RESIDENTIAL ELECTRONIC IGNITION SYSTEMS

by Marcus G. Metoyer, Jr., CMS

INTRODUCTION

The information contained in this publication is generic in nature. It may or may not illustrate a given manufacturer's recommendations for a particular product. Always follow manufacturer's instructions, specifications, and service/safety practices.

Never do anything while working on a furnace or boiler that would place you or anyone else in danger. Before leaving a system unattended, be certain that all items have been tested according to the manufacturer's specifications and industry standards. Be aware of a lack of combustion air, poor system venting, heat exchanger leaks, fuel leaks, or combustibles that may be stored around the appliances.

Always check *all* safety devices on each visit to a customer's home or place of business.

DEFINITIONS

microampere One microampere (1 µA) is one one-millionth of an ampere (0.000001 A), and indicates the flame signal of a system that proves flame through flame rectification.

flame signal Systems that utilize flame rectification for the sensing method (see pages 4–5 for a full description) require a technician to measure the current that passes through the flame. The amount of current that passes through a flame signals to the ignition controller that flame either has or has not been sensed. Flame signal is measured in microamperes of direct current. It varies with the control, usually ranging from about 0.012 µA dc to 25.0 µA dc, depending on the controller specifications. Flame signal is measured with a microammeter in the ground wire for most local sensing control designs, or in the sensor wire for most remote sensing systems.

MV Main valve terminal

PV Pilot valve terminal

MV/PV Main valve/pilot valve terminal (also called COMMON by some manufacturers)

prepurge The period after the call for heat is initiated and before the trial for ignition period begins. Used mainly on draft-induced furnaces and boilers so that the heat exchanger may be evacuated (e.g., of unburned gases) before the spark begins on IID or DSI systems, or before the HSI begins its warm-up cycle.

lockout The ability of an IID control to close both the pilot valve and the main valve in the event that flame is not proven in a given amount of time. Every LP-fired IID system must have lockout built into its ignition controller. An IID system fired by natural gas may or may not incorporate lockout into its controller design (this feature is manufacturer-dependent). Because DSI and HSI systems light the main burners directly (not just a pilot as with IID), these systems always employ 100% lockout with very short elapsed times before shutdown if the flames have not been proven.

retries The number of times a control will attempt ignition before going into lockout. Multiple retries can prevent nuisance lockouts.

trial for ignition The safety timing period for which a control will attempt to light the pilot in an IID system, or the period for which the control will attempt to light the main burner(s) in a DSI or HSI system. Some natural gas-fired IID systems have a continuous trial for ignition period. If the pilot does not light in such systems, the control will try continuously to light the pilot. Lockout will not occur with a non-100% lockout IID control if the

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pilot fails to light—it will try continuously to light the pilot. Remember that LP-fired IID systems must always employ 100% lockout, which means that there is a finite trial for ignition period, not a continuous trial for ignition.

Be aware that natural gas is lighter than air. If the pilot fails to light on a non-draft-induced appliance that burns natural gas, the gas will be vented to the outdoors. By contrast, LP gas is heavier than air. If the pilot fails to light, the gas will fill the basement or mechanical room up to the first point of ignition, and an explosion will result.

Natural gas or LP-fired appliances can employ 100% lockout systems. Non-100% lockout controls should be used on natural gas-fired, non-draft-induced systems only if the original equipment manufacturer installed them on the appliance to begin with. When in doubt, use 100% lockout controls for natural gas as well as LP appliances.

Warning: Never select a replacement ignition control that has a longer trial for ignition period and/or more retries than the original. Be sure to follow manufacturer's instructions.

RESIDENTIAL GAS APPLIANCE IGNITION SYSTEMS

There are four types of ignition systems that the HVAC industry has used for many years. Their overall purpose, regardless of type, is to light the main burner or burners safely and to continue supervising the process to be certain that the system remains safe. The four systems employed are:

- *Standing pilot.* A continuously burning pilot light ignites the main burner(s) if and when there is a call for heat. These systems may use a thermocouple or bimetallic element to sense whether the pilot is properly lit before the main gas valve is allowed to open and provide gas to the manifold. Because a standing pilot uses gas even during OFF cycles, IID, DSI, and HSI systems were developed to eliminate this waste.

