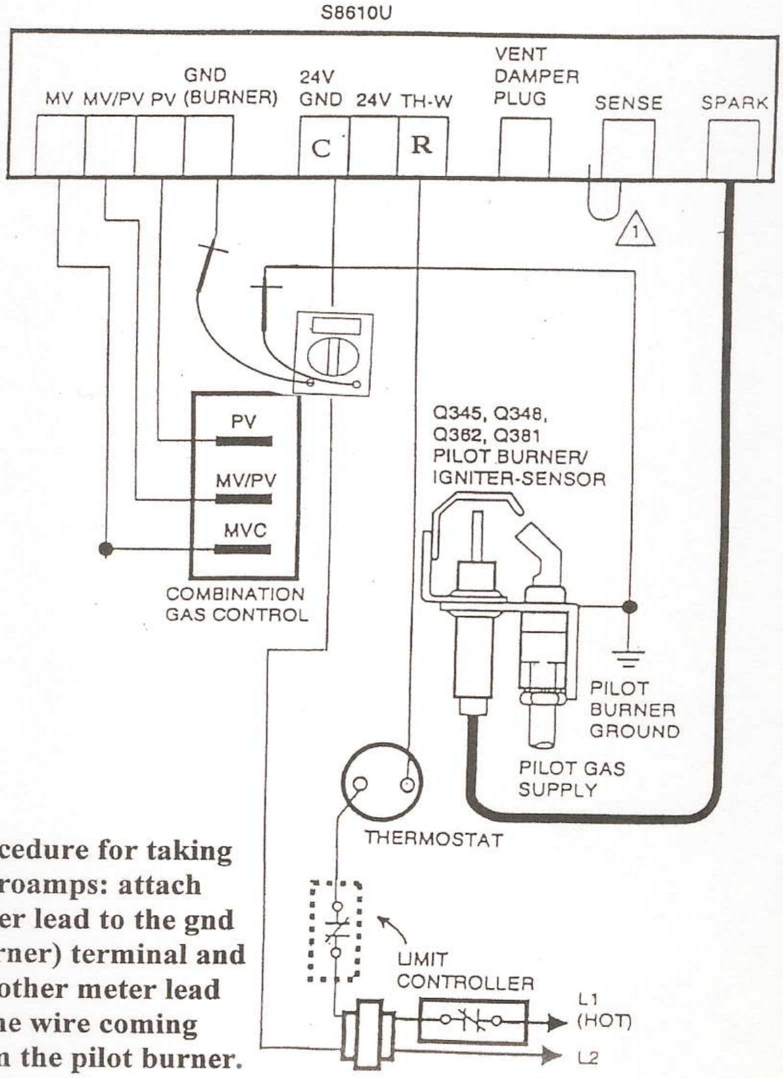


Procedure for taking microamps: place the microamp meter between gnd (burner) connection on module and the wire coming from the pilot burner. You could also place it on the sense terminal and attach the other side of microamp meter to the wire coming from the sensor at the pilot.

Figure 39

Figure 40 is the correct wiring with a single rod (local sense) pilot. The microamps are measured by placing the meter in series with the wire from burner ground and the burner ground terminal on the S8610U module.

SINGLE ROD SYSTEM



Procedure for taking microamps: attach meter lead to the gnd (burner) terminal and the other meter lead to the wire coming from the pilot burner.

