ComEd
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Energy Efficiency

# Controls Guide

## Air Source Heat Pumps

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# Controls Guide

## Air Source Heat Pumps

» ComEd 2030 Roadmap

ComEd's commitment to a low-carbon energy future is outlined in the "ComEd 2030" vision. Key to this vision is advancing the policy goals of the Climate and Equitable Jobs Act (CEJA) legislation through its investments in infrastructure and customer programs. As renewable energy supply on the grid increases, electrifying heating and cooling of buildings is just as important as transportation electrification in the transition to a clean energy future. ComEd believes that heat pumps, both all-electric and dual-fuel systems, are an important component to achieving economywide decarbonization as part of its 2030 goals.

In order to drive heat pump adoption by customers, we must ensure they have a positive experience with the technology. Contractors can ensure this positive experience by understanding customers' needs for comfort & affordable energy bills, setting expectations, and educating consumers on the best way to manage their heat pump and its supplemental heating sources.

This Controls Guide is designed to provide options and opportunities that align with a contractor's experience and business models, particularly with ducted dual-fuel air source heat pumps.

This guide will be broken into two sections to provide more focused content for both ducted and ductless air source heat pumps.

# Table of Contents

# Ducted Air Source Heat Pump Systems

## Introduction

Ducted heat pumps have grown in popularity in recent years and are increasingly the focus of energy efficiency programs intended to reduce reliance on fossil fuels for space heating. Ducted heat pumps can be retrofitted into spaces where air conditioning units need replacement as well as spaces where both the air conditioner and furnace need replacement.

A ducted heat pump system can be implemented in two ways – either an all-electric system where the heat pump replaces both the air conditioner and furnace or a dual-fuel system where the heat pump replaces the air conditioner and defaults to furnace supplemental heat when it can no longer meet the heating load. This flexibility in application allows ducted heat pumps to be a viable option for system replacement depending on the status of existing equipment, needs of the customer, and utility costs.

The purpose of this guide is to provide an overview of efficient methods to control the ducted heat pump system as part of either a dual-fuel or all-electric system. There are a variety of strategies that can be implemented depending on the heat pump system type, new or existing thermostat and controls systems, and needs of the homeowner(s) or occupant(s). These controls strategies include, but may not be limited to:

- Using upstage timers and droop settings
- Applying thermal balance point switchover temperatures
- Applying economic switchover temperatures
- Applying comfort switchover temperatures
- Engaging simultaneous operation of primary and supplemental heating systems

# Thermostat Selection

## WHY IS IT IMPORTANT?

### Heat pumps can achieve the best possible performance with proprietary thermostats.

System operation and efficiency can be impacted by whether a proprietary thermostat or third-party thermostat is installed with the heat pump. Proprietary systems that communicate between the thermostat, indoor unit and outdoor unit require a thermostat that can properly communicate with as many components as possible to ensure the most efficient overall system operation.

When a third-party thermostat is paired with a fully modulating system, the system can lose stages of operation due to the limited ability of the controls. Both unitary and ductless products are affected by staged controls – be sure to check with your manufacturer's representative before installing a staged thermostat.

### Not all thermostats are dual-fuel compatible.

Selecting a thermostat that is described as 'heat pump compatible' is not enough to guarantee full dual-fuel system compatibility. Additionally, not all dual-fuel thermostats are compatible with variable capacity heat pumps without a "bridge" or external module incorporated. It is important to understand the features needed for dual-fuel compatibility when choosing a thermostat solution – these key features can be found in the **Dual-Fuel Air Source Heat Pumps** section below. Beyond these recommendations, **ALWAYS** check with your distributor or manufacturer's representative about which thermostats and controls will work with your heating and cooling system choices.

# Thermostat Configuration – General Concepts

## Most heat pumps activate the reversing valve in heating.

Specific wiring instructions for this operation vary depending on the heat pump model and number of wires from the thermostat. Bosch Inverter-Driven System (IDS) and Rheem are common exceptions to this rule – it is important to always check for each system being installed.

## Some systems can call the supplemental heat during defrost events.

While this has not always been the case, some systems are now able to activate supplemental heat while the heat pump is in defrost to increase the supply air temperature during these cycles.
Be sure to check the heat pump model and control capabilities to understand if this is the case for each system being installed.

**Homeowner education around defrost cycles is critical as well for positive experiences. It's a recommended practice for contractors to either force the system into defrost to educate the homeowner, or to show the homeowner a video of the equipment in defrost mode for their education.**

