Technical Bulletin: Smart Equipment™ Controls Sequence of Operation Overview

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Contents

Introduction

This document provides an overview of the controls system components, supported features, and operating modes of packaged units and split system units with a Smart Equipment™ controller.

Overview

Some sequences in this document use operational setpoints and temperatures. Operational setpoints and temperatures are the values that the control uses at a specific moment. The following examples show setpoints and temperatures in sequences.

- On a variable air volume (VAV) unit, the operational VAV cooling setpoint can be either the supply air temperature (SAT) upper setpoint or the SAT lower setpoint. The temperature and humidity control sequence can alter both the SAT upper setpoint or SAT lower setpoint. See Temperature and humidity control for additional information.
- Sequences such as demand ventilation, fixed variable, or low ambient can alter the economizer minimum position. See VAV economizer minimum position reset for additional information.
- The operational space temperature can be from a space sensor, net sensor, a communicated value, or the value of the return air temperature sensor in the absence of a space sensor. You can view all of the operational setpoints and temperatures on the UCB local display.

System parameters

Several heating, cooling, unit protection, and timer parameters affect the heating and cooling operation for both constant volume and variable air volume sequences. Ensure that they are set appropriately for proper operation.

Adaptive tuning

Use adaptive tuning to change the cooling and heating reaction time for the staged percent command.

Adaptive tuning only operates on multi-stage units. When adaptive tuning is on, the adaptive tuning learning feature is enabled.

Heating parameters

The heating parameters include the following items:

- Heating mode enabled for operation (**Htg-En**)
- Number of heating stages installed (**#HtgStgs**)
- Heating type (**Htg-Type**)
- Fan on delay for heat (**FanOnDlyHeat**)
- Fan off delay for heat (**FanOffDlyHeat**)
- OA heating cutout setpoint (**HtgOATCutout**)

No heat setup

Heating enabled is set to off.

Gas heat setup

Heating enabled is set to on.

Number of heating stages is set to 1, 2, or 3.

Number of gas valves is set to 1, 2, or 3.

Heating type is set to staged.

Electric heat

Heating enabled is set to on.

Number of heating stages is set to 1, 2, or 3.

Number of gas valves is set to 0.

Heating type is set to staged.

Hydronic heat

Heating enabled is set to on.

Heating type is set to proportional.

Cooling parameters

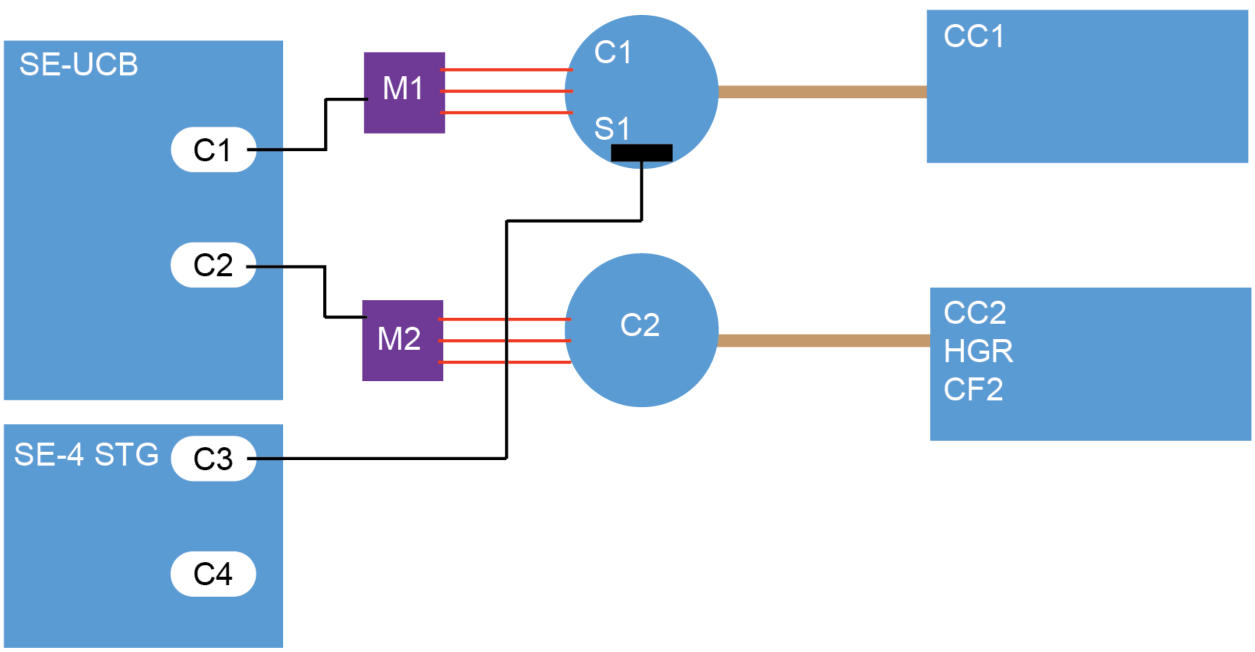
The cooling parameters include the following items:

- Cooling mode enabled for operation (**Clg-En**)
- Number of cooling stages installed (**#ClgStgs**)
- Fan on delay for cool (**FanOnDlyCool**)
- Fan off delay for cool (**FanOffDlyCool**)
- OA cooling cutout enable (**ClgOATCutout-En**)
- OA cooling cutout setpoint (**ClgOATCutout**)

Unique Equipment Identifiers

Figure 1: MAP View - 2 Stage Cir1 With Single Cir2

Figure 2: 2 Stage Compressor on Circuit 1 with a Single Compressor on Circuit 2

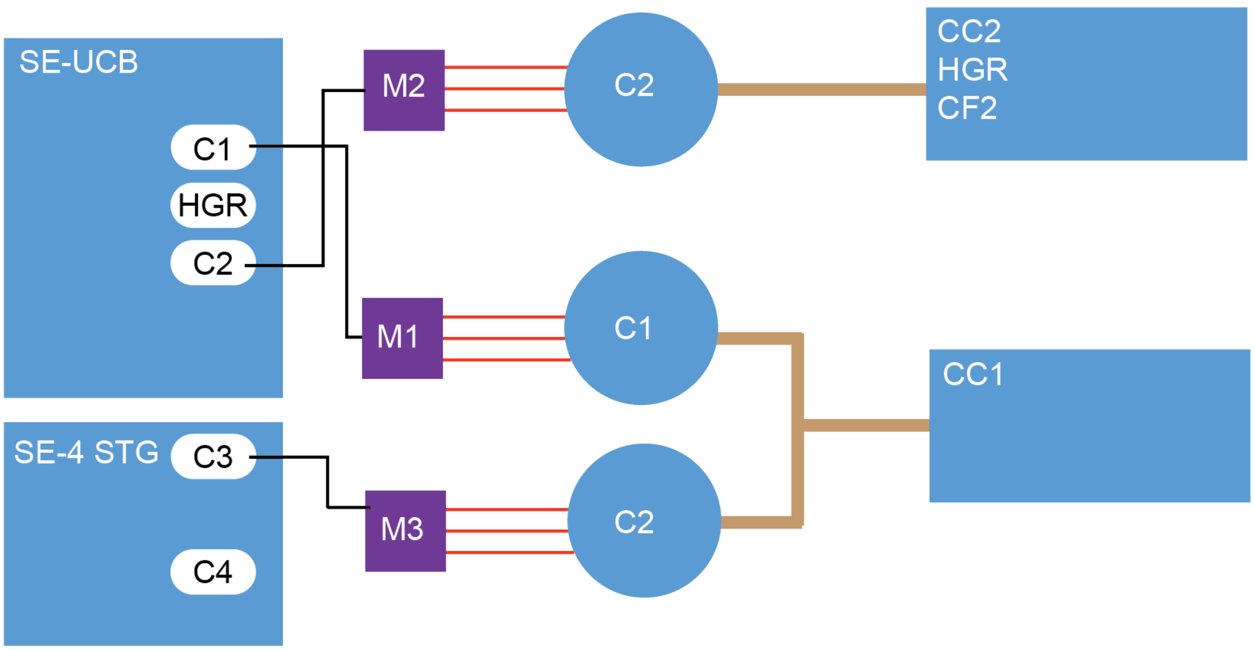


- HGR operation is associated with the C2 output.
- Modulating HGR operation is available.
- HGR Binary output is associated with bleed valve functionality.
- Both condenser fan outputs need to be active any time a compressor is active. CF2 may be turned off if HGR operation is active and outdoor air temp is too low.

- 2 stage make/break percentages adjusted to account for capacity differences.
- C3 output is linked to C1 faults/sensors
- Evaporator Leaving Air temperature needs to use the EC4 analog input on the 4 stage board.

Figure 3: MAP View - Tandem Cir1 With Single Cir2

Figure 4: Tandem Compressors on Circuit 1 with a Single Compressor Circuit 2



- HGR operation is associated with the C2 output.
- Modulating HGR operation is available.