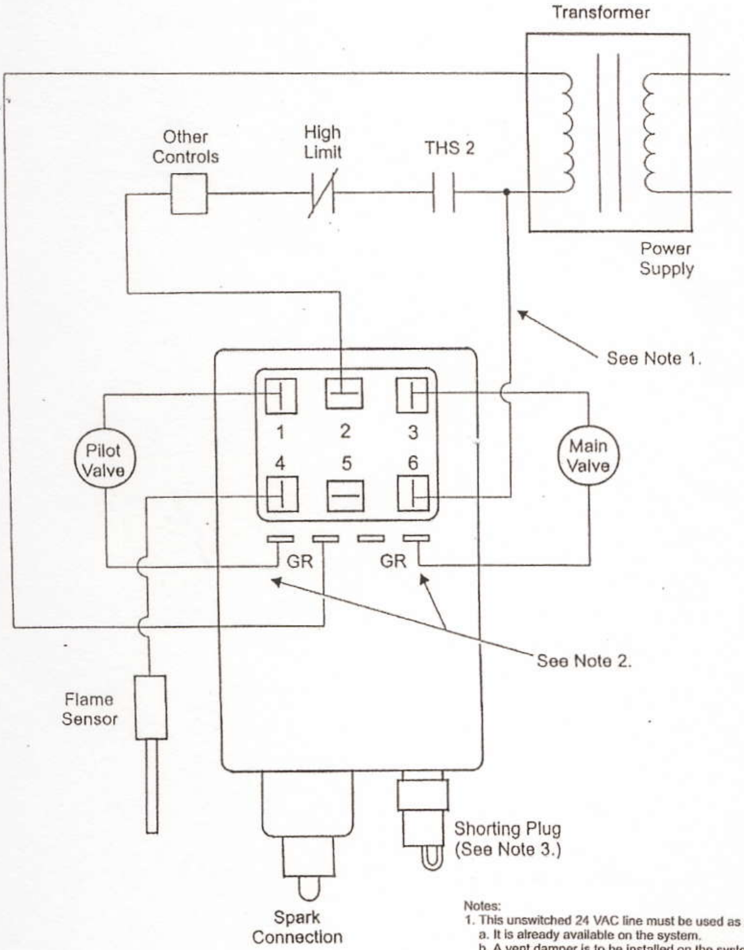
Figure 40

In Figure 10 we have the typical wiring of the Johnson Controls module. Instead of designating terminals they use a numbering system. To compare to other manufacturers designations for terminals it would follow this pattern:

Terminal 1 – Pilot Valve (PV)
Terminal 2 – Thermostat (TH)
Terminal 3 – Main Valve (MV)
Terminal 4 – Burner Ground (Sensing)
Terminal 5 – MV/PV (varies with modules) Ground
Terminal 6 – MV/PV (varies with modules) Ground

The ground (GR) terminals are attached to the body, which is metal. This insures good ground with this system, no matter if it is valve mounted or cabinet mounted.

This module also has the capability to have a vent damper connected, see the notes attached to the diagram.



Notes:
1. This unswitched 24 VAC line must be used as shown if:
   a. It is already available on the system.
   b. A vent damper is to be installed on the system.
   Otherwise, omit the 24 VAC line and connect Terminal 5 to 6 with the jumper provided.

2. If the G600 is mounted directly to a valve having two leads numbered 1 and 3, it is internally grounded and does not require the ground connection shown.

3. Shorting plug installation instructions:
   a. If the original control was not connected to an external control (i.e., M35) through the 6-pin receptacle, the shorting plug must be inserted.
   b. If the original control was connected to an external control through the 6-pin receptacle, reconnect as found and discard the shorting plug.

Wiring Diagram for Non-100% Lockout G600

Figure 10

OPERATING SEQUENCE

In Figure 11 the schematic diagram for the non-lockout system is shown. On a call for heat from the thermostat, which is wired off the "R" terminal on the transformer as, is also the Red Heyco connector to insure proper polarity. The other side the "C" terminal (ground or common) is wired to the Blue Heyco and also terminals 5 and 6. Then 24 volts will be sent to terminal # 2 on the module. The 24 volts then goes through the internal fuse in the module. This fuse is in the module for use when a vent damper is connected. It blows on the first call for heat with the damper attached, that way the system can never operate unsafely in the event the damper is removed. In other words the damper must be connected in order for the system to work. The 24 volts after going through the fuse goes through the dummy plug to normally closed R3, it splits off in two directions one to power the Q relay coil to terminal 6 which is ground this will pull in relay contact Q1. The 24 volts is also applied to the spark circuit through normally closed R1. Power is also applied to terminal 1 which brings in the pilot valve. The pilot gas is flowing and is ignited by the spark. When the flame is proven through the number 4 terminal the sensing circuit is energized by the microamp signal created by the pilot. This causes relay R to be energized which opens (NC) R1 shutting off the spark and (NC) R3 also opens but a circuit is maintained through contact Q1 which will keep the PV valve open. Relay contact R2 that was normally open now is also closed powering the number 3 terminal and brings in the main valve MV.