## Multi-stage blower speed must be set to the heat pump coil specifications.

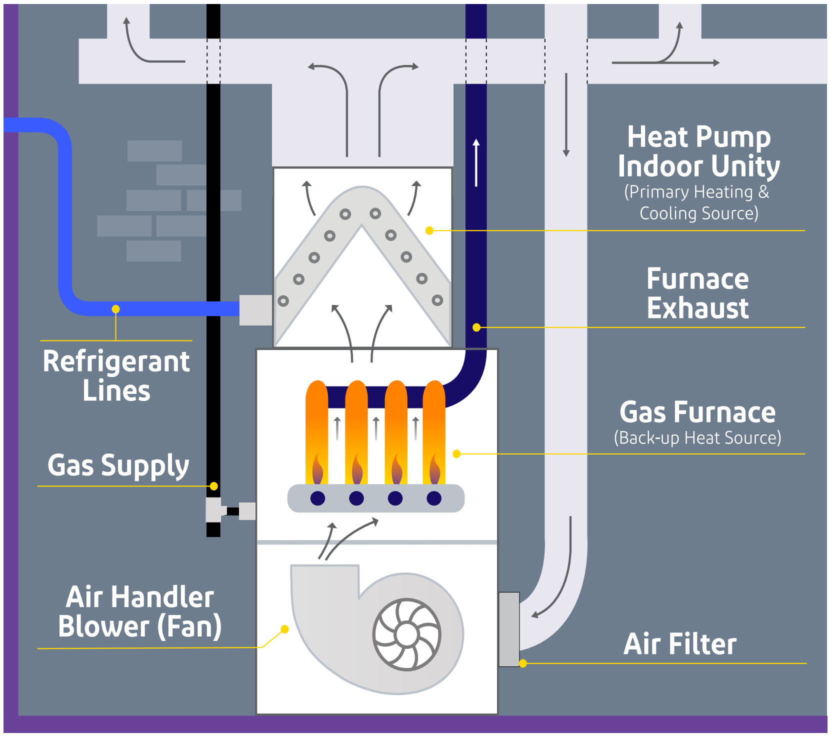
Multi-stage systems should also be configured for appropriate staging and droop settings as described in more detail in the below sections. It is important to follow manufacturer's instructions regarding setting blower speeds to specifications.

## Dual-fuel thermostats have a switchover temperature to configure.

Switchover temperature can also be referred to as compressor lockout or balance point. The switchover temperature can be determined depending on the home heat load (capacity), homeowner needs (comfort), or maximized cost savings (economic).

» **To learn more about switchover temperatures and balance points, please refer to the Switchover Temperature Guide, available on the GoElectric website: GoElectric.ComEd.com on the For Contractors page.**

# Dual-Fuel Air Source Heat Pump Systems




Graphic courtesy of Slipstream

These systems consist of three components – the heat pump, the indoor coil, and the fossil fuel furnace.

Since the heating load will be shared by both the heat pump and the furnace as determined by the switchover temperature, an integrated controls strategy is required to ensure proper communication and operation between the two.

## Heat Pump Types & Capabilities

| | SINGLE-STAGE | TWO-STAGE | MODERN INVERTER SYSTEM | STANDALONE ADD-ON INVERTER | MULTIZONE INVERTER SYSTEM |
|---|---|---|---|---|---|
| **Gas furnace match** | Single-stage or better | Two-stage or modulating | Communicating | Any | Two-stage or modulating |
| **Typical control type** | 24V w/temp sensor | Two-stage or communicating | Communicating | 24V w/temp sensor | Any |
| **Examples*** | All manufacturers | Most manufacturers | Top-tier manufacturers | » Bosch IDS<br>» Gree Flex<br>» Daikin Fit<br>» Mitsubishi Intelli-Heat | » Daikin VRF<br>» Mitsubishi Intelli-AIR<br>» Carrier Bryant |
| **Largest sizing choice** | Cooling load | Cooling load at low stage | Heating load | Heating load | Heating load |
| **Switchover temp** | Thermal or Comfort BP | Thermal or Comfort BP | Economic or Comfort BP | Economic or Comfort BP | Economic or Comfort BP |

*These example lists are not exhaustive and are only meant to give you a starting point reference.

Chart used courtesy of Slipstream

# Dual-Fuel Controls Strategies

## How do you optimize energy savings and minimize risk of increased costs?

Integrated controls should be configured to prioritize operation of the heat pump and switch to supplemental heat when the heat pump can no longer deliver the needed capacity at lower ambient temperatures. This ensures that the heat pump is running as much as possible to take advantage of its high efficiency to minimize energy usage and carbon production. The two main strategies for integrated controls are **Droop Setting** and **Switchover Temperature Selection**. Both droop and switchover temperature can be utilized simultaneously – droop allows for additional controls protection to allow the fossil fuel furnace to engage if the heat pump cannot deliver the needed capacity before the switchover temperature would activate the fossil fuel furnace.

## Droop Setting

**What is droop?** Droop is a specified temperature value that defines the maximum allowable temperature swing below the heating setpoint before supplemental heat is engaged. Droop is typically set between one and three degrees, and the system controls will define a maximum value that droop is allowed to be set at (e.g.: five degrees). This controls strategy method requires a setting in the thermostat that recognizes when the difference between room temperature and thermostat set point exceed a droop setting. This tells the system to engage supplemental heat when the temperature drops below the set droop value under the set point.

**Droop Setting Selection.** Selection of a droop temperature will depend on whether the customer wants to prioritize system efficiency or occupant comfort. Maximizing the droop temperature will result in higher efficiency, while minimizing the droop temperature will improve comfort. While the selected value can change depending on many system factors, rough recommendations are provided below.