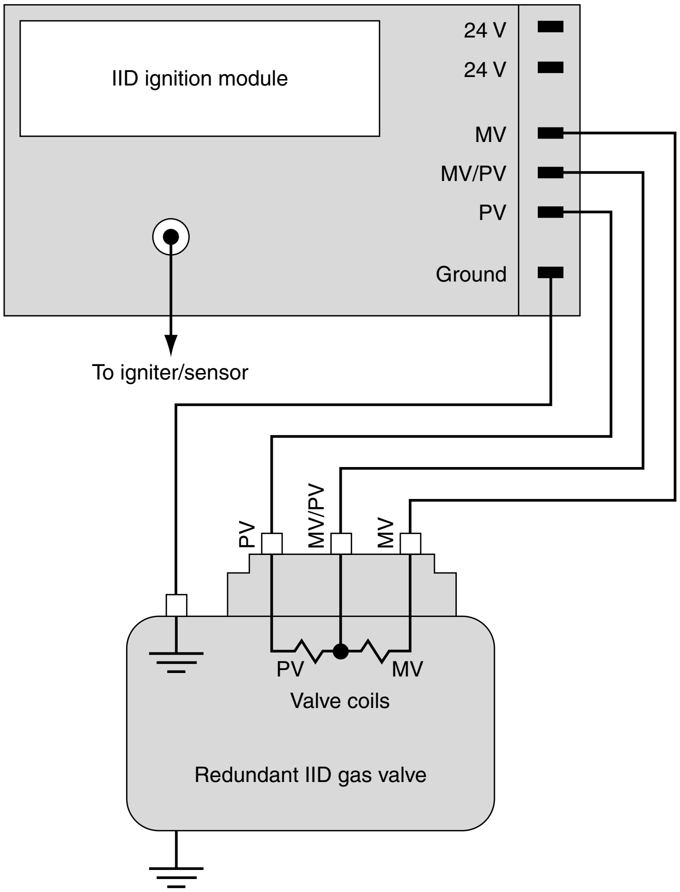


Figure 1. Typical IID module/gas valve wiring

- *IID (intermittent ignition device).* IID systems light a pilot and then the main burners only after the pilot has been proven to be lit, usually either through flame rectification or thermal detection. When a call for heat ends, the pilot valve closes, interrupting gas flow to the pilot. If the system utilizes natural gas, these systems may or may not be 100% lockout, depending on the manufacturer. LP gas-fired appliances must be 100% lockout if the pilot is not proven to be lit within a relatively short period of time. IID gas valves normally have three electrical connection terminals. As shown in Figure 1 above, they are the PV (pilot valve), MV (main valve), and MV/PV (or common). Some flame rectification systems use a separate sensor and igniter, called *remote sensing*, while others use a combination igniter/sensor, referred to as *local sensing*.

- *DSI (direct spark ignition).* DSI systems are so called because they light the main burners directly with a spark igniter. All systems have a short time (only a few seconds) to prove that the main burners are lit. If they do not light within this short safety period, the control will shut off the system automatically. In order to prevent nuisance lockouts, dome systems will try to relight the burners for a predetermined number of times. Flame rectification is used with DSI systems. DSI systems are 100% lockout whether the system is natural gas or LP-fired.

- *HSI (hot surface ignition).* Most HSI systems light the main burners directly with a silicone carbide igniter (hot surface igniter). In other respects, HSI systems are similar to DSI systems. That is, if the main burners do not light within a few seconds, the control will shut off the system. Some systems will try to relight the burners for a set number of times to prevent nuisance lockouts. Flame rectification is used as the method of proving ignition of the gas. HSI systems are 100% lockout whether the system is natural gas or LP-fired. Figure 2 shows a typical HSI module.

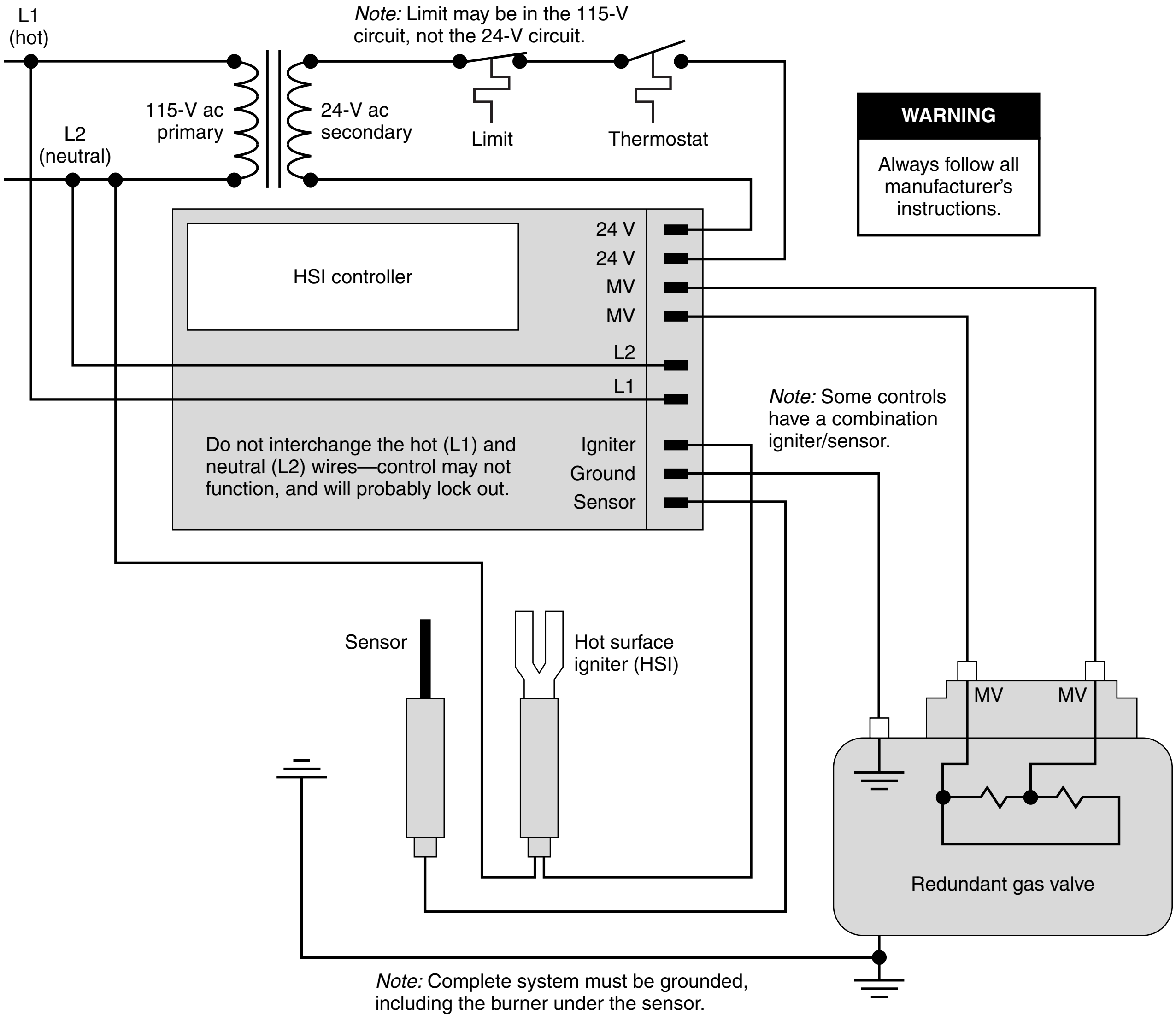


Figure 2. Typical HSI module/gas valve wiring

FLAME IONIZATION AND FLAME RECTIFICATION

Heat in the flame causes the molecules in and around the flame to collide violently with one another. These collisions free some of the outer electrons of the atoms that form the molecules. The creation of “free” electrons and positive ions allows a small current to be conducted through the flame. This process is called *flame ionization*. Current conducted through the flame (flame current) is generally in the range of 0.1 µA to 10 µA. If two electrodes are placed in a flame and a voltage is applied, a current can be conducted between them. If the electrodes are the same size, the current will be ac (since the voltage applied to the sensor is ac).