- HGR Binary output is associated with bleed valve functionality.
- Both condenser fan outputs are active any time a compressor is active. CF2 will be turned off if HGR operation is active and outdoor air temp is too low.
- Tandem circuit make/break percentages are adjusted to account for capacity difference.
- C3 output is linked to C1 faults/sensors.
- Evaporator Leaving Air temperature uses the EC4 analog input on the 4 stage board.

Method (non-HGR functionality) Implementation

A new configuration point has been added which is required to be set. Setting this point correctly for this equipment is necessary to distinguish this equipment from others.

- The display information is automatically configured to ignore the normal sensors associated with the C3 and C4 outputs. However, the Cooling Stage 3 area will still display many applicable indications (Status, Command, Runtime, etc). All Cooling Stage 4 parameters are hidden.
- The EC4 input is rerouted to the Evaporator Leaving Air Temp.
- 4 stages of cooling are available, with make/break points at approximately 25%, 50%, 75%, and 100%.
- Start Count minimization functionality enforced.

Figure 5: MAP View - Inverted Single Cir1 With Single Cir2

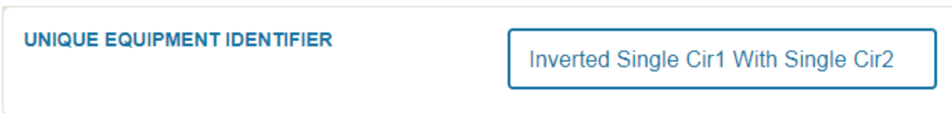
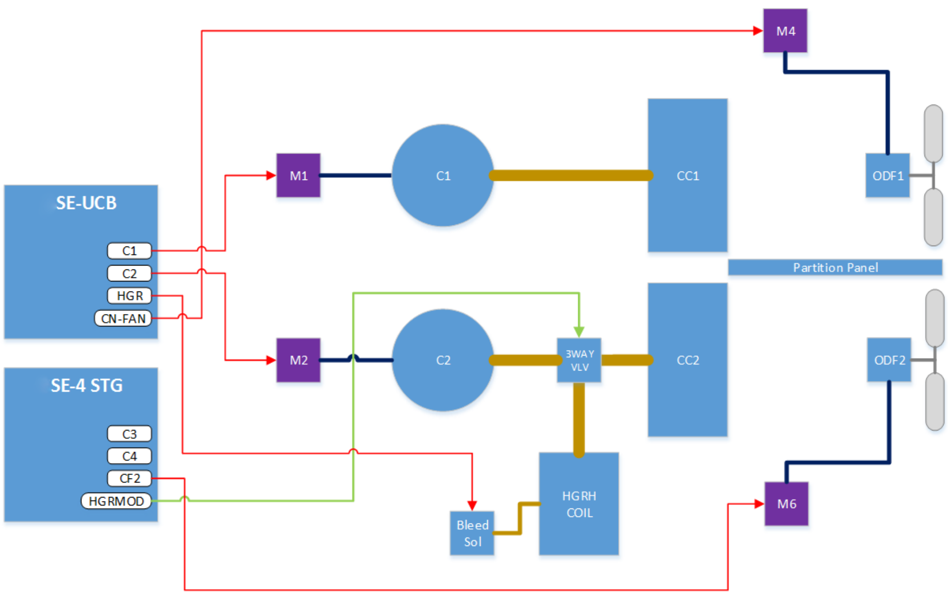


