Chippewa Valley Technical College

HVAC Gas Furnace Training

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Testing Resistance on a Control Circuit

Objective One: The student will test the resistance of components in a typical control circuit in a gas furnace.

Before the readings can be taken, identification of components/terminal designation must be done.

Standard Fan Relay: Coil Terminals _____

Contacts: Normally Open (NO) _____ Normally Closed (NC) _____

Standard Contactor: Coil Terminals _____

How Many Contacts _____ Contacts: Normally Open (NO) _____

Thermostat Designations:

Rc _____ Rh _____ W _____ G _____ Y _____ C _____

Transformer:

Primary Side Colors _____ Secondary Side Colors _____

Caution: Make sure power is OFF!

Using your meter, set to read ohms, record the resistance of the following low voltage components.

Single Pole, Single Throw Switch (SPST) _____

Relay Coil _____

Contactor Coil _____

Step-down Transformer: Primary _____ Secondary _____

Standard Heat/Cool/Fan Thermostat

Place Thermostat in Cooling Mode: Rc to Y _____ Rc to G _____

Place Thermostat in Heating Mode: Rh to W _____

Testing Voltage on a Control Circuit

Using your meter, set to read voltage, record the voltage of the following low voltage components.

Single Pole, Single Throw Switch (SPST) _____

Relay Coil _____ Contacts: Normally Open (NO) _____ Normally Closed (NC) _____

Contactor Coil _____ Contacts: Normally Open (NO) _____

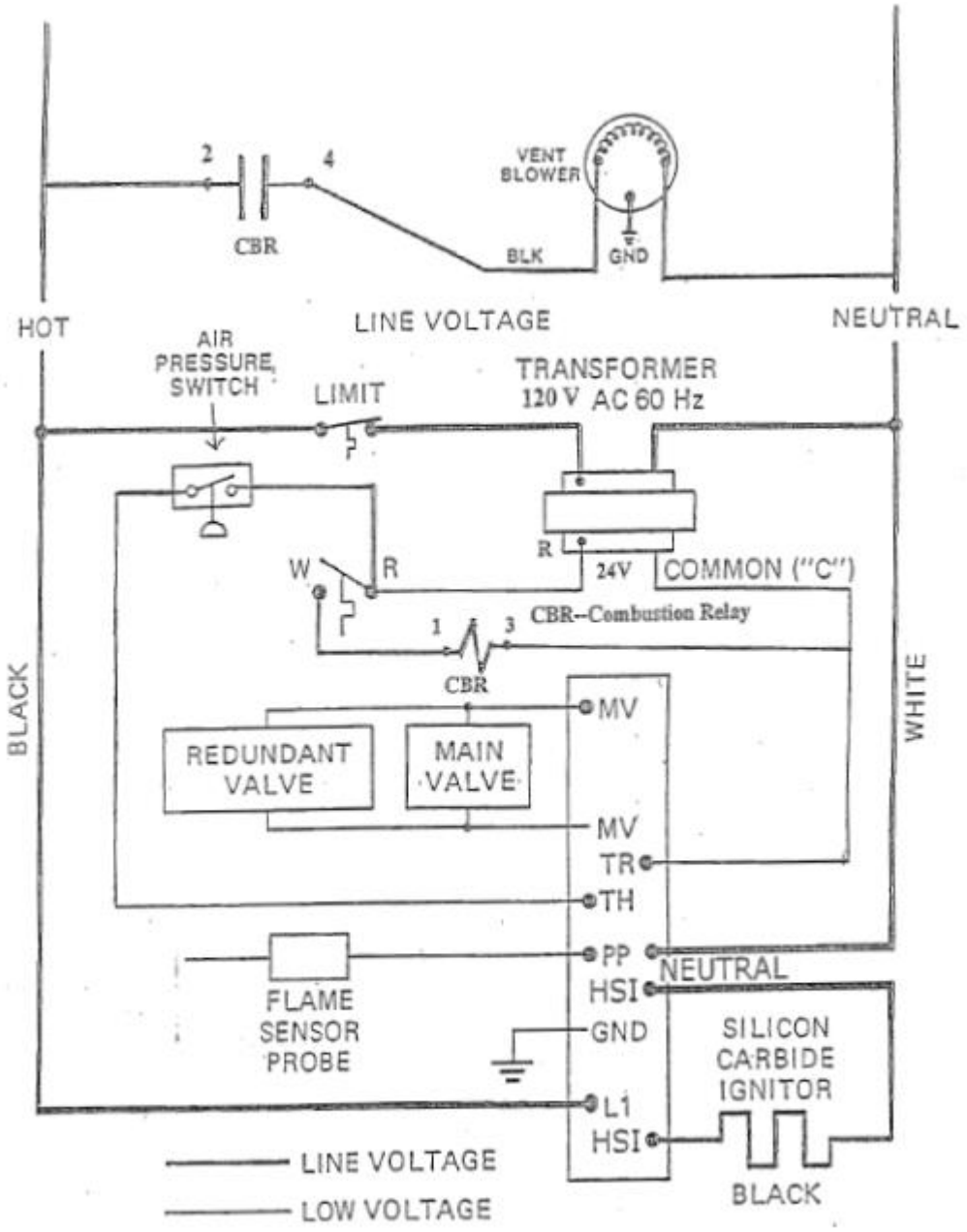
Step-down Transformer: Primary _____ Secondary _____

