

Heating, Ventilation and Air Conditioning

What Kind of HVAC System You Have and How to Use It



SKILL SET

Be sure you have the experience needed for these maintenance tasks. If you are in doubt, hire a contractor.

SAFETY

These upgrade tasks may require working with electricity. Disconnect power sources and exercise common sense when working with electricity.

TOOLS

Screwdriver, electricians pliers

MATERIALS

Programmable thermostat, electrical tape

COST BENEFIT

Increased energy savings and improved comfort with proper use of HVAC controls.

PRIORITY LEVEL

LOW MED HIGH

SKILL LEVEL

DIY PRO

Identifying HVAC Systems

The majority of American homes contain a forced-air Heating Ventilation and Air Conditioning (HVAC) system and associated ductwork. A forced-air system contains a blower motor and fan in what is referred to as the air handling unit (AHU) that is then connected to the associated distribution system (ductwork).



Fuel-fired furnace

Furnaces – a furnace burns fuel (natural gas, propane, oil) to generate heat in a combustion chamber. Heat from the combustion chamber is transferred through a heat exchanger to air inside the home. It is critical that the furnace be properly vented to

the outdoors and have an adequate supply of air to support efficient, safe combustion.

The efficiency of the furnace in converting fuel to heat is measured by the Annual Fuel Utilization Efficiency (AFUE) rating. A standard efficiency 80% AFUE furnace has a metal flue while a more efficient “condensing” furnace has an efficiency greater than 90% AFUE and features a PVC flue pipe.

Commonly a furnace is coupled with an electric air conditioner that uses the same AHU and ductwork as the furnace.

Air Conditioners and Heat Pumps – a forced-air or central air conditioner has two pieces of equipment:

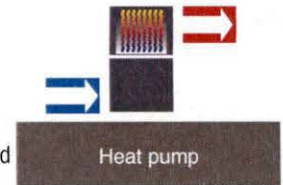
- An indoor evaporator coil located in the AHU that cools the air circulated from the home through the ductwork.
- A condensing unit located outside the home that rejects heat to the exterior.

The refrigerant line forming a loop between these two units transfers heat from the air circulating in the HVAC system to the outdoor air.

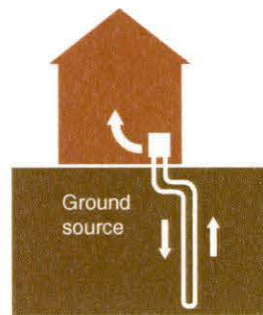
Heat pumps work the same as an air conditioner in summer, but in winter they reverse the process and the refrigerant pulls heat from outdoor air and “pumps” it to inside the home.

On cold days, heat pumps rely on a “back-up” source of heat to maintain comfort. Typically, the back-up heat source is electric resistance coils located in the AHU. Another option is to use a gas furnace as a back-up. This is typically referred to as a “dual-fuel” heat pump.

Standard heat pumps reject heat to, or extract heat from outdoor air, depending on the season. These units are referred to as air-to-air heat pumps. Their performance and efficiency is greatly impacted by the air temperature outside.



Heat pump

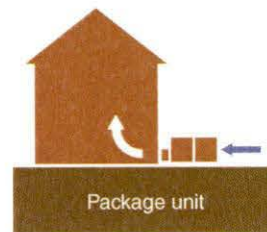


Ground source

A **ground-source heat pump** (sometimes referred to as a geothermal heat pump) is a more efficient approach than air-source heat pumps. Instead of an outdoor condensing unit, ground-source heat pumps rely on buried pipes filled with water or other fluid to transfer heat between the ground and the house. Ground-source heat pumps are more

efficient because they use the more constant temperature of the ground.

Most heat pumps and air conditioners are **split systems**, meaning the AHU is located inside the home and the condensing coil or ground loops are located outside the home. Keeping the AHU and ductwork inside the home increases efficiency as the equipment can be buffered from temperature extremes.

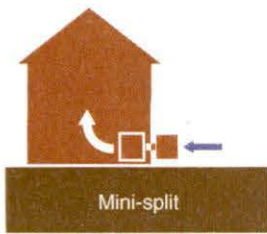


Package unit

A **packaged system** has the air conditioner and furnace or the heat pump components contained in one larger outdoor metal box. There is one large supply and return duct connection from the outdoor equipment to the home's duct system.

Packaged systems take up more outdoor space but offer the advantage of easy access to the equipment components for maintenance. Since it is located outside, a packaged system with electric air conditioning and a gas furnace (often referred to as a “gas pack”) will safely use only outside air for combustion.