Figure 6: Inverted Single Compressor on Circuit 1 with Single Compressor on Circuit 2



- HGR operation is now associated with the C2 output (hence the term "inverted").
- Modulating HGR operation is available
- HGR Binary output is associated with bleed valve functionality
- Both condenser fan outputs are active any time a compressor is active. CF2 may be turned off if HGR operation is active and outdoor air temp is too low.
- Evaporator Leaving Air temperature uses the EC4 analog input on the 4 stage board.

Method (non-HGR functionality) Implementation

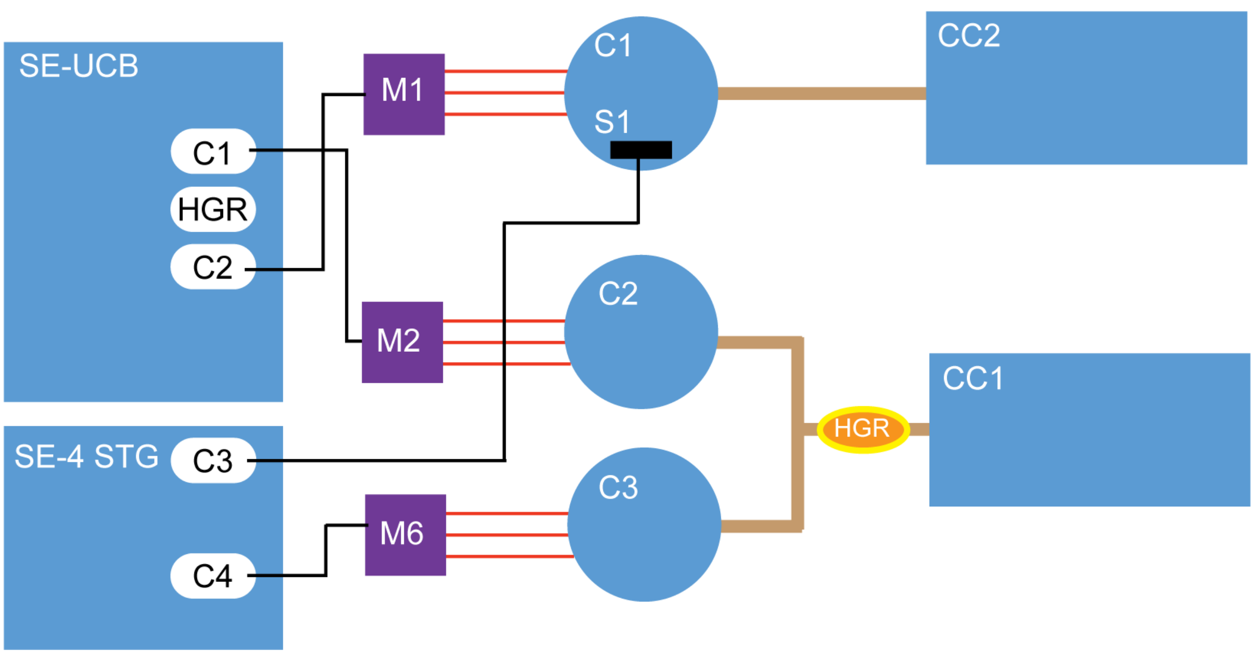
A new configuration point has been added which is required to be set. Setting this point correctly for this equipment is necessary to distinguish this equipment from others.