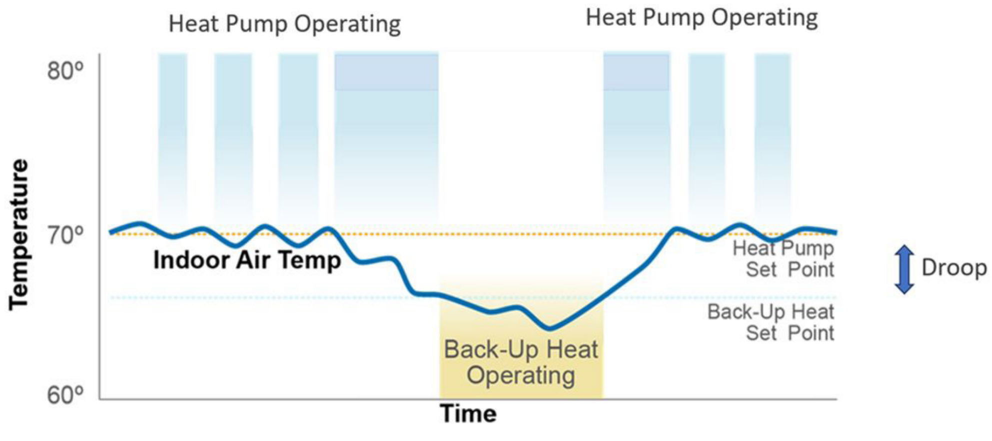
- **2 degrees – typically recommended for cold climates such as Northern Illinois**
- **1 degree – lower for comfort**
- **3 degrees – higher for efficiency**

**Indoor Temperature Set Point = 70°F**

**Droop Setting = 3°F**

**70°F – 3°F = 67°F**

Since the droop is set at 3°F below the set point 70°F, the supplemental heating system will engage when the indoor air temperature is measured to be less than 67°F.




**Note** – for dual-fuel systems, the droop setting may turn off the heat pump until the supplemental heat completely satisfies the thermostat set point.

Graph courtesy of NYSERDA's Controls Training

## Switchover Temperature Selection

**What is a switchover temperature?** A switchover temperature is a defined outdoor ambient temperature at which the heat pump should no longer be used for heating, turning on the supplemental heat system to supply the heating load.

### Switchover Temperature = Balance Point = Compressor Lock Out*

*For some controls/thermostats, both a switchover temperature and a separate compressor lockout are available. For other brands, the compressor lockout is used as the switchover temperature.

**Switchover Temperature Selection.** The switchover temperature can be selected depending on the home heating load or if the homeowner cares more about cost savings or occupant comfort.

### THERMAL BALANCE POINT

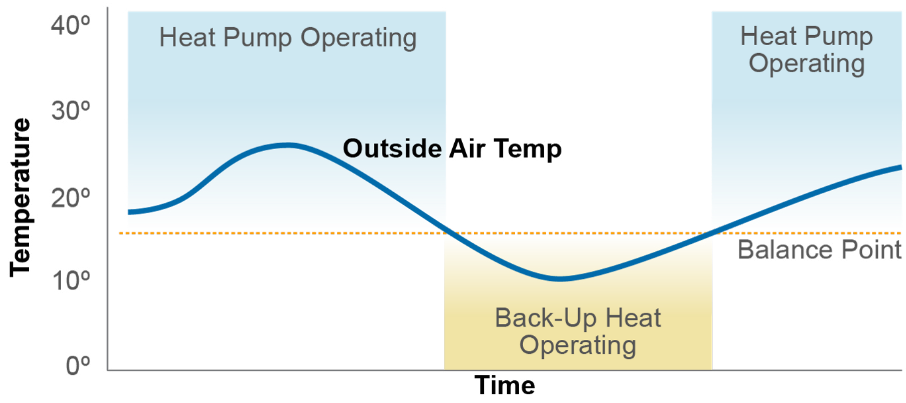
- **The outdoor temperature at which the heat pump can no longer produce the heat needed for the home.**
- **Also called capacity balance point.**

### ECONOMIC BALANCE POINT

- **The outdoor temperature at which the cost to heat the home with the HP is the same or more expensive than the supplemental heat cost.**
- **Depends on both the primary and supplemental heat fuel cost.**

### COMFORT BALANCE POINT

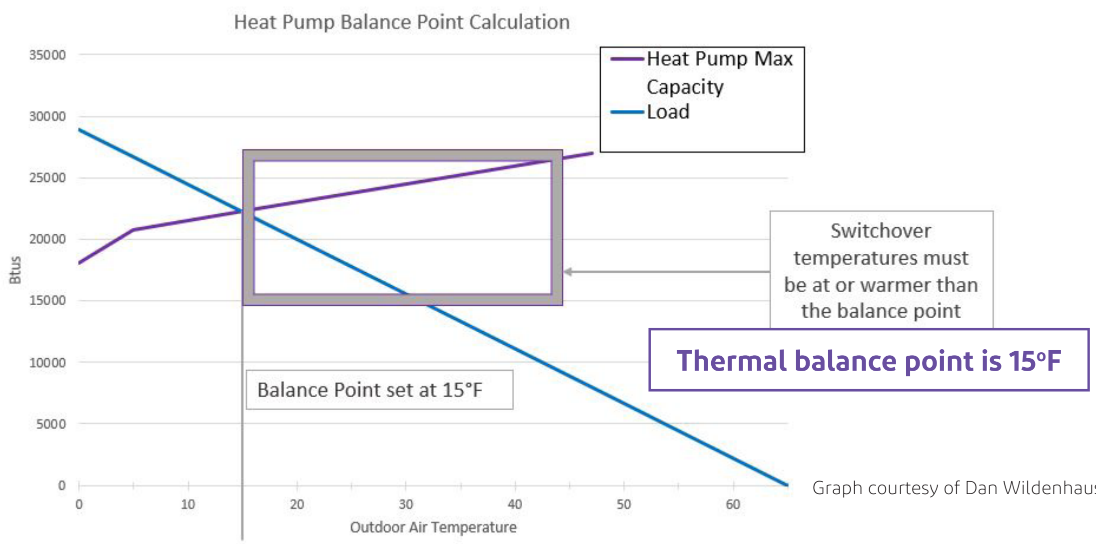
- **The outdoor temperature at which the homeowner experiences discomfort when running the heat pump.**
- **Typically the economic balance point + 1°F to 5°F or controlled with a supply air temperature sensor**




