Heating Zone Controls: The Basics

Proper wiring is critical to the effectiveness and safety of a hydronic control system. **By Mike Miller**

Any electrician would agree that shoddy wiring is a sure-fire recipe for disaster. The following includes some of the basics of correct hydronic control wiring and answers to some of the most commonly asked questions about the intricacies of proper wiring.

All wiring circuits consist of a power source, a switch and a load. The source usually originates (from a building-wiring requirement perspective) at the breaker panel. The switch is in the heating control wiring of a thermostat or switching relay. The load, in this case, is the device that is switched on when needed. A device could be a zone valve, pump and/or boiler.

Let's review what a heating zone control wiring could look like in average- and smaller-sized hydronic heating applications. Most of the zone control wiring is done in 24V AC and a step-down transformer is used for zone thermostats and zone valves/manifold actuators. Other system equipment, such as pumps, may remain on a 120V AC circuit.

A brief legend of the symbols used in this example is provided in Figure 1.

The zone valves/actuators used here are four-wire normally closed, powered open. Two of the four wires are yellow and are used for the motor. The motor requires a 24V AC current to power the valve open. In most cases, the remaining two wires are red and provide a dry-contact closure once the valve has opened. These wires can be used to enable additional devices and are shown enabling a pump and a boiler in Figure 2.

Figure 2 shows a typical radiant system consisting of a condensing boiler with built-in outdoor reset control. The boiler is piped in primary/secondary to the system, which has four zones or manifolds using zone valves with motor end switches. Zone valve motor end switches will close whenever the valve is powered open and will be used to bring on the primary pump and the boiler through an isolation relay.

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**FIGURE 1**

- Two-Wire Thermostat
- Black (L) White (N)
- Class II Transformer 24V AC
- Zone Valve w/ End Switch
- Primary Pump
- 24V AC Isolation Relay DPDT

A thermostat is a device that provides a contact closure when the room temperature falls below the desired setpoint.

A transformer provides 24V AC power for our zone control wiring.

A zone valve/actuating motor is a device that is powered through the thermostat's switch to allow the flow of heating water through the radiant loops in that zone.
Please note that if domestic hot water (DHW) production is also required, it is often piped off the side of the boiler and the boiler’s internal control handles DHW with priority. The boiler pump is usually wired to the boiler’s internal pump control terminals.

Manual Wiring Steps:
As shown in Figure 3, a 24V AC step-down transformer is powered by connecting the 120V AC leads to the 120V AC power source. On the 24V AC side, there are two poles referenced as either positive or negative, or simply abbreviated with R (24V AC Hot) and C (24V AC Common). Each zone essentially has its own small electrical circuit, where the transformer becomes the common source, a thermostat becomes the switch and the zone valve becomes the load. On a traditional two-wire thermostat, connect one wire from the thermostat to R (24V AC Hot) on the transformer. The second thermostat wire connects to one of the two normally yellow zone valve/actuator motor wires. The other yellow zone valve motor wire connects to the C found on the same transformer. When the wiring is complete for all four zone thermostats and zone valves, each thermostat will be able to power up its own zone valve on a call for heat.

For our purposes, the red end switch wires on the zone valves will be used to energize an external relay. Since this relay must be energized when any one of the four zones call for heat, the four end switches are wired in parallel.

Once a zone valve is open, bring on the primary loop pump and ensure that the boiler fires to its own internal outdoor reset water temperature in order to achieve full system efficiency. Use a readily available double pole double throw (DPDT) relay with a 24V AC relay coil for this purpose. A relay, as such, will often have two N/O and two N/C contacts available that can be used for various additional switching requirements.

One of the red wires from each of the four zone valves must be connected to the R-side on the transformer. The second set of red wires found on each of the four zone valves connects to one side of the external DPDT relay’s coil. A relay coil is only energized once its circuit is complete, so the other side of this external relay’s coil connects to the C-side of the same transformer.

In this installation, the transformer is still the source and the four end-switches are now the switches in parallel, so that any of them can energize the external relay, which is the load. Once the relay’s coil is energized, an N/O contact closes and an N/C contact opens. The primary pump must be switched ON and a call for heat provided to the boiler. For the primary pump, introduce 120V AC (L) from the power supply to one side, off one of the N/O contacts on the relay; then connect the black (hot) wire from the pump to the other side of the same N/O contact on the same relay. The white (neutral) wire from the pump wires back to neutral (N) on the power supply.

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This circuit is now complete. The source is the power supply; the switch is the relay’s switch that closes once the relay’s coil is energized; and the load is the pump’s motor.

To bring on the boiler itself, use the second N/O contact that is still available on the same relay. Most boilers would look for a volt-free or dry-contact closure as a command to fire on a call for heat in the building. Two terminals are usually available at the boiler and are referenced as the “T T” or thermostat connections. Wire those two connections to the second N/O contacts on the relay and the boiler will fire when any one of the four zone thermostats call for heat, and any one of the four zone valves is powered open. The primary pump will come on through the relay.

If this process sounds too challenging or time-consuming, several manufacturers produce wiring convenience boxes, also known as relay boxes or zone controls.

Your time in the field is valuable. For this reason, zone controls speed up wiring by providing point-to-point connections and accommodating visual indicators for zones, making troubleshooting and system operating status identification easier.

The two-wire thermostats are connected to designated thermostat connections, usually found near the top of the wiring boxes, where the four wire zone valves with end switches have their point-to-point connections, often on the bottom. Normally, these wiring boxes also come with isolated end switches that can be used to switch power to the pump and to bring on the boiler as shown in Figure 4.

This sums up the most basic forms of hydronic zone control wiring. In future editions of Wiring 101, external or standalone outdoor reset mixing control strategies and wiring examples for some of the most common hydronics systems controls in the market will be addressed.

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Author’s Note: Always ensure that installations in the field are performed according to local jurisdictions and code requirements.

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FIGURE 4