- The display information is automatically configured to ignore the normal sensors associated with the C3 and C4 outputs. However, the Cooling Stage 3 area will still display many applicable indications (Status, Command, Runtime, etc). All Cooling Stage 4 parameters are hidden.
- The EC4 input is rerouted to the Evaporator Leaving Air Temp.
- 2 stages of cooling are available, with make/break points at approximately 50%, and 100%
- Start Count minimization functionality enforced

Ultra High Efficiency Compatibility

Figure 7: MAP View - Tandem Cir1 With Single Cir2

Figure 8: Ultra High Efficiency Unit with Tandem Compressors on Circuit 1 with 2 Stage Compressor on Circuit 2



- Fully load circuit 1 when utilizing HGR
- Ignore faults/sensors normally used with C3 and C4 outputs (example: EC3, LPS3, LPS4)
- Apply faults/lockouts to appropriate devices (example: LPS1 applies to C4)
- Hide Lead/Lag configuration point. Default is always set to disable this functionality.

Implementation Method

A new configuration point has been added which is required to be set. Setting this point correctly for this equipment is necessary to distinguish this equipment from others.

- When a demand to energize the HGR valve with the C1 output is present, the C4 output is automatically tied to C1 output.
- The display information is automatically configured to ignore the normal sensors associated with the C3 and C4 outputs. However, the Cooling Stage 3 and Cooling Stage 4 areas will still display many applicable indications (Status, Command, Runtime, etc).

User Interaction

1. Menu Location(s):
    1. a. Commissioning → Quick Start

       b. Commissioning → Standard
2. Name: Unique Equipment Identifier
3. REQUIRED VALUE: 2 Stage Cir1 With Tandem Cir2 (enum member 1)

Figure 9: MAP View - 2 Stage Cir1 With 2 Stage Cir2

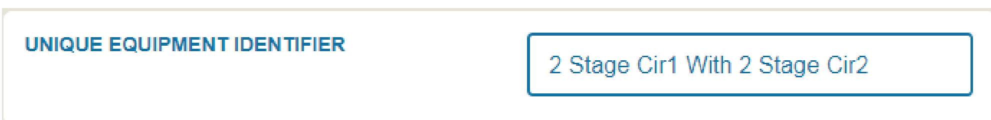
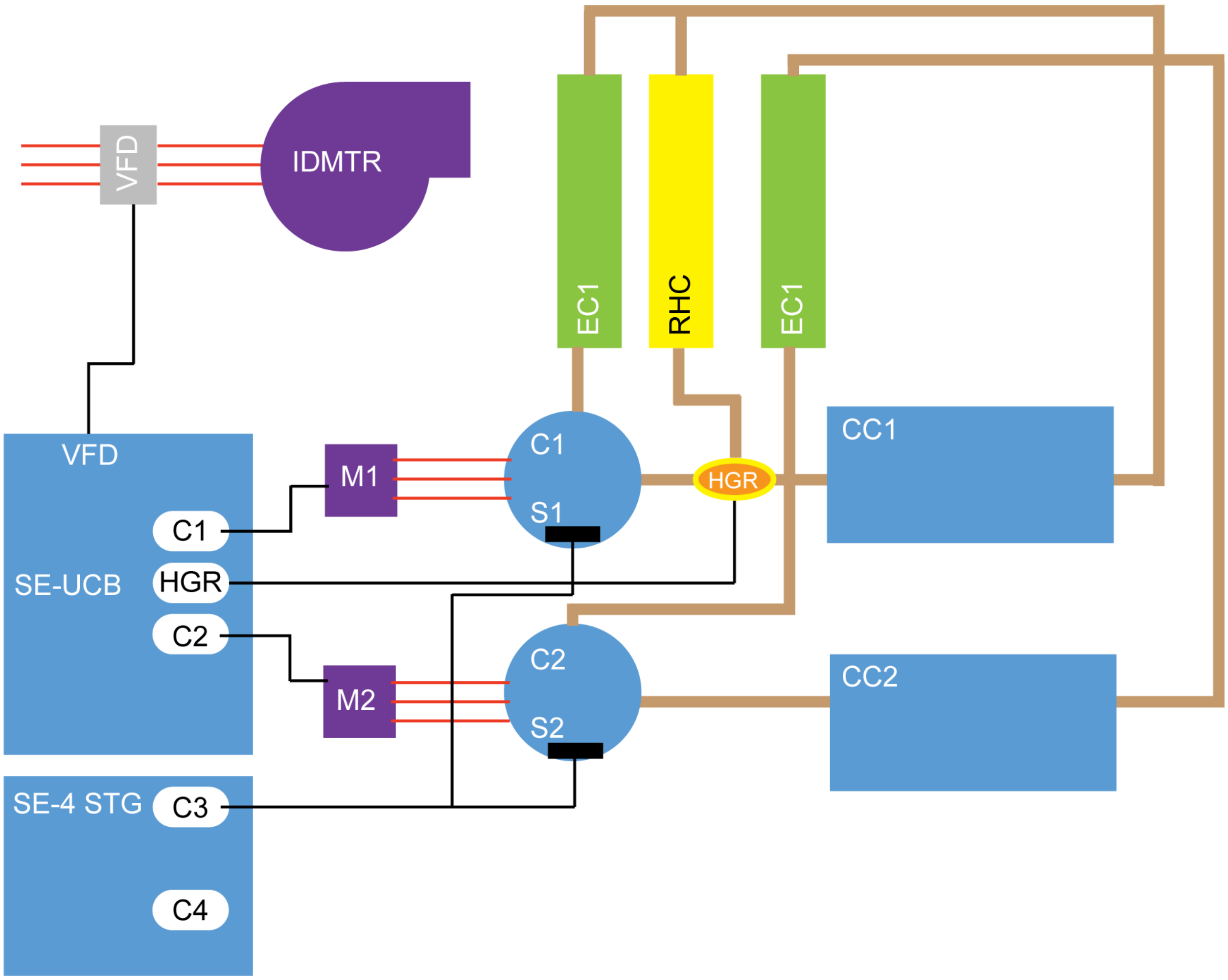