Mini-split air conditioning and heat pump systems are frequently used in other parts of the world and are gaining acceptance in North America. Mini-splits come in smaller capacities than conventional split systems, are often



installed as wall-mounted ductless units (although short ducted runs are possible), and offer potential for zoning. They are ideal for conditioning additions and smaller zones such as bonus rooms. Ductless mini-splits usually heat and cool a room or two while ducted models can provide comfort to an entire home. Certain manufacturers offer variable speed and capacity units which can result

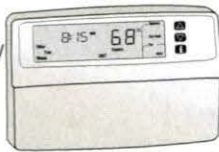
in exceptionally high efficiencies. In addition, ductless systems avoid the significant energy penalty common in many homes from leaky ductwork or ductwork located in an unconditioned space, such as a vented attic.

Occasionally a home will feature two completely separate systems for heating and cooling. An example would be a ducted air conditioning system and a radiator, baseboard, or radiant floor heating system.

Operations and Temperature Control

Modern electronic thermostats generally have three primary settings which impact function and efficiency (varying depending on thermostat):

- Heating or Cooling
- Fan Auto or On
- Program/Run or Hold



Heating or Cooling – Select Heating or Cooling depending on seasonal comfort needs. Some thermostats will switch automatically between the two using user-defined setpoints (see following section).

Fan Auto or On – The HVAC system will function most efficiently in the *Fan Auto* setting, in which the fan will only turn on when there is a need for heating, cooling or ventilation. In the *Fan On* mode, the fan will operate continuously, even if the air is not being heated or cooled, using significant excess energy and can lead to potential moisture problems.

Program/Run or Hold – A programmable thermostat has the *Program/Run* mode that will run a user-defined schedule of setbacks which change the home's temperature based on typical daily needs. The program can always be temporarily overridden or reprogrammed if needs change. This is the most efficient way to use a programmable thermostat, and is explained in detail below. The *Hold* function will maintain the home at a fixed temperature.

Thermostats control the operation of the heating and cooling system based on a user determined temperature setpoint. A common misconception is that a thermostat acts like a car accelerator pedal. In fact, adjusting the setpoint temperature by 2° or 12° has no impact on how fast the air conditioner will cool or the heat pump or furnace will heat the space.

Thermostats that Learn



Today, some programmable thermostats don't have to be programmed. Instead, they create a schedule based on temperature adjustments made by the occupant and continually adapt over time. They also sense time when the home is unoccupied and can be adjusted remotely by a smart phone or computer.

Thermostat Programming

Most homeowners can save up to several hundred dollars a year by using thermostat setback. Setback works by reducing run time, which in turn saves energy, by adjusting the setpoint temperature higher in the summer or lower in the winter when the building is either unoccupied or the occupants have gone to sleep. As a wintertime example:

6:00 AM	Normal occupied setpoint at 70°F
8:00 AM	All occupants gone for the day, the setpoint drops to 60°F
6:00 PM	Occupants return, setpoint at 70°F
11:00 PM	Occupants asleep, setpoint drops to 60°F
6:00 AM	Setpoint returns to normal at 70°F

While setback can be performed manually, a programmable thermostat can direct both setback and recovery and is especially useful if the occupants have a fairly regular schedule. If the first person awakens at 6:30 a.m., the heating system can be programmed to begin heating earlier (say at 6:00 a.m.) so that the occupant wakes up to a warm house. Likewise in the summertime, when the occupants leave in the morning the setpoint temperature in the home can automatically be allowed to drift up from a normal setpoint of, say 75°F, to an unoccupied setpoint of 85°F. If the first person arrives home at 6:00 p.m., the programmable thermostat can automatically activate the cooling system at 5:30 p.m. to ensure that setpoint recovery has been achieved by the time the occupant arrives. Most programmable thermostats allow the user to set weekday and weekend programs which can be overridden easily if there is a change in occupancy.

Heat pump thermostats - A special heat pump programmable thermostat is required for use with a heat pump system. Confirm that the thermostat model is compatible with the heat pump model or consult an HVAC professional. Follow installation instructions to prevent improper wiring, which can result in unnecessary, and costly, electric resistance operation.

Heat pumps operate two to three times more efficiently when heating in heat pump mode than when heating with electric resistance "strip" heat. While the backup heat will occasionally be necessary when the outdoor temperature drops below a particularly cold temperature, the goal is to operate in heat pump mode as much as possible.

To test for improper thermostat wiring, pick a time when the outdoor air temperature is in the low 50's, set the thermostat to call for heating and increase the setpoint by 5°F. If the auxiliary heat comes on, the heat pump control may be incorrect or improperly wired.

A solution is to install the correct programmable thermostat that is made especially for heat pumps. Often featuring adaptive learning, these smart heat pump thermostats permit the user to program for setback but automatically adjust the recovery time to ensure the heat pump operates without unnecessary supplemental strip heat. Another solution is to have an HVAC technician install an outdoor lockout thermostat that prevents the backup strip heat from being energized unless the outdoor temperature gets cold enough.

The occupant will always have the option to manually override the thermostat and call for emergency strip heat so they will be both efficient and comfortable.