Naturally, the positively charged ions will flow to the negatively charged rod (see Figure 3). In order to use this process to determine the presence of flame and to prevent the potential hazard of a high-resistance short to ground (simulating a flame), the flame current is “rectified,” or changed from ac to dc. Generally referred to as *flame rectification*, this process is achieved by placing a grounding electrode in the flame. The electrode is approximately four times larger than the area of the flame rod or sensor.

Remember that an ac supply voltage is applied at the sensor (flame rod). In the first half of the ac cycle, the flame rod is positive and the ground rod is negative. The positively charged ions flow to the negatively charged grounding area. The large grounding area increases the capacity to hold electrons. This results in a relatively high flame current flowing through the flame during the *first half cycle*. During the *second half cycle*, the reverse process takes place. This results in a much smaller flame current, rectifying the ac current through the flame (see Figure 4). The only type of current accepted by the system is the rectified flame current. Any high-resistance short circuit will result in an ac flame current that will be rejected by the ignition controller.

In HSI and DSI systems, the grounding electrode generally forms part of a burner. It is part of the pilot burner in IID systems. *Flame rods*, also called *sensors*, are small-diameter metal rods supported by a ceramic insulator. The end of the sensor should project into the flame (see Figure 5). Sensors typically are made of Kanthal®, a high-temperature alloy capable of operating in environments of up to 2,400°F (1,300°C).

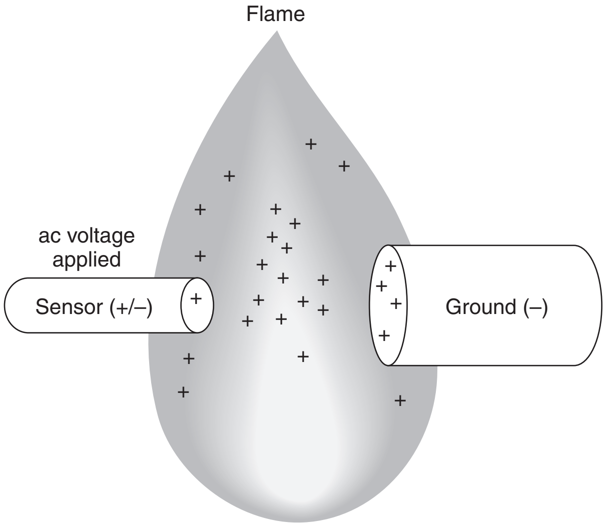


Figure 3. Flame rectification

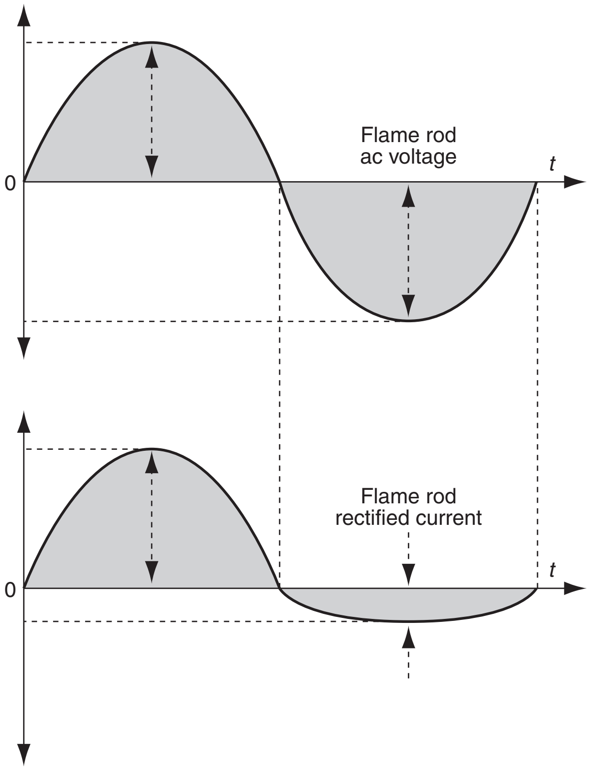


Figure 4. Sensing voltage and current

In summary, it is important to note that this process does not rely on the flame *heating* the sensor. The flame is used as a *conductor*. Because the grounding electrode and sensor electrode are not the same size, the current becomes directional—thus the dc µA flame signal.

Requirements for successful applications include:

- adequate grounding area-to-flame rod area proportions (4-to-1 minimum)
- stable flame (no movement from the flame rod)
- proper placement of the flame rod in the flame
- proper ground from the main burner or pilot to the ignition controller
- proper rectifying flame current and associated circuitry.