Figure 10: Ultra High Efficiency Unit with Dual 2 Stage Compressors



- Fully load circuit 1 when utilizing HGR.
- Ignore faults/sensors normally used with C3 and C4 outputs (example: EC3, LPS3, LPS4).
- Hide Lead/Lag configuration point. Default is always set to disable this functionality.

Implementation Method

A new configuration point has been added which is required to be set. Setting this point correctly for this equipment is necessary to distinguish this equipment from others.

- When a demand to energize the HGR valve with the C1 output is present, the C3 output is automatically tied to C1 output.
- The display information is automatically configured to ignore the normal sensors associated with the C3 and C4 outputs. However, the Cooling Stage 3 area will still display many applicable indications (Status, Command, Runtime, etc). All Cooling Stage 4 parameters are hidden.

User Interaction

1. Menu Location(s): a. Commissioning → Quick Start b. Commissioning → Standard

2. Name: Unique Equipment Identifier
3. Required value: 2 Stage Cir1 With 2 Stage Cir2 (enum member 2)

Unit protection

Timers

The timers include the following items:

- Anti-short cycle delay (ASCD) cool: 300 seconds
- Min comp runtime: 180 seconds
- Min heat runtime: 180 seconds
- ASCD heat: 120 seconds
- Heat to cool delay: 300 seconds
- Cool to heat delay: 120 seconds

The sequences described within this document assume all safeties are closed. See Unit protection for additional information.

A heating to cooling and cooling to heating changeover timer must expire before any heating or cooling functions occur.

