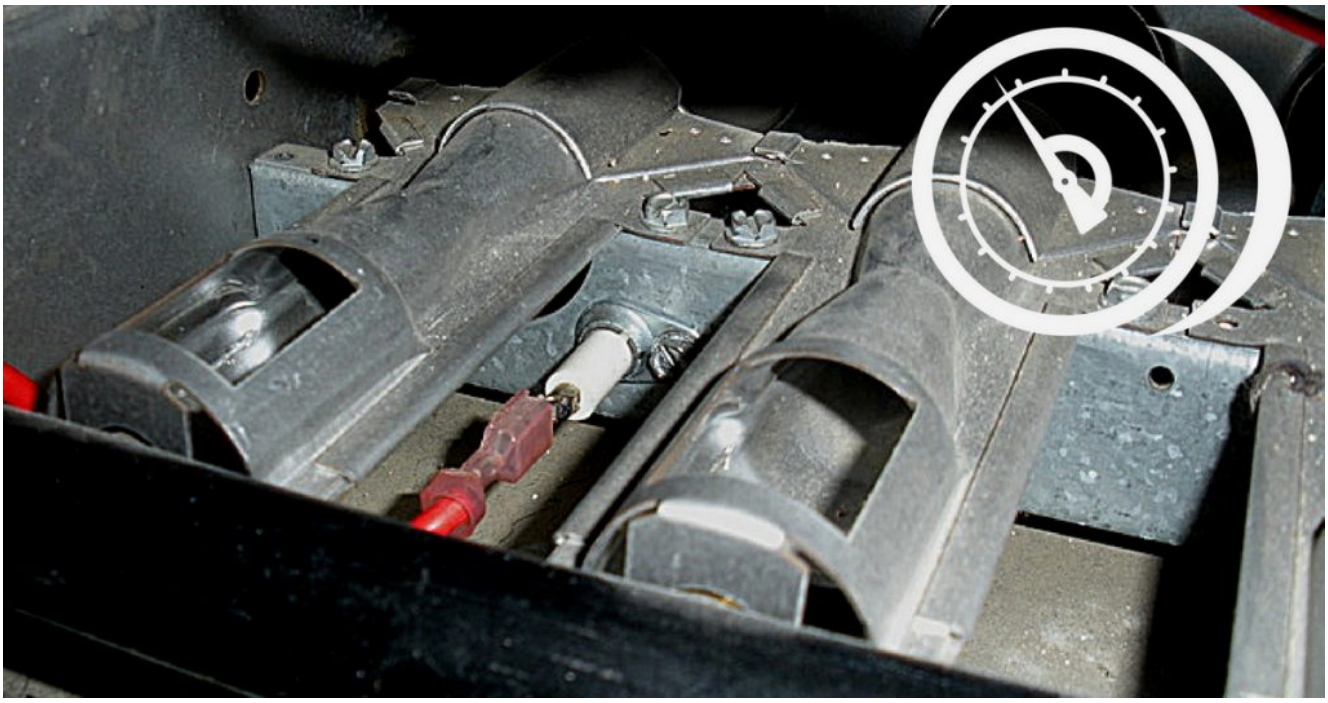
Flame Sensing – The Basics



Proving flame is an important part of the gas firing sequence. Without proof of flame you risk dumping unspent gas into the heat exchanger resulting in an explosion.

There are many ways to “prove flame” we are focusing on the flame sensing rod method here.

Here are the facts-

Flame sensing rods, also know as flame rectifier rods or flame rectification rods are commonplace in modern hot surface and ISI (intermittent spark ignition) gas fired appliances.

Flame sensing rods stick out into the flame and connect back to the furnace board. Once the board sends a call to the gas valve to open, it monitors current flow on the flame sensing rod. It does this by generating a potential (voltage) at the flame sensing terminal, this terminal is connected to the sensor with a conductor. When no flame is present there will be potential at the rod and no current, when a flame is present a small microamp DC current will be present as a path is made between the rod and the ions in the flame. This small

DC current signals the board that flame exists and all is well with the world. If it does not sense this microamp DC current within a few seconds it will shut off the gas valve and try again.