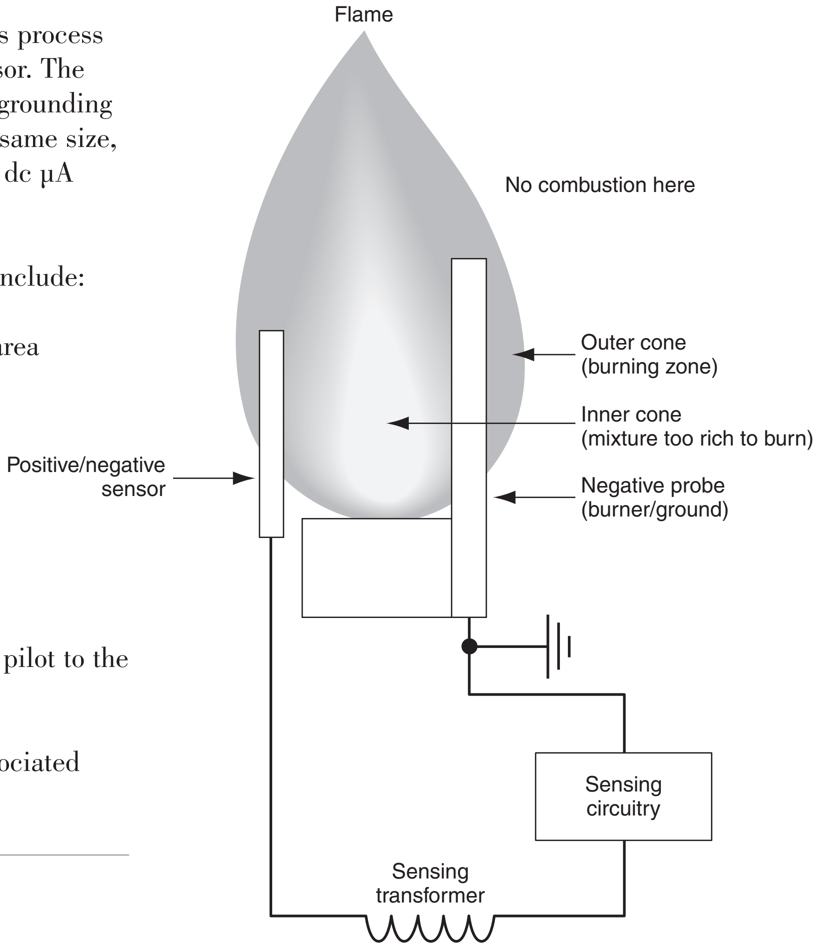


Figure 5. Sensing circuitry

RESIDENTIAL SENSING METHODS

Thermal

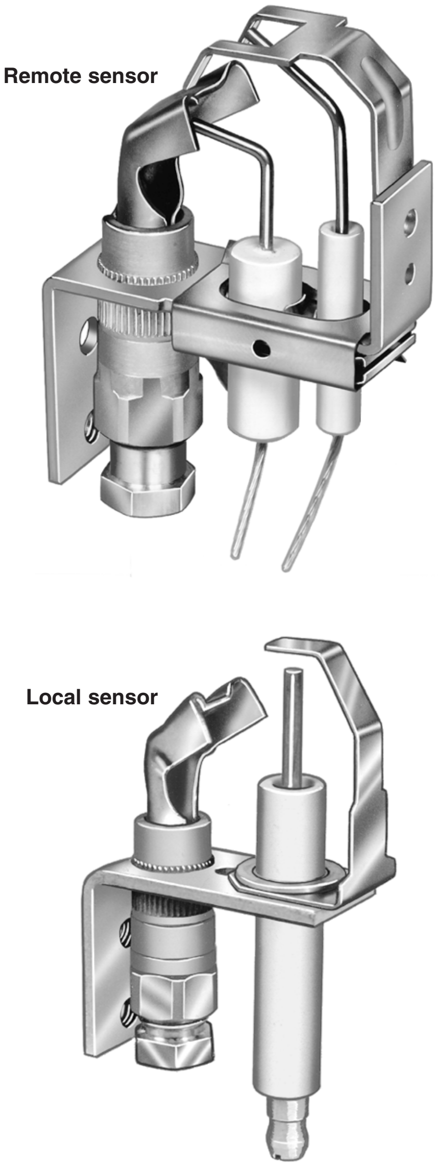
There are three commonly used thermal methods of sensing flame:

- The *liquid-filled* sensing system utilizes a liquid (such as mercury) that expands in the presence of heat. The expansion of the liquid causes pressure on a diaphragm, which in turn makes or breaks a set of contacts in a microswitch. Enabling or disabling the flow of gas is based on whether the pilot is lit or not. The most popular liquid-filled thermal sensing system is manufactured by White Rodgers.
- The *metallic* sensing method uses a mono-metallic or bi-metallic strip to sense the presence of flame. Distortion of the metallic element makes or breaks a set of contacts, thereby energizing or de-energizing a valve to control the flow of gas. Most metallic thermal sensing devices are manufactured by Carrier/BDP.
- A *thermocouple* is made of dissimilar metals. When the connected end (the “hot junction”) is heated, a current will flow. This current causes an electromagnet to become energized, and allows the flow of gas to the main burner. Failure of the pilot flame causes a loss of current, and results in an interruption of gas flow to the main burner. Gas flow to the pilot will also be interrupted if the system is completely shut off.

Flame rectification

As explained previously, flame rectification relies on the process of changing current flow from ac to dc in order to prove or disprove the presence or absence of flame. If the flame were used only to conduct electricity, a piece of rust could become the conductor from the sensor to ground, making the system prove flame when a flame did not actually exist. This would cause a very unsafe condition.

Flame rectification is used instead of thermal detection in most IID systems, and is used almost exclusively as the flame-proving method in DSI and HSI systems. Flame rectification responds in approximately 0.8 seconds to a flame or no-flame condition. This is much faster than responding to heat (thermal detection).



HONEYWELL INC.

Figure 6. IID sensing assemblies

There are two ways of utilizing flame rectification—*remote sensing*, which uses a separate igniter and sensor, and *local sensing*, which uses a combination igniter/sensor (see Figure 6).

Optical

In the past, oil burners used thermal sensing. These controllers were called “stack” controls, since the sensing element was mounted in the vent pipe. Today’s residential and light commercial oil burners use *optical* sensing technology, with the *cad cell* being the primary type of flame sensor.