Graph courtesy of NYSERDA's Controls Training

It is very important to consider the Thermal or Capacity Balance Point of the equipment related to the home heating load and the needs of the homeowner when determining the switchover temperature. In addition to the initial selection, the switchover temperature should be recorded and monitored over time so that changes can be made to ensure the best possible customer experience and avoid callbacks.

» **For more detail on switchover temperature selection, please refer to the Switchover Guide, available on the GoElectric website: GoElectric.ComEd.com on the For Contractors page.**




Graph courtesy of Dan Wildenhaus

## Thermostat Features To Look For

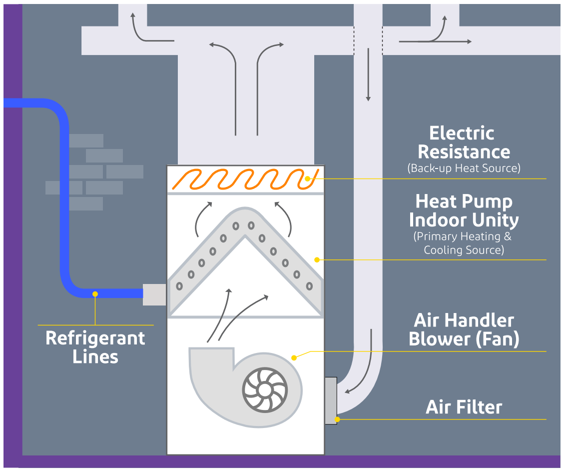
» **4 or more wires/wireless**
Must be able to control the HP reversing valve to operate both heating and cooling modes.

» **Dual-fuel controls software**
Some thermostats can control an HP, but not an HP with a supplemental heat source.

» **Outdoor air temperature monitoring**
Can be a hardwired sensor, wireless sensor, or Wi-Fi connectivity to a local weather station. Required to set a condenser lockout temperature.

» **Multi-stage heating controls**
Optional, but may improve comfort or eliminate condenser lockout at low temperatures.

# All-Electric Air Source Heat Pump Systems




These consist of three components:

- The heat pump
- The air handler
- Electric resistance heaters
  - Custom sized based on heat load.
  - Multiple stages.
  - Almost all strip heat is capable of staging, but not all controls are set to operate staging.

Graphic courtesy of Slipstream

## All-Electric Controls Strategies

Controls should be configured to prioritize operation of the heat pump and switch to supplemental electric resistance heaters when the heat pump can no longer deliver the needed capacity at lower ambient temperatures. This ensures that the heat pump is running as much as possible to take advantage of its high efficiency to minimize energy use.

Auxiliary strip heat can be controlled using lockout controls, supply air temperature sensors (SAT), and staging by time or droop temperature definition.

In Northern Illinois, it is typically recommended to use a cold climate heat pump in all-electric applications. A cold climate all-electric heat pump installed with recommended controls strategies will minimize the need for supplemental electric heat.

### Lockout Controls

Auxiliary strip heat lockout is an important setting in an all-electric ducted system. This is a control setting that prevents the resistance heat from being used above a selected outdoor temperature. This setting requires the use of an outdoor temperature probe or the ability to pull outdoor temperature from a nearby weather station through Wi-Fi connectivity.

This setting will prevent the use of resistance heating during a thermostat setback or when the heat pump is able to provide 100% of the heating demand. The temperature value should be determined from the thermal or capacity balance point between the heating load and heat pump capacity.

For homeowners focused on comfort, 25°F – 35°F is a typical range for the lockout temperature. For homeowners focused more on savings, this value can be set lower and near/at the capacity balance point.

#### Single- and two-stage wiring - defrost operation

Defrost control on most systems will still be able to activate the resistance heat – the typical wiring for a 24V heat pump allows the defrost control board to call for auxiliary heat even though the thermostat has them locked out from the temperature setting. Many single-stage, two-stage, and variable capacity systems will utilize a similar wiring strategy.

## Supply Air Temperature Sensor (SAT)

Supply air temperature sensors, available from some manufacturers, are an alternative method for regulating the auxiliary heat. Some thermostat systems and integrated control boards allow for the heat kit to run based on the supply air temperature.

The sensor will be a 10KΩ or 20KΩ resistor probe and is typically controlled by a dip switch on the control board – it is recommended to check with your manufacturer for details. By setting the plenum sensor to 85°F, the auxiliary heat will stage based on the SAT and remain off when it is not needed.