The board outputs this potential (voltage) on the flame sensing terminal right at the beginning of the sequence to confirm that the path is “open” with no flame. This ensures against false positives (sensing flame / current when there should be none) andonce it goes from 0 current to the rated micoamp current the board “knows” that flame is present.

These flame sensing rods are “dumb” devices. They do not generate potential (volts) or current (amps), their predecessor the thermocouple (seen in standing pilot systems) does generate a potential itself which is often the source of the confusion.

A flame sensing rod is a piece of metal with a ceramic insulator that keeps it from grounding out. That is all. However because it is conducting in the Millionths of an amp (microamp) a lot can go wrong with it that a normal electrical component wouldn’t have any issue with. Tolerances are tight so small factors make a big difference.

Flame sensors fail when:

1. They short out due to a cracked insulator
2. They Fail open because they are broken
3. They don’t conduct because they are not properly placed in the flame
4. They become coated in silica (glass) or carbon

Before I go any further I want to address a common question. Do flame sensors have a special coating that can be rubbed off with improper cleaning?

Well… If we are talking about a thermocouple or a thermopile then yes.. absolutely, but we aren’t discussing standing pilot

systems here.

I have seen a lot of flame sensing rods, and I have done a good deal of research and I have found no evidence that most flame sensing rods have a special coating on them that can be rubbed off. Now, if you have real, quantifiable proof from an manufacturer that says otherwise.. PLEASE provide it to me so I can retract this statement.

Here are the steps to test a flame sensor –

- Ensure the furnace is properly grounded. You can do this by powering down the heater and taking an ohm reading between neutral and the burner assembly. You should read a few ohms of resistance max, the lower the ohm reading the better grounded it is.
- Make sure your polarity is correct, incoming hot connected to hot, neutral to neutral.
- Ensure the rod is positioned so it will be covered in flame
- Get a meter that reads in the microamp scale with a .10 resolution minimum. Use a good QUALITY meter for this and make sure your leads are in the correct locations.
- Connect your leads in SERIES. This means you have to disconnect lead from the rod, connect one lead to the rod and the other to the terminal to the board WITH THE CONNECTOR UNHOOKED FROM THE ROD
- When the flame lights you should read between .5 and 10 microamps depending of the furnace. Readings between 2 and 6 are common.

If you do not have a proper microamp reading you can confirm the following

- That the flame rod is not open. Ohm from tip to terminal on the rod. If the rod is open it is failed.
- Check the insulator and make sure it isn’t cracked or grounded
- Check for proper burner grounding and incoming power polarity (as mentioned)
- Clean the rod… Now this is a controversial one. I suggest using a very fine steel wool or abrasive pad (magic erasers often work). remove and clean the rod and ensure you wipe it clean of any particles left over from cleaning. Handle very gently. Once complete perform an ohm test from tip to terminal again to ensure you haven’t damaged during cleaning. If you want to be real crazy, use some electrical contact cleaner on it after cleaning to help remove any residue… just nowhere near flame, unless you don’t want eyebrows.

Once you have established all of the above and you are still not getting the required microamps then you are left replacing the board.

Word of warning –

Test your tools regularly. If you are trusting your meter and you aren’t 100% sure your meter is working and set up properly you may end up with a misdiagnosis. Test and calibrate your tools regularly.

Do every possible test before replacing a board. Many techs advocate just replacing a flame senor if they suspect it isn’t conducting well. I am cool with that so long as

1. You don’t charge the customer for it is there was nothing wrong with it
2. You company is OK eating the cost of rods that were not needed

Or.. you just install a new one long enough to test. That is all fine and good if you have extra flame rods in your truck. Many techs do not have that luxury.

Finally…

If flame rods are getting dirty / coated often, you will want to find out why. There is something in the environment or the combustion that is causing it.

In Summary flame rods should be

1. In the flame
2. Clean
3. Not open
4. Not shorted

Now is the part where the furnace techs from all over the world tear me apart.

– Bryan