Standard Heat/Cool/Fan Thermostat

Place Thermostat in Cooling Mode: Rc to Y _____ Rc to G _____

Place Thermostat in Heating Mode: Rh to W _____

Hot Surface Ignitor Furnace Trainer Wiring Diagram



Schematic Wiring Diagram for Hot Surface Ignitor

Sequence of Operation

Sequence of operation of a gas furnace can be broken into 8 standard steps. These steps are typical of all high efficiency furnace operation. We call these the “8 Steps”.

1. ***Thermostat*** calls for heat R & W closes.
2. ***Heating Relay*** is energized closing HR-1 set of contacts.
3. ***Vent Motor*** starts, closing ***VPS*** that energizes ***Control Module*****.**
4. ***Control Module*** energizing ***Ignitor*** for approximately 45 seconds.
5. ***Gas valve*** is energized by ***Control Module*** opening valve to permit ignition of gas/air mixture.
6. ***Ignitor*** shuts off and ***Flame Sensor*** senses flame that produces approximately 1.5 to 7 micro-amps.
7. Burners remain on and heat exchanger heats up to approximately 130 degrees, closing the ***Fan Switch***. (Note: A timed switch may be used.)
8. ***Indoor Blower*** is energized and blows air through the furnace.

Procedure: On the furnace trainer, using the above 8 steps, the student will use their multimeter to test components and verify voltages present. Set the multimeter to Volts.

1. **Thermostat calls for Heat, R & W closes.**

   Place your meter leads on Rh and W and record the voltage _____

2. **Heating Relay is energized, closing HR-1 set of contacts.**

   Place your meter lead on coil terminals 1 and 3 and record the voltage _____

3. **Vent Motor starts, closing the (3a)Vent Pressure Switch, thus energizing the (3b)Control Module.**

   Place your meter leads on vent blower terminals and record the voltage _____

   3a. See worksheet for testing procedure.

   3b. On the control module, place your meter leads on terminal TH and TR, record voltage _____

4. **Control Module energizes the (4a)Ignitor for approximately 45 seconds.**

   4a. See worksheet for testing procedure.

5. **Gas Valve is energized by Control Module, opening the valve to permit ignition of gas/air mixture.**

   See worksheet for testing procedure.

6. **Ignitor shuts off and Flame Sensor senses flame that produces approximately 1.5 to 7 micro-amps.**

   See worksheet for testing procedure.

CHECKING FLUE VENT PRESSURES/PRESSURE SWITCH

3a. Using the following procedure:

THE PRESSURE SWITCH: The pressure switch is an air-actuated switch typically with normally open contacts. These contacts are connected to a tube that runs from the pressure switch to the vent blower housing. When the vent motor starts, a negative (-) or positive (+) pressure is developed (pressure type depends on the manufacturer of the furnace) which typically closes the contacts on the pressure switch. If the flue should become obstructed, the contacts on this switch will not operate. A low-pressure reading indicated a severely restricted flue or combustion air inlet. A properly operating vent motor assembly should produce well over 0.5 in. wc negative pressure or0.05 to 0.65 in. wc positive pressure.

USE THE FOLLOWING STEPS TO CHECK THE FLUE VENT PRESSURES:

1. Using a manometer, remove the tube from the pressure switch, use a tee and attach the gauge as show in the diagram.
2. Measuring positive pressure: With the vent fan operating, the normal pressure should be above 0.60 in. wc. Once the normally open switch is closed, it should not open unless the pressure drops below 0.45 to 0.55 in. wc.
3. If the pressure reads 0.60 in. wc and the switch does not close, remove the tubing from the blockage side of the switch. If the switch still does not close, replace the switch assembly.
4. If the pressure is below the 0.60 in. wc, check for soot in the heat exchanger and on the blower wheel. Also, check the condition of the sensor tube to make sure it is not broken or cracked. Clean and correct the condition causing the soot to buildup. Replace the sensor tube if necessary.
5. Measuring negative pressure: Follow the same procedure as above. A low pressure reading indicates a restricted flue or combustion air inlet. A properly operating vent motor assembly should produce well over 0.5 in. wc negative pressure.

   Note: Verify pressure readings according to each manufacturer's specifications.