## Upstaging by Time

Multistage heating is most economic when controlled in stages. Upstage timers are timed options to engage additional stages of heat – think of downshifting in a car to get more torque to maintain speed when going uphill.

There are built-in dip switches on the control board that will have predetermined time lengths that you can select from in the manual. Thermostats will typically have options starting at 15 minutes and increasing in five- to 10-minute increments.

Longer run times are better – they keep temperatures consistent throughout the home and allow the system to operate in the most efficient way (running all day with the lowest capacity possible). Make sure to understand the homeowner's priorities between comfort and savings – timers may have to be adjusted if the temperatures are dropping too frequently when prioritizing longer runtimes.

## Upstaging by Droop Temperature

Droop was previously defined in the dual-fuel section above and can also be utilized for staging within all-electric systems. This method assesses a drop in room temperature compared to the set temperature. The typical setting is in the range of 1/2°F – 2°F per stage; the more stages there are, the lower this stage temperature can be.

It is important to understand how the customer will be operating their thermostat – the droop method may turn on resistance heat more often when programmed setback temperatures are larger than droop settings.

- Thermostat offset determines upstage (set temp – room temp)
- Two-stage heat typically set to 2°F
- The more stages you have, the lower the upstage temp
- Typically increases by 1/3°F, 1/2°F, 2°F, or 3°F

# Summary & Key Takeaways

- Modern dual-fuel thermostats need outdoor or supply air temperature measurement
- Not all heat pump thermostats are dual-fuel compatible
- Heat pumps operate ideally with proprietary thermostats

# Third-Party Thermostat Solutions

## WHAT PRODUCTS ARE AVAILABLE IN THE MARKET?

While it is always recommended to install a proprietary thermostat with the heat pump, there are a variety of third-party thermostat products available in the market for different types of Air Source Heat Pumps (ASHPs). Products are listed in the table below with information on dual-fuel and all-electric compatibility. All thermostats listed are compatible with single- and two-speed systems, while variable capacity compatibility is not available by default with any third-party thermostats and will depend on the equipment controls interface module.

Table courtesy of Center for Energy and Environment

| MANUFACTURER | MODEL | DUAL-FUEL COMPATIBLE? | ALL-ELECTRIC COMPATIBLE? |
|---|---|---|---|
| Honeywell | **Prestige IAQ** (All models) | Yes | Not compatible with Linevolt applications. * |
| | **T6 Pro** (TH6320U2008 & TH6220U2000) | Yes | Not compatible with Linevolt applications. * |
| | **T6 Pro** (TH6210U2001) | No | No |
| | **T6 Pro Smart** (TH6320WF2003) | Yes | Not compatible with Millivolt or Linevolt applications. * |
| | **T6 Pro Smart** (TH6220WF2006) | No | No |
| | **T10 Pro Smart** (THX321WFS2001W & THX321WF2003W) | Yes | Not compatible with Millivolt or Linevolt applications. * |
| | **RedLINK VisionPRO 8000** (TH8320R1003, TH8321R1001, & YTH8321R1002) | Yes | Not compatible with Millivolt or Linevolt applications. * |
| | **RedLINK VisionPRO 8000** (TH8110R1008) | No | No |
| | 3 | Yes | Not compatible with high voltage/ Linevolt applications. * |
| | 4 | Yes | |
| **Ecobee** | 2nd Gen | Yes | Not compatible with high voltage/ Linevolt applications. * |
| **Nest** | 3rd Gen | Yes | |

*A stepdown transformer may be a solution to controlling high voltage electric baseboard heat as these thermostats need a 24V connection, but this will always require further assessment depending on the thermostat model and system.

This table is meant to show a few examples of common third-party thermostat models, but it is not fully comprehensive of everything available in the market. It is essential to engage your distributor or manufacturer's representative when selecting a third-party thermostat to ensure it is compatible with the heat pump you are installing. In addition to equipment compatibility, it is also important to understand which controls features are available between the thermostat and equipment controls interface board.

If the third-party thermostat doesn't have a specific control feature you are looking to utilize, check with your manufacturer to understand if this feature is available when connected to the equipment controls interface board. Below are examples of important controls features to look for when planning full system controls between a third-party thermostat and equipment interface board.

- Droop temperature setting
- Ability to modify defrost operation
- Upstage timers
- Supply air temperature sensor input

# Detailed Example: Honeywell RedLINK

As noted in the table above, three of the four Honeywell RedLINK VisionPRO models are compatible with dual-fuel applications by default. They need to be modified to be compatible with all-electric applications. For this example, we will assume that this thermostat is being installed on a dual-fuel system with a furnace providing auxiliary heat when the heat pump can no longer deliver the needed capacity.

# Which Type of Heat Pump is Being Installed?

- **Single- or two-stage heat pumps** – this thermostat is compatible with these systems.
- **Variable capacity heat pumps** – this thermostat is not compatible with these systems, though it is possible that the equipment controls interface board may allow variable capacity system controls with this thermostat. It is critical to engage your distributor or manufacturer on variable capacity compatibility.