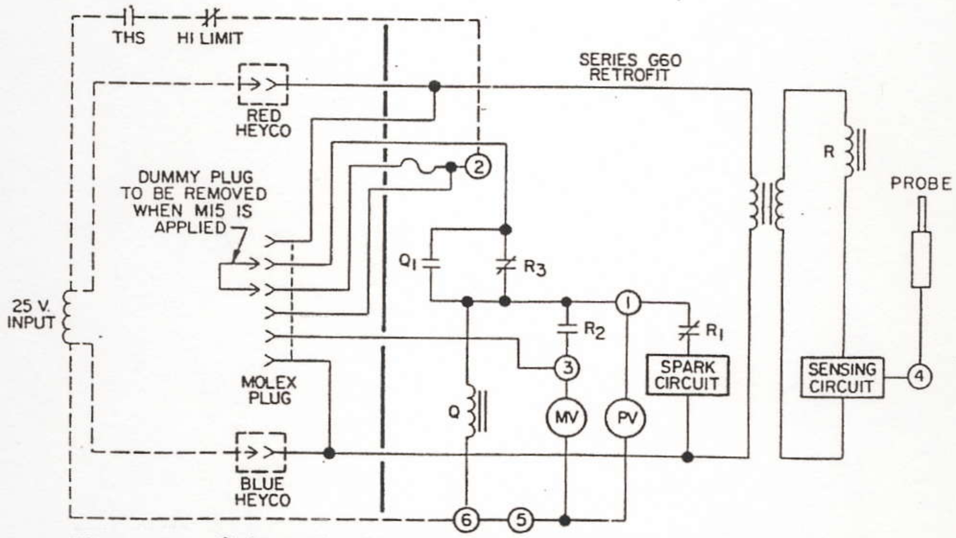


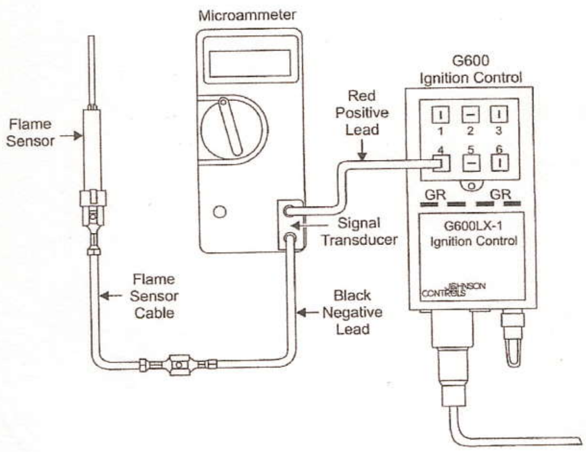
Figure 11 —**Schematic wiring diagram of the ignition control system.**

TROUBLESHOOTING

Using the diagram in Figure 11. With a multimeter set on AC volts ground one lead of the meter to #6 terminal. With the thermostat calling

you should have 24 volts at terminal #2. The system should be sparking and there should be 24 volts at terminal #1. The pilot gas should ignite and you then should have 24 volts at terminal #3. The main burner should come on and the spark should cease.

If you do not get a spark with 24 volts applied then the module is bad. If you get a spark and the pilot lights and then the spark ceases and you have 24 volts at terminal #3 but the valve does not open then the valve is bad. If you get spark and the pilot lights but the spark does not stop then you have a sensing circuit problem. This will require you to take some microamp readings. Figure 12 illustrates the procedure for hooking up the multimeter to test for proper microamps. There should be somewhere between 2 to 10 microamps 3 to 5 in normal. The sensing terminal #4 is the proper place to connect to.



Wiring Diagram Showing Negative Lead Connected to Flame Sensor and Positive Lead Connected to Series G600 Ignition Control

Figure 12

FLAME SENSING CURRENT MAINTENANCE

Flame sensing current is a requirement for proper operation of an electronic ignition control. If the current reads below the required minimum (See Figure 13), corrective maintenance of the flame sensing current circuit increases the signal. The flame sensor is made of carbon steel and is prone to contamination and oxidation buildup. Because the flame-sensing signal is such a small current, any buildup on the sensor adds resistance and may drop the signal below the required minimum.

Carbon and oxidation can also build up on the pilot hood and because flame-sensing current flows between the flame sensor and pilot hood, it is important to keep both clean. Clean the flame sensor with steel wool or an emery cloth. Clean the pilot hood with a small wire brush to remove any carbon or oxidation buildup. Replace the flame sensor if the ceramic portion is broken or if the contamination is extensive.

Minimum Current Requirements

Product Number	Minimum Flame Sensing Current Required for Relay Pull-In
Original Controls	
G60 (All Models)	0.7 Microamps DC
G65 (All Models)	0.2 Microamps DC
G66 (All Models)	
G67 (All Models)	0.2 Microamps DC
G770 (All Models)	0.15 Microamps DC
Replacement Controls	
CSAs (All Models Except CSA 45A-601R And CSA 51A-601R)	0.7 Microamps DC
CSA 45A-601R CSA 51A-601R	0.2 Microamps DC
G600 AX, AY	
G600 KX, LX, LY, MX, NX, RX	0.15 Microamps DC
G670AW	0.2 Microamps DC
G770 (All Models)	0.15 Microamps DC

Figure 13