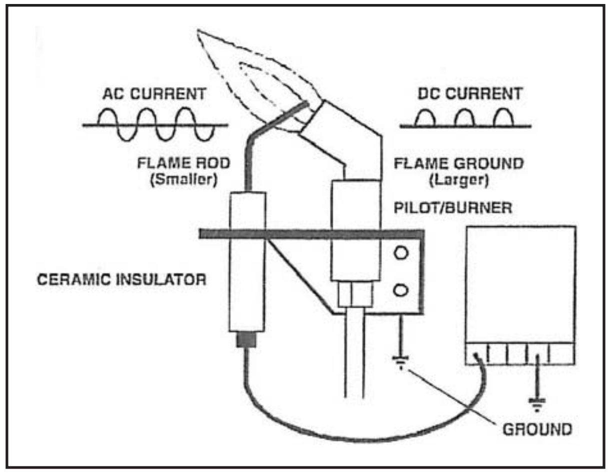
CONTROL TIPS

A ROBERTSHAW® INFORMATIONAL GUIDE

THIS ISSUE

FLAME RECTIFICATION

Flame Rectification Definition



Flame Rectification is a method of flame sensing whereby the flame sensor (flame rod or element) is located in the pilot or burner flame and a current applied to the sensor flows through the flame to the pilot assembly or the burner head and then to ground.

Because the flame sensor is smaller than the ground electrode (the pilot assembly in pilot ignition systems, or the main burner in hot surface or direct spark systems), an alternating current (AC) applied to the flame sensor flows in one direction and the AC current is rectified to a pulsating direct current (DC), or rectified current.

This current tells the control module that a flame is present and the system operates as long as the DC signal from the flame rod is present. When the signal ceases, drops below a specific level, or is interrupted, the control module closes the main gas valve immediately to prevent an unsafe condition. The system either recycles itself or locks out and must be reset by cycling the thermostat or in some instances, be checked by a qualified service technician.

Types of Ignition Systems

There are three styles of electronic ignition systems in use on gas fired heating equipment. One common method is to light a pilot which then lights the main burner. The pilot flame must be proven (the ground of the control module senses the DC current flow) before the main burner gas valve is energized. This system is known as an Intermittent Ignition Device (IID).

A second system uses a silicon-carbide element heated to a high temperature to light the main burner directly. This system is referred to as a Hot Surface Ignition (HSI).

The third system uses a spark to light the main burner directly. This system is commonly referred to as a Direct Spark Ignition (DSI).

A basic review of the sequence of operation of the IID and HSI systems will help in understanding how flame rectification works in each system.

IID System Operation

In Intermittent Ignition Device (IID) systems, the ignition control's spark transformer and pilot gas valve are automatically energized when the thermostat calls for heat. The spark lights the pilot on each operating cycle. The flame sensor proves the presence of the flame. The ignition control then shuts off the spark, and at the same time, the main gas valve is opened. (Some systems allow the spark to continue for a short period of time after the main burner lights.) Lockout models provide for shutdown of the entire system when the pilot does not light within some fixed period of time and/or number of ignition trials (usually 60 seconds and 1 to 3 tries). Non-lockout systems, which are no longer used on new equipment, will continue to spark indefinitely and attempt to light the pilot until the pilot is lit, or the power is removed. After the main burner ignites, the system continues normal operation until the temperature control is satisfied and the main-burner and pilot valves are de-energized, shutting off all gas flow.

HSI System Operation

In HSI/DSI systems, a call for heat energizes and warms the ignition element for a number of seconds or establishes a spark before opening the gas valve. When the valve is opened, the hot surface ignitor lights the main burner gas. If ignition is not sensed (proven) within a predetermined period of time, the unit shuts down and recycles. Depending on the control module design, ignition timing may be from 2 to 12 seconds, and the number of tries may vary from 1 to 3.

These ignition systems use solid state electronic circuitry and a flame sensor to replace the safety pilot valve and thermocouple normally associated with standing pilot systems. Flame sensing is a very important aspect of the ignition controls operation and is accomplished through the phenomenon of flame conduction and rectification. The area of conduction within a flame (pilot or main burner) is the outer area of the flame where most of the burning occurs and the atmosphere becomes ionized. This ionization within the flame allows an electrical current to be conducted through the flame. If two probes are placed in the area of the pilot flame, a current can be conducted from one point to another through the flame. To identify and isolate the current conducted by the flame, the principle of flame rectification is used.

Flame Rectification

When the surface area of one probe is made larger than that of the other probe, current tends to flow more in one direction. DC current flows in only one direction as opposed to AC current, which alternates its direction. The AC current applied to the flame sensor/element is rectified (changed) from AC to DC by increasing the surface area of one probe and decreasing the surface area of the other.

In most IID systems, the probes exposed to the pilot flame are the flame sensor and the pilot burner hood. Because the surface area of the pilot hood is much larger than that of the flame sensor, the current rectification process takes place.

The flame sensing circuit begins with the current conducted from the control through the flame sensor. As the current is conducted through the flame to the pilot hood, it is rectified from AC to DC because of the difference in surface area. The pilot hood is grounded back to the control, thereby completing the circuit.

Flame Sensing Circuit

For the ignition control to function properly, a minimum amount of current must flow through the flame sensing circuit.

As the pilot flame is established and current begins flowing in the flame sensing circuit, the current energizes a relay. A minimum amount of current is required to pull in the relay. When the relay pulls in, one set of contacts opens which shuts off the high energy spark. Another set of contacts closes, putting voltage on the main gas valve terminals which opens the gas valve. The minimum current required varies between component manufacturers and with different systems and components. This value should be obtained from the rating plate on the control module or from installation instructions.

Voltage Versus Current

In normal operation, an AC voltage will be present from the module to ground and a current (usually somewhere depending on the system and manufacturer, between .25 and 8 DC microampere) will be present in the flame sensing circuit.

Even though an AC voltage is present, flame rectification occurs and a DC current flows in the sensing circuit.

For service checkout purposes, measuring these voltages and currents can provide useful information regarding the integrity of the ignition control.

Measuring the current flow rather than the voltage is the preferred procedure. The voltage may be unstable; while the current, though low, will provide a stable reference. Due to the internal circuitry of the ignition control and the varying input impedance of voltmeters, the measured voltage will vary depending on type and model of voltmeter being used. However, when it is necessary, measuring the current (usually microampere, and in some cases nanoampere) provides a more precise evaluation of the ignition control and flame sensing circuit.

A proper reading not only indicates a functional control, but also verifies all components of the circuit such as flame sensor, cable, and ground. If there is not adequate amperage, there may be something inhibiting the flow such as a bad flame rod, oxidized or rusted pilot/burner assembly, poor grounding connections of the components, cracked or deteriorated sensor, or bad wiring.

These troubleshooting and testing procedures are just a few of the processes. As noted earlier, the minimum current required varies between component manufacturers and with different systems and components. The minimum current should be obtained from the rating plate on the control module or from installation instructions, and proper testing based upon their recommendations.

Invensys. Controls

191 E. North Avenue
Carol Stream, IL 60188
www.invensyscontrols.com

For Customer Service:
Telephone 1.800.304.6563
Facsimile 1.800.426.0804
HVACCustomerService@invensyscontrols.com

For Technical Service:
Telephone 1.800.445.8299
Facsimile 1.800.260.7242
technicalservice@invensys.com