# Which Controls Settings Need to be Modified for a Heat Pump?

The table below shows some examples of default controls settings that would need to be changed for installation with a heat pump – it is important to refer to the installation guide for all settings as this example is not fully comprehensive.

| SETUP FUNCTIONS | | SETTINGS & OPTIONS (FACTORY DEFAULT IN BOLD) |
|---|---|---|
| **0170** | System Type | **Default: 1 heat/1 cool conventional**<br>Heat Pump Options:<br>» 1 heat/1 cool heat pump (no aux. heat)<br>» 2 heat/1 cool heat pump (with aux. heat)<br>» 2 heat/2 cool heat pump (no aux. heat)<br>» 3 heat/2 cool heat pump (with aux. heat) |
| **0173** | Heat Pump Type | **Default: Air to air heat pump**<br>Other Option: Geothermal heat pump |
| **0200** | Auxiliary Heat | **Default: Electric backup heat**<br>Other Option: Fossil fuel backup heat |
| **0350** | Heat Pump Compressor Lockout | **Default: No heat pump compressor lockout**<br>Other Options: 5°F to 60°F (-15°C to 15.5°C) |
| **0360** | Heat Pump Auxiliary Lockout | **Default: No heat pump auxiliary lockout**<br>Other Options: 5°F to 65°F (-15°C to 18.5°C) |

Table courtesy of Jordyn Purvins at Center for Energy and Environment

## What are the Default Values and Options for the Main Dual-Fuel Heat Pump Controls Strategies?

The table below shows some examples of defaults and options for the main dual-fuel heat pump controls strategies covered in this guide – it is important to refer to the installation guide for all settings as this example is not fully comprehensive.

| SETUP FUNCTIONS | | SETTINGS & OPTIONS (FACTORY DEFAULT IN BOLD) |
|---|---|---|
| **0340** | Remote Sensor | **Default: No remote sensor**<br>Other Options:<br>» Outdoor sensor (display only)<br>» Outdoor sensor for control (select lockouts and frost protection) |
| **0345** | Dual-Fuel Heat Pump Control | **Default: Droop control**<br>Other options:<br>» No droop control<br>» Droop control with aux. heat lockout |
| **0346** | Dual-Fuel heat pump upstage to furnace timer | **Default: 1 hour**<br>Other options:<br>» Off<br>» 0.5, 1.5, 2-6, 8, 10, 12, 14, 16 hours |
| **0347** | Droop temperature | **Default: 1°F (1°C)**<br>Other options: 2°F to 5°F (1°C to 2.5°C) |

Table courtesy of Jordyn Purvins at Center for Energy and Environment

## How Does The Auxiliary Heat Operate?

Below are the special functions described in the installation manual for how auxiliary heat can operate depending on the system configuration.

### Heat Pump Control – Fossil Fuel Supplemental (Setup Function 0345)

- **Option 0 (No Droop Control):** If outdoor temperature is above balance point (Function 0350), only the compressor operates. Below this temperature, only supplemental heat operates.
- **Option 1 (Droop Control):** As above, but supplemental heat is activated if room temperature drops to the selected droop temperature setting (compressor is deactivated).
- **Option 2 (Droop Control with Aux Heat Lockout):** Compressor works only above auxiliary lockout temperature, supplemental heat works only below balance point, 2°F droop between temperatures. If temperature is not reached in a reasonable time, set the upstage timer (Function 0346). After the designated time, the compressor will be deactivated and the system will switch to supplemental heat.

### Heat Pump Control – Electric Supplemental (Setup Functions 0350 – 0360)

If an outdoor temperature sensor is installed, select a compressor lockout temperature (Function 0350). Below this temperature, only electric resistance heat operates. An auxiliary lockout temperature (Function 0360) should also be selected. Above this temperature only the compressor operates. Between these temperatures, both heat sources operate.

# Ductless Air Source Heat Pump Systems

## Introduction

Mini-split heat pumps have grown in popularity in recent years and are increasingly the focus of energy efficiency programs and beneficial electrification efforts intended to reduce reliance on fossil fuels for space heating. Note, in this guide ductless heat pumps (DHPs) and ductless mini-splits are used interchangeably. Ductless mini splits can readily be retrofitted into spaces that lack a central forced-air heating and cooling system, making them popular choice for homes with existing boiler-based heat as well as for spaces such as converted attics and porches that lack an existing means for space conditioning.

A ductless mini-split heat pump consists of two parts: an outdoor unit containing the compressor that drives the heating and cooling for the system and one or more wall-mounted indoor units (heads) that distribute warmed or cooled air to the rooms in which they are located. The two parts are connected by a cable bundle that contains electrical connections, refrigerant lines, and a drain line for condensate from the indoor unit.

The fact that these systems can readily be retrofitted into homes with existing space heating systems also creates a potential system-coordination issue, however. Mini-split systems are generally installed to be operated independently, with temperature sensed and controlled at the indoor head. If a separate heating (or cooling) system with its own thermostat is also present, the two systems may not be well coordinated.

The purpose of this guide is to present efficient methods to control the separate systems. The first method is the droop method. The droop method will utilize separate controls with off-set heating set points. When using the droop method, the heat pump thermostat is the primary thermostat control. The second method will be the use of integrated controls. This would be a single thermostat that can control both the ductless heat pump and the existing heat source.