A cad cell uses a varying resistance across a cadmium sulfide grid to indicate to the primary control whether the flame is lit properly or not. Visible light is the energy used to vary the resistance. As more light falls on the cad cell, the resistance decreases. If no light strikes the cad cell, the resistance remains high, indicating no flame. When no flame is present, the cad cell causes the primary control to lock out after 15, 30, or 45 seconds rather than allow the fuel unit (the oil pump) to continue to pump unignited oil from the storage tank into the combustion chamber.

Cad cell resistance is normally less than 1,500 Ω with proper flame detection, and greater than 1,500 Ω with improper flame detection or no flame. Dark cell resistance should be greater than 20,000 Ω. A lower resistance reading when dark may indicate a flame-simulating condition that will not allow the burner to start on the next call for heat.

COMMERCIAL AND INDUSTRIAL SENSING METHODS

Although flame rectification is used on smaller commercial systems, optical *ultraviolet* (UV) and *infrared* (IR) detection sensors are used primarily on larger commercial and industrial systems. These types of sensors are designed to respond to selective wavelengths of electromagnetic radiation produced by flames. The sensed signals are then analyzed using a predetermined technique to determine the presence or absence of flame. The UV type is the most popular sensor used on larger gas, oil, and coal systems.

MEASURING THE FLAME SIGNAL

In systems that use flame rectification as the proving method, the ignition controller is designed to respond to dc current (not ac current) flowing from the sensor, through the flame, and back to ground on the ignition module. Although the current passing through the flame is not actually true dc, it is more dc than ac, as you can see by comparing the sine waves shown in Figure 4.

As a service technician, you should get in the habit of measuring the flame signal in order to be certain that the system will work reliably and run without callbacks. A system that requires a minimum flame signal of 1.0 μA dc may appear to be working normally while you are doing a fall tune-up. However, if it is operating at a lesser value, the system may lock out at a later date, resulting in a callback.

When you are ready to measure the flame signal, *always* follow the manufacturer's directions. If the manufacturer's instructions are not available, the following procedures, while generic in nature, will provide some basic guidance.

Regardless of whether the system uses local sensing or remote sensing, begin by shutting off all power. Observe all safety precautions and procedures to ensure a safe start. Then proceed as explained in the paragraphs that follow.

IID systems

Disconnect the MV wire at the ignition controller or gas valve and insulate the loosened connector so that it does not touch ground or another connection and short out the system. The MV wire is disconnected so that you will test the worst-case flame signal, which is that of the pilot flame *only*.

For local sensing:

1. Connect a dc microammeter in series with the ground wire from the ignition control to the pilot burner (if the control has a dedicated ground). If no ground wire exists, add one.
2. Start the system. Don't be alarmed if the main burners do not light. Remember, you have the main valve disconnected.
3. Read the microamperes and compare your reading

For remote sensing:

1. Connect a dc microammeter in series with the sensor wire.
2. Start the system. Don't be alarmed if the main burners do not light—you have the main valve disconnected.
3. Read the microamperes and compare your reading to the minimum value specified by the manufacturer.

DSI and HSI systems

For local sensing:

1. Connect a dc microammeter in series with the ground wire from the ignition control to the burner that is under the igniter/sensor. If no ground wire exists, add one. Some local-sensing DSI and HSI systems require a special adapter to measure the flame signal. (Robertshaw makes such an adapter.)
2. Start the system.
3. Read the microamperes and compare your reading to the minimum value specified by the manufacturer.

For remote sensing:

1. Connect a dc microammeter in series with the sensor wire.
2. Start the system.
3. Read the microamperes and compare your reading to the minimum value specified by the manufacturer.

For *IID systems*, some of the reasons why the microampere reading may be less than the minimum include:

- poor pilot flame
- poor ground connection from ignition control to pilot burner
- sensor improperly positioned in flame
- flame not contacting sensor and pilot burner at same time
- defective conductor from sensor or igniter/sensor to ignition module
- dirty sensor.

For *DSI and HSI systems*, some of the reasons why the microampere reading may be less than the minimum include:

- poor main burner flame
- poor ground connection from ignition control to burner underneath sensor
- sensor improperly positioned in flame
- flame not contacting sensor and burner underneath sensor at same time
- defective conductor from sensor or igniter/sensor to ignition module
- dirty sensor.

If the system that you are servicing does not have a dedicated ground, it may be because the cabinet acted as a good ground when the system was originally manufactured and tested in the factory. Corrosion between the gas valve and piping, burners, and manifold can interrupt the ground that years ago may have been adequate. Adding a dedicated ground in the path from the burner or pilot will help ensure reliable operation. IID systems should have a dedicated ground wire from the ignition control module to the pilot. DSI and HSI systems should have a dedicated ground wire from the ignition control module to the main burner located under the sensor.

Figure 7 shows an IID spark ignition module that utilizes a combination igniter/sensor (for local sensing). To measure the flame signal, first interrupt power to the unit. Then disconnect the ground wire from the ignition module and connect a microammeter in series with the ground wire. Disconnect the MV wire from the module or the gas valve and insulate the end of the MV wire to prevent grounding or shorting against ground or another wire. Disconnecting the MV wire means that only the pilot will be lit, which will produce the worst-cast flame signal.