THE INSTRUCTOR WILL ASSIGN A FURNACE TO COMPLETE THE FOLLOWING

LAB ASSESSMENT:

1. Obtain a DIGITAL MANOMETER from the instructor.
2. Record the manufacturer and model number of the assigned furnace.

   Furnace 1:

   Manufacturer: _____ Model Number: _____

3. Connect the gauge, start the vent motor, and record the pressure readings for the furnace.

Furnace 1: _____

4. What is the voltage across the pressure switch before the induced draft motor starts _____

5. What is the voltage across the pressure switch after the induced draft motor starts _____

Have instructor sign work _____

Checking the Igniter of an HSI Ignition System

4a. Using the following procedure:

Use any furnace that has a HSI Ignition System

Procedure

1. Turn power off to the furnace and open access panel.
2. Locate and remove the HIS two-prong electrical connector or remove igniter power leads from igniter.
3. Set your meter to measure resistance.
4. Measure across the HSI electrical pins and to find the resistance of the igniter.
5. Record the ohms value reading. _____
6. Is this in the acceptable range of 30-60 ohms? _____
7. Reconnect the igniter, set the thermostat to heating and raise thermostat to fire the furnace.
8. Observe ignition sequence up to main burner ignition.
9. Did the igniter come on to light the main burner or pilot?_____
10. Close up the furnace and shut down power and gas supply

11. Have instructor sign work _____

Checking a Gas Valve

5. Using the following procedure:

Use any furnace with a standing or direct ignition gas valve.

1. Turn ON the gas supply and electrical power to the furnace.
2. Remove the access panel.
3. Set the thermostat to the heating mode.
4. Set the thermostat higher than the ambient temperature.
5. Allow time for the furnace to ignite the burners.
6. Set a voltmeter to AC volt function.
7. Test the gas valve electrical leads.
    a. *Record your voltage reading._____*

    If you have 24 volts and the main burner is not firing there is a problem with the gas valve. If there is not a 24-volt reading at the gas valve, the valve is probable OK but there is problem elsewhere in the furnaces ignition system.

8. Turn the thermostat to the off position.
9. Turn the power off.
10. Remove the power lead wires to the gas valve solenoid coil.
11. Set the meter to measure resistance.
12. *Record the resistance of the solenoid coil._____*
13. Replace gas valve leads and access cover.

A measured resistance means the gas valve is probably good. An infinity reading indicates the gas valve solenoid is open and valve requires replacement.

1. What is the purpose of the gas valve in a furnace?

_____

_____

Instructor will not sign off until all steps have been filled in and completed.

USING THE MICROAMMMETER

6. Using the following procedure:

The ignition control module provides ac power to the flame sensor (or igniter-sensor) which the burner flame rectifies to direct current. If the flame signal back to the control module is not high enough (at least so many microamps [uA] dc) the system will lock out.

The output of the flame sensing circuit cannot be checked directly, so check the flame sensing circuit indirectly by checking the flame sensing current from the flame sensor to the control module as follows.

1. Connect a meter (dc microammeter scale) in series with the flame signal ground wire (see diagram). Disconnect the ground wire at the control module. Connect the red (positive) lead of the meter to the free end of the ground wire. Connect the black (negative) meter lead to the ground terminal on the control module. The microammeter must always be in series. (**NOTE: If the unit has an actual flame sensor the microammeter must be wired in series with it).**

2. Start the system and read the meter. The flame sensor current should be in the range of 1.5uA to 7uA depending on manufacturer ignition module type. The reading must be steady. If the reading is below the designated value or is unsteady, check the burner flame, flame sensor (igniter-sensor) location and electrical connections.

ASSIGNMENT:

1. Connect the microammeter to a furnace the instructor assigns

   a. What are the micro amps reading _____

   b. What happens if you disconnect the flame rod while the furnace is running_____

Have instructor sign work _____

Checking for Correct Electrical Polarity

The correct electrical polarity is necessary for many furnaces to function correctly.

Procedure

1. Turn on power to the furnace.
2. Gain access to the furnaces main line voltage terminals (L-1 and L-2/neutral).
3. Set voltmeter to read in a range suitable for 120 volts.
4. Place one of the voltmeter leads to the L-1 terminal and the opposite lead to a metal ground on the furnace.
5. *Record your voltage.* _____
6. Place one your leads to the L-2/ neutral terminal and the opposite lead to a metal ground on the furnace.
7. *Record your voltage.* _____

   The correct polarity should give you a voltage reading of 115 to 125 volts between L-1 and ground. The voltage between L-2/neutral and ground should be close to 0.

1. Reverse polarity refers to what?

   _____

   _____

2. How could the polarity of equipment become reversed?

   _____

   _____

3. What problem could reverse polarity cause to a furnace?

   _____

   _____

Instructor will not sign off until all steps have been filled in and completed.