# Thermostat Selection

Ductless air source heat pumps are inverter driven, communicating systems. The wire between the indoor and outdoor unit is used to send signals between them to coordinate operation. Most ductless heat pumps are controlled with a wand style remote, Webapp, or a communicating remote thermostat. These systems allow full communication between the indoor and outdoor unit as well as temperature sensors. When selecting a thermostat, keep in mind that these systems are proprietary systems. The factory provided controls are the best way to efficiently control the units.

Many ductless manufacturers have kits to allow the use of third-party thermostats to control their units. Third party thermostats are on/off controllers and do not communicate with the indoor or outdoor unit in the same way as the manufacturer controls will, this will cause loss of staging control and limit capabilities of the heat pump.

## Thermostat Wand

- This is the most common factory provided control. The wand sets the temperature for the indoor unit and the temperature is read at the return air temperature sensor built into the indoor unit. The control board built in the indoor unit will monitor and adjust operation to meet the need of the installed location.

## Web App

- Many manufacturers have built in Wi-Fi abilities that allow similar control of the indoor unit through a manufacturer App or web portal.
- This control allows programing and a larger user interface than the wand style controller. It requires a Wi-Fi connection.

## Wall Thermostat

- The wall thermostat is a wired communicating thermostat that connects to the indoor unit and adds the benefit of a remote temperature sensor.
- Larger rooms that are heated and cooled by a DHP can be better controlled with this addition when the thermostat is located in a proper area where it will be able to read a mixed air temperature during operation.  Some manufacturers may sell wall mounted controllers that are not actually thermostats, so be sure to verify before installation.

## Third Party Controls Adaptor

- Allows the use of third party 24V thermostat.
- Many outdoor units lose staging or dehumidification abilities.

# Separate Thermostats

When utilizing the manufacturer specific controls like the thermostat wand, webapp, or communicating wall thermostat, you will need to maintain separate controls and settings for the secondary heat. The most common method is the "droop" method.

## Droop Setting

**What is droop?** Droop is a specified temperature value that defines the maximum allowable temperature swing below the heating setpoint before secondary heat is engaged. Droop is typically set between one and three degrees, and the system controls will define a maximum value that droop is allowed to be set at (e.g.: five degrees). This controls strategy method requires an indoor temperature sensor to tell the system to engage secondary heat when the temperature drops below the set droop value under the set point.

**Droop Setting Selection.** Selection of a droop temperature will depend on whether the customer wants to prioritize system efficiency or occupant comfort. Maximizing the droop temperature will result in higher efficiency, while minimizing the droop temperature will improve comfort. While the selected value can change depending on many system factors, rough recommendations are provided below.

- **2 degrees – typically recommended for cold climates.**
- **1 degree – lower for comfort**
- **3 degrees – higher for efficiency**

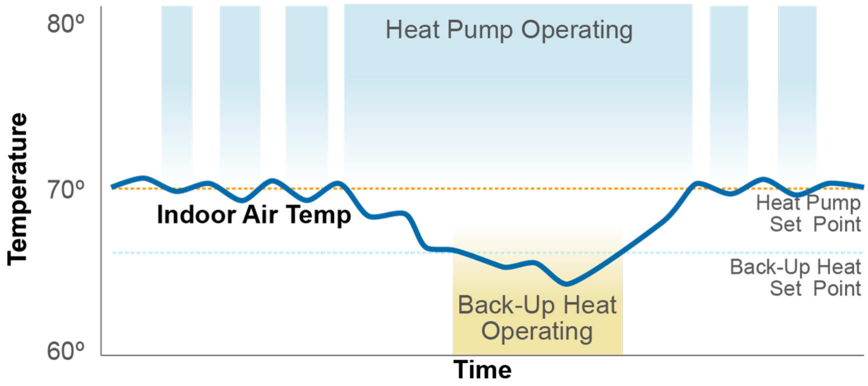
**Droop Setting Example**

**Indoor Temperature Set Point = 70°F**

**Droop Setting = 3°F**

**70°F – 3°F = 67°F**

Since the droop is set at 3°F below the set point 70°F, the secondary heating system will engage when the indoor air temperature is measured to be less than 67°F




Graph courtesy of NYSERDA's Controls Training

Using separate thermostats will maintain the existing controls for the secondary heating system and the ASHP. Set your thermostat for the heat pump to your desired room temperature in the heating mode. Set thermostat for the secondary heating system at a lower temperature typically two degrees lower than the desired set point. The temperature difference in the set points is the droop. In the droop method, the ASHP runs as the primary source of heat, once the room temperature drops lower, the secondary heating system will turn on and prevent discomfort. The droop method is the least expensive way to operate the ductless ASHP. The illustration above shows the operation of the heat pump in blue and the secondary heat coming on when needed as the room droops below the ASHP set point.