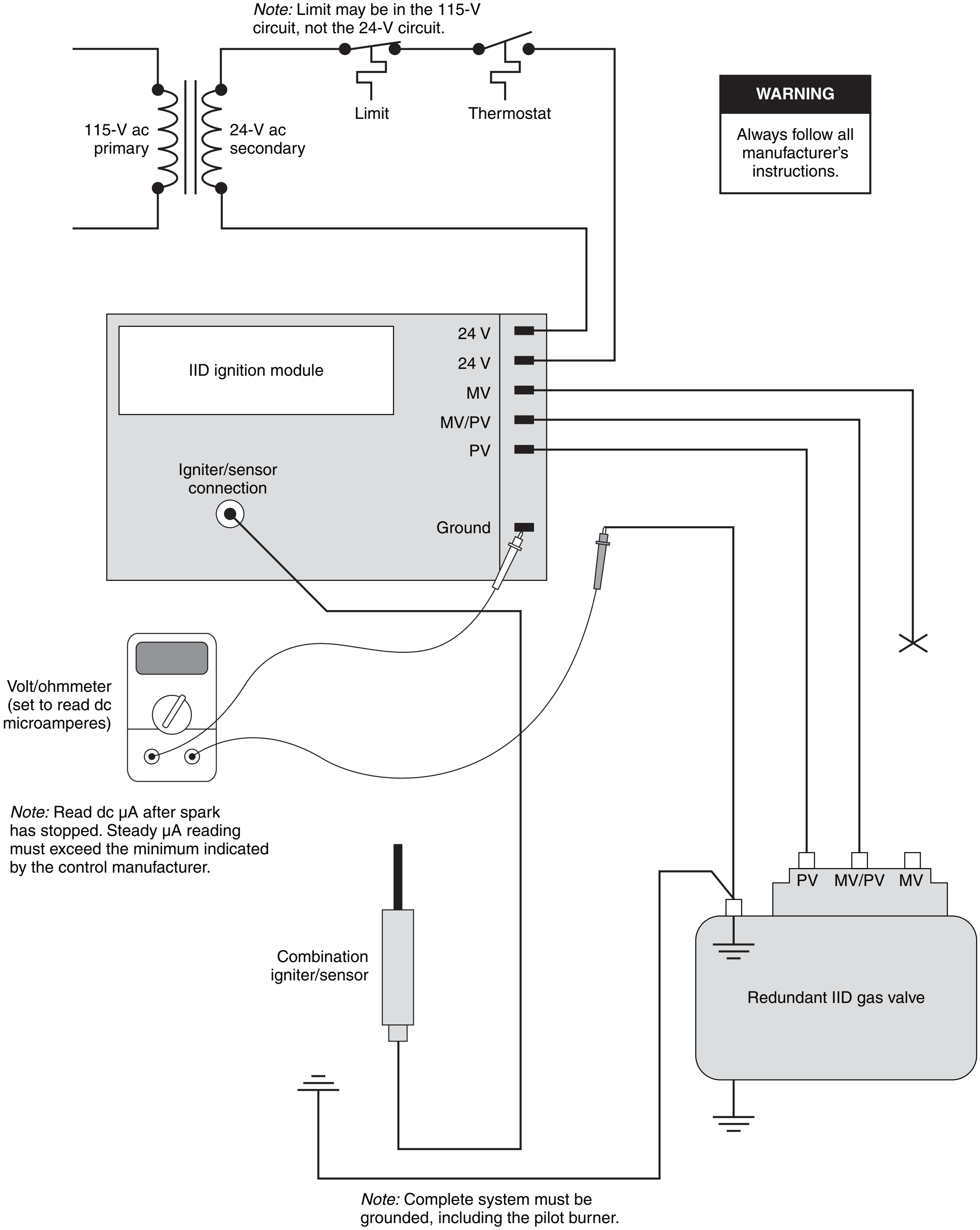
Figure 8 on page 10 shows an IID spark ignition module that utilizes a separate igniter and sensor (for remote sensing). To measure the flame signal, first interrupt power to the unit. Then disconnect the sensor wire from the ignition module and connect a microammeter in series with this wire. Disconnect the MV wire from the module or the gas valve and insulate the end of the MV wire to prevent grounding or shorting against ground or another wire.

SYSTEM CHECKOUT

Warning: Only trained service technicians should attempt to perform measurements on electronic ignition systems. Failure to perform the tests correctly may result in personal injury, property damage, or both. Adhere to all manufacturer's instructions, warnings, and cautions.

Before attempting to complete system tests, be certain that there are no gas leaks, that the appliance is drafting properly, and that no products of combustion are escaping from the appliance. Make sure that the power is off, the gas valve is off, and the appliance is in good general working order.

Always test any ignition controller module that is supposed to lock out if a flame failure occurs. If you don't test it, you won't know if your customer is protected against delayed ignition—or worse yet, an explosion.