Operational values

Operational space temperature

Related data and inputs

The related data and inputs include the following items:

- Operational space temperature (**OprST**)
- Space temperature source (**STSrc**)
- Network override space temperature (**NetST**) communicated input on FC bus
- Net sensor space temperature value to SA bus
- Space temperature input (**ST**) to ST and COM
- Return air temperature input (**RAT**) to RAT pins

Operation

The operational space temperature (**OprST**) uses the assigned priority levels for inputs ranked from highest to lowest in the following order:

1. Network override space temperature
2. Net sensor space temperature value (**NetST**)
3. Space temperature input (**ST**)
4. Return air temperature input (**RAT**)

If the input in use becomes invalid, operational space temperature (**OprST**) reverts to the next highest priority input.

When Single Setpoint mode is enabled, the control will automatically determine if it is in heating or cooling mode. If the zone temperature exceeds the Common Setpoint, cooling or heating (depending on mode of operation) will be initiated. The control will change between heating and cooling mode if the zone temperature exceeds the Common Setpoint +/- the Auto Changeover.

The space temperature source (**StSrc**) describes the input in use for the operational space temperature (**OprST**), and the indications include the following items:

BAS Override

Indicates the network override space temperature (**NetST**)

Network Sensor

Indicates a NetSensor

Local Input

Indicates a space temperature input (**ST**)

Return Air Temp

Indicates the return air temperature (**RAT**)

Unreliable

Indicates no valid input is available for the operational space temperature (**OprST**) and the control functions that use the **OprST** are not permitted

The network override space temperature is used if a value is set or communicated within the last 15 minutes. If 15 minutes pass without a communicated value, the UI displays `Value Timed Out` and the next highest priority input is used.

The net sensor space temperature value is used after approximately 30 seconds from the time a net sensor with space temperature capability is connected to the SA Bus.

Space temperature input is used if the temperature sensor is connected to the ST and COM terminals.

Return air temperature input is used if the temperature sensor is connected to the RAT pins.

Operational space temperature setpoint offset

Setpoints and related data

The setpoints and related data include the following items:

- Operational space temperature setpoint offset (**OprSSO**)
- Space temperature setpoint offset source (**SSOSrc**)
- Space temperature setpoint offset range (**SSORange**)

Inputs

The inputs include the following items:

- Network override space setpoint offset (**NetSSO**) communicated on the FC Bus
- Net sensor space temperature setpoint offset to the SA Bus
- Space temperature offset input (**SSO**) to SSO and COM terminals

Operation

The space temperature setpoint offset range sets the maximum amount a net sensor space setpoint offset or the space temperature setpoint offset input can offset the operational space temperature setpoint offset (**OprSSO**). The selectable range is 0.0°F to 5°F in 0.1°F increments.

ⓘ **Note:** The network override space setpoint offset is not bound by the space temperature setpoint offset range (**SSORange**).

The highest valid priority input is used for the operational space temperature setpoint offset (**OprSSO**). The operational space temperature setpoint offset assigns priority levels for inputs in the following highest to lowest order:

- Network override space setpoint offset (**NetSSO**)
- Net sensor space setpoint offset
- Space temperature setpoint offset input (**SSO**)

If the input in use becomes invalid, the operational space temperature (**OprST**) reverts to the next highest priority input.

The space temperature setpoint offset source (**StSrc**) describes the input in use for the operational space temperature (**OprST**), and the indications include the following items:

BAS Override

Indicates the network override space setpoint offset

Network Sensor

Indicates a net sensor

Local Input

Indicates a space temperature offset input (**SSO**)

Unreliable

indicates no valid input is available and CV occupied cooling setpoint (**ClgOcc-Sp**) and CV occupied heating setpoint (**CVHtgOcc-SP**) are not offset

The network override space setpoint offset is used if a value is set or communicated within the last 15 minutes. If 15 minutes pass without a communicated value, then the UI displays `Value Timed Out` and the next highest priority input is used.

The net sensor space setpoint offset is used after approximately 30 seconds from the time a net sensor with space temperature setpoint offset capability is connected to the SA Bus.

The space temperature setpoint offset input is used if the space sensor is connected to the SSO and COM terminals.

If a valid input is not available for the operating space temperature setpoint offset, the CV occupied cooling setpoint (**ClgOcc-Sp**