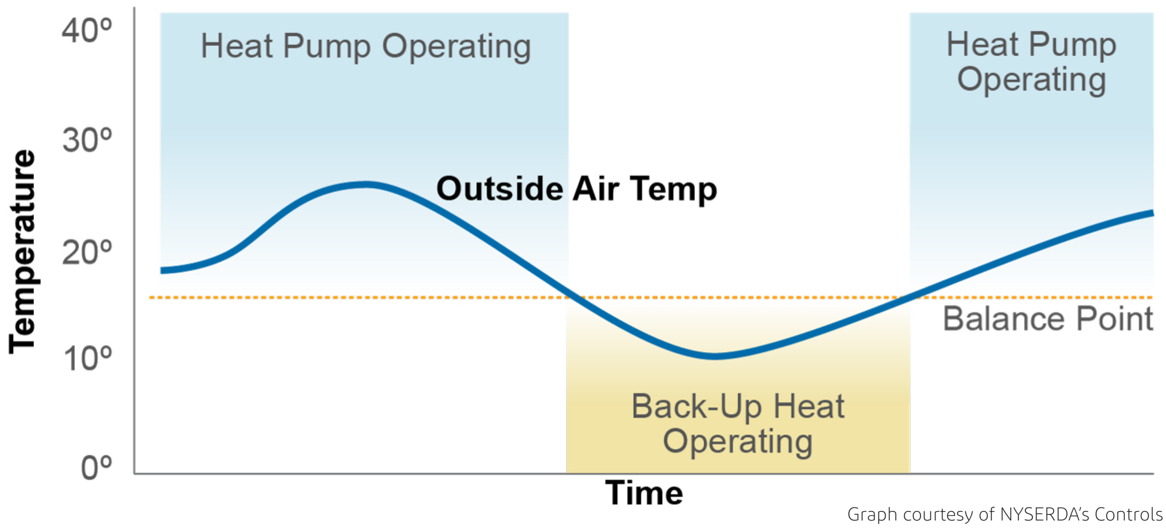
# Integrated Controls

Integrated controls require a manufacturer interface device which will allow the heat pump and the secondary heating system to be connected to the same control or thermostat. Heat pumps do not require integrated controls, but they can be added when a single control is desired. Integrated controls may affect the performance and efficiency of the heat pump as they may interfere with communication of the heat pump system. Check with the manufacturer, distributor and installation contractor before installing integrated control systems to be sure the effects of the controls will not cause reductions in efficiency. When the heat pump is sized for partial heating loads or the secondary heat is high efficiency, integrated controls may provide a more seamless operation of both heat sources and allow for "set it and forget it" operation.

Integrated controls should be set to prioritize the ASHP as the primary heat source for first stage operation. Switchover to the secondary heating system can happen in two ways, upstaging by droop, or switchover to the secondary heat.

Staging by droop is the same as using droop with separate controls except that one thermostat is controlling both systems. Utilizing droop is best when the secondary heat energy source is expensive such as electric baseboard heat, a propane or fuel oil furnace, as well as a propane boiler. Utilizing both systems at the same time has the benefit of prioritizing the most efficient system being the ASHP and systems will deliver heat until the temperature can be maintained by the ASHP.

The switchover method acts the way a ducted dual-fuel system does. The control will require an outdoor temperature reading either through a Wi-Fi connection or a wired outdoor temperature sensor. Use of the switchover method will require knowledge of the capacity balance point or the calculation of the economic balance point in order to be set based on the homeowners' goals. The illustration below shows the heat pump operation in blue the switch over to the secondary heat in yellow, and the switch back to the heat pump based on the outdoor temperature setting for switch over. Note that with this scenario, the heat pump and secondary heating system are not working simultaneously.




Graph courtesy of NYSERDA's Controls Training

### THERMAL BALANCE POINT

» The outdoor temperature at which the heat pump can no longer produce the heat needed for the home.

» Also called capacity balance point.

### ECONOMIC BALANCE POINT

» The outdoor temperature at which the cost to heat the home with the HP is the same or more expensive than the secondary heat cost.

» Depends on both the primary and secondary heat fuel cost.

### COMFORT BALANCE POINT

» The outdoor temperature at which the homeowner experiences discomfort when running the heat pump.

» Typically the economic balance point + 1°F to 5°F or controlled with a supply air temperature sensor

## Switchover Temperature Selection

**What is a switchover temperature?**

A switchover temperature is a defined outdoor ambient temperature at which the heat pump should no longer be used for heating, turning on the secondary heat system to supply the heating load.

## Switchover Temperature = Balance Point = Compressor Lock Out*

*For some controls/thermostats, both a switchover temperature and a separate compressor lockout are available. For other brands, the compressor lockout is used as the switchover temperature.

**Switchover Temperature Selection.**

The switchover temperature can be selected depending on the home heating load or if the homeowner cares more about cost savings or occupant comfort.

It is very important to consider the Thermal or Capacity Balance Point of the equipment related to the home heating load and the needs of the homeowner when determining the switchover temperature. In addition to the initial selection, the switchover temperature should be recorded and monitored over time so that changes can be made to ensure the best possible customer experience and avoid callbacks.

» **For more detail on switchover temperature selection, please refer to the Switchover Guide, available on the GoElectric website: GoElectric.ComEd.com on the For Contractors page.**

# Summary & Key Takeaways

» Integrated controls may affect operation of multistage and variable capacity heat pumps the manufacturer should be consulted to ensure the integrated controls will not cause a loss of efficiency when used.

» Integrated controls should be checked for compatibility before being used.

» Hydronic heat sources may have a warmup period that is longer than a forced air system, this can cause a delayed response when controlled by the droop method.

» Controls can and should be adjusted for comfort or efficiency, adjust in small increments until the desired goals are achieved.

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