WARNING

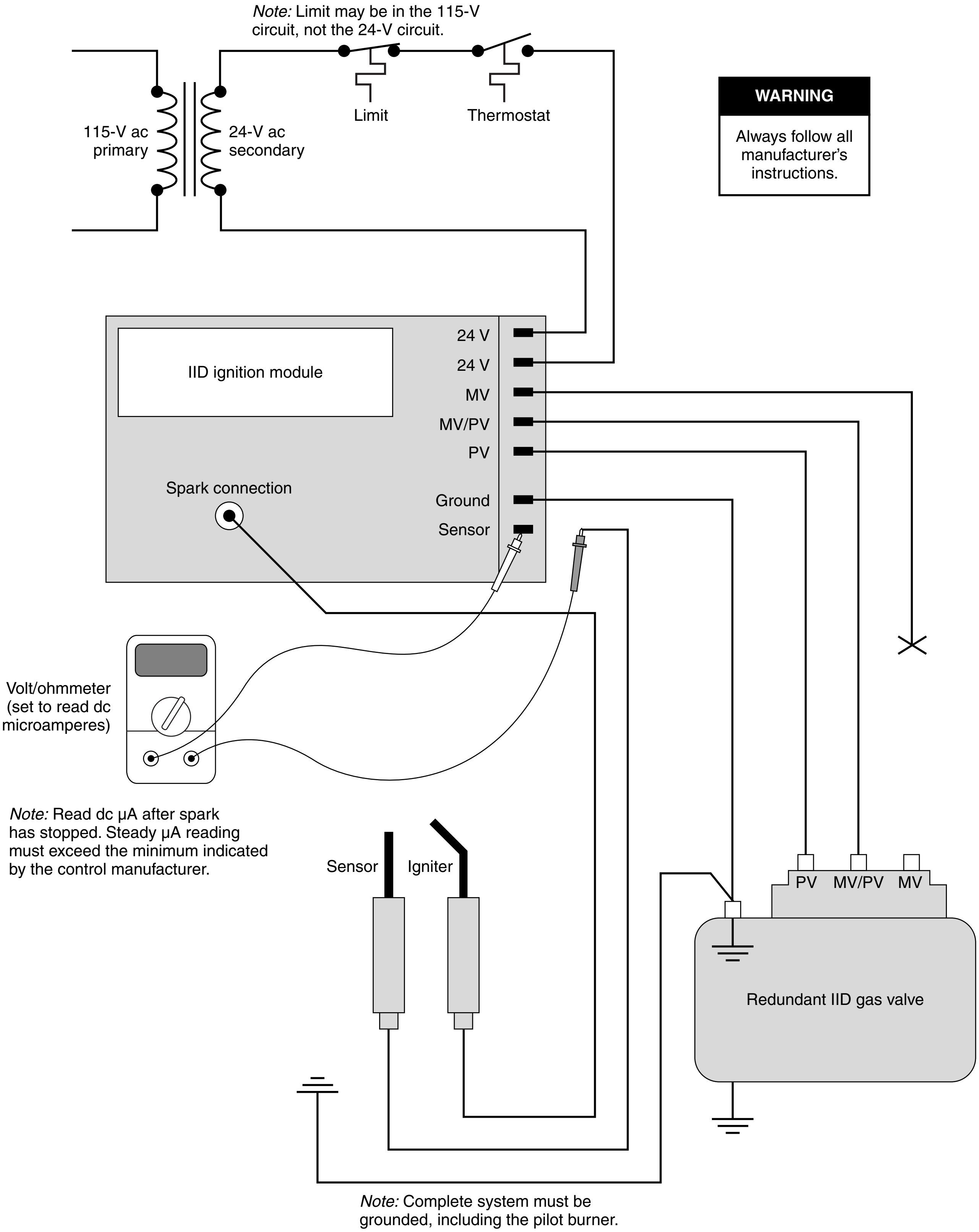
Always follow all manufacturer's instructions.

Note: Limit may be in the 115-V circuit, not the 24-V circuit.

Note: Read dc µA after spark has stopped. Steady µA reading must exceed the minimum indicated by the control manufacturer.

Note: Complete system must be grounded, including the pilot burner.

Figure 7. Measuring IID flame signal (local sensor)



Note: Limit may be in the 115-V circuit, not the 24-V circuit.

WARNING

Always follow all manufacturer's instructions.

Note: Read dc µA after spark has stopped. Steady µA reading must exceed the minimum indicated by the control manufacturer.

Note: Complete system must be grounded, including the pilot burner.

Figure 8. Measuring IID flame signal (remote sensor)

Reference tables

Table 1, on pages 12 and 13, lists the specifications that a service technician will need for some of the more common IID, DSI, and HSI controllers. Particular attention should be paid to some of the earlier Honeywell IID and DSI controllers, which do not output 24 V ac to the PV or MV, as one might expect (since they operate from an input of 24 V ac). The S86A, C, and G output dc voltage to either the MV, PV, or both. However, a 24-V ac gas valve will still open when the dc voltage indicated in Table 1 is supplied.

Table 2 on page 14 provides additional information about troubleshooting IID, DSI, and HSI controllers.

1 Mfg.	2 Model	3 Type	4 MV-MV/PV	5 PV-MV/PV	6 MV-MV	7 Spark or HSI volts	8 100% lockout	9 Pre-purge	10 Min. dc µA
H	S86A-0	IID	10 V dc	24 V ac	—	30,000	No	No	1.0
H	S86A-4	IID	24 V ac	24 V ac	—	30,000	No	No	1.0
H	S86B	IID	24 V ac	24 V ac	—	30,000	No	No	1.0
H	S86C	IID	10 V dc	4-5 V dc	—	30,000	Yes	No	1.2
H	S86D	IID	24 V ac	24 V ac	—	30,000	Yes	No	1.0
H	S86E	IID	24 V ac	24 V ac	—	15,000	No	No	1.0
H	S86F	IID	24 V ac	24 V ac	—	15,000	No	No	1.0
H	S86G	IID	10 V dc	8 V dc	—	15,000	Yes	No	1.2
H	S86H	IID	24 V ac	24 V ac	—	15,000	Yes	No	1.0
H	S87A, B, C, D, J	DSI	—	—	24 V ac	30,000	Yes	Check	1.5
H	S89C	HSI	—	—	24 V ac	120-V HSI	Yes	No	1.0
H	S90A	IID	24 V ac	24 V ac	—	15,000	No	No	1.0
H	S90B	IID	24 V ac	24 V ac	—	15,000	Yes	No	1.0
H	S825C	DSI	—	—	5–15 V dc	*	Yes	No	#4.0/10.0
H	S825D	DSI	—	—	24 V ac	*	Yes	No	#4.0
H	S860C	IID	10 V dc	10 V dc	—	15,000	*	Yes	1.2
H	S860D	IID	24 V ac	24 V ac	—	15,000	*	Yes	1.0
H	S8600A/8610A	IID	24 V ac	24 V ac	—	13,000	No	No	1.0
H	S8600B/8610B	IID	24 V ac	24 V ac	—	13,000	Yes	No	1.0
H	S8600F/8610F	IID	24 V ac	24 V ac	—	13,000	No	No	1.0
H	S8600H/8610H	IID	24 V ac	24 V ac	—	13,000	Yes	No	1.0
H	S8600M	IID	24 V ac	24 V ac	—	13,000	Yes	No	1.0
H	S8610U	IID	24 V ac	24 V ac	—	—	Check label	No	1.0
H	S8660D/8670D	IID	24 V ac	24 V ac	—	13,000	Yes	Yes	1.0
H	S8910U	HSI	—	—	—	120-V HSI	Yes	Check label	1.0
H	SV9500 & 9600	HSI	24 V ac	24 V ac	—	24-V HSI	Check label	Check label	0.2
H	SV other	HSI	24 V ac	24 V ac	—	24-V HSI	Check label	Check label	1.3
FW	05-15 (12 V)	DSI	—	—	24 V ac	*	Yes	No	5.0
FW	05-16 (24 V)	DSI	—	—	24 V ac	*	Yes	No	5.0
FW	05-21	HSI	—	—	24 V ac	120 V	Yes	No	**

Every effort has been made to ensure the accuracy of the data contained in this table. However, no express or implied warranties are given for this information. Consult individual manufacturers for exact specifications and instructions.

Table 1. Ignition control specifications

1 Mfg.	2 Model	3 Type	4 MV-MV/PV	5 PV-MV/PV	6 MV-MV	7 Spark or HSI volts	8 100% lockout	9 Pre-purge	10 Min. dc µA
JC	G60	IID	24 V ac	24 V ac	—	*	Check label	No	0.70
JC	G65, G66	IID	24 V ac	24 V ac	—	*	Check label	No	0.20
JC	G600 AX	IID	24 V ac	24 V ac	—	*	Check label	No	0.20
JC	G600 KX, LX, LY, MX, NX, and RX	IID	24 V ac	24 V ac	—	*	Check label	No	0.15
JC	G670	IID	24 V ac	24 V ac	—	*	Check label	No	0.15
JC	G770	IID	24 V ac	24 V ac	—	*	Check label	No	0.20
JC	G750	HSI	24 V ac	24 V ac	—	120-V HSI	Yes	Check label	0.20
JC	G779	IID	24 V ac	24 V ac	—	*	Check label	No	0.15
R	SP715	IID	24 V ac	24 V ac	—	*	No	No	0.69
R	SP735	IID	24 V ac	24 V ac	—	*	Yes	No	0.70
WR	50A65-843	HSI	—	—	24 V ac	120-V HSI	Yes	Yes	1.0
WR	50E47	HSI	—	—	24 V ac	120-V HSI	Yes	Check label	2.0
WR	50A55	HSI	—	—	24 V ac	120-V HSI	Yes	Yes	1.0
WR	50M61-843	HSI	—	—	24 V ac	120-V HSI	Yes	Yes	0.3

Columns

1 Manufacturer
2 Model number
3 Controller type
4 Main valve to common voltage output for IID
5 Pilot valve to common voltage output for IID
6 Main valve voltage output for DSI or HSI
7 Ignition voltage output
8 Is control 100% lockout?
9 Does control have pre-purge timer?
10 What is the minimum flame signal to be measured in microamps?

Manufacturer

H = Honeywell
FW = Fenwal
JC = Johnson Controls
R = Robertshaw
WR = White Rodgers

Control type

DSI = Direct Spark Ignition
IID = Intermittent Ignition Device
HSI = Hot Surface Ignition

Symbols

*	Not published (unknown)
**	Requires Fenwal Tester Part #05-080223-001
µA	Microamperes (flame signal)
#	Minimum/maximum microamperes

If IID control and 100% lockout, use for LP or natural gas. If not 100% lockout, use for natural gas *only* (if original equipment manufacturer specified a non-100% lockout control). *All* DSI and HSI controls must be 100% shutoff for LP or natural gas.

Always follow all manufacturer's safety requirements, service and installation instructions, and recommendations.

Table 1. Ignition control specifications (continued)

Visual checks	IID	DSI	HSI
1. Ignition system operation	Proper spark is occurring at the pilot burner. If no spark is present: 1) the controller may not be providing the spark voltage, or 2) the controller may not be receiving the proper control voltage, or 3) the spark cable may be defective, or 4) the sensing circuit may be grounded. Gas should be present at the pilot burner hood. If no gas is present: 1) be certain that gas is available at the gas valve inlet, and 2) check for proper voltage to the PV and MV/PV terminals at the gas valve.	Proper spark is occurring at the main burner. If no spark is present: 1) the controller may not be providing the spark voltage, or 2) the controller may not be receiving the proper control voltage, or 3) the spark cable may be defective, or 4) the sensing circuit may be grounded. Gas should be present at the burner that is used for ignition. If no gas is present: 1) be certain that gas is available at the gas valve inlet, and 2) check for proper voltage to the MV and MV terminals at the gas valve.	Igniter heats and glows cherry red. If igniter does not heat: 1) the igniter is defective, or 2) the igniter is not receiving the proper voltage, or 3) the sensing circuit may be grounded. Gas should be present at the burner that is used for ignition. If no gas is present: 1) be certain that gas is available at the gas valve inlet, and 2) check for proper voltage to the MV and MV terminals at the gas valve.
2. Gas delivery	Pilot lights. Spark should stop—flame is not being proven if spark continues. If pilot lights and the spark stops, but there is no main burner ignition: 1) check for proper voltage to MV and MV/PV, or 2) if the proper voltage is available and gas is being supplied, the gas valve is defective.	Main burner lights. Spark should stop—flame is not being proven if spark continues. If main burner lights and the spark stops, the flame is being proven.	Main burner lights. Igniter should go off after flame is sensed. If main burner lights and the spark stops, the flame is being proven.
3. System continues to run until call for heat ends	Flame is probably not being sensed adequately. Measure flame signal (μA dc). It should be greater than the minimum indicated in the manufacturer's instructions. *(See Table 1, Column 10, for some common controllers).*	Flame is probably not being sensed adequately. Measure flame signal (μA dc). It should be greater than the minimum indicated in the manufacturer's instructions. *(See Table 1, Column 10, for some common controllers).*	Flame is probably not being sensed adequately. Measure flame signal (μA dc). It should be greater than the minimum indicated in the manufacturer's instructions. *(See Table 1, Column 10, for some common controllers).*

Table 2. Troubleshooting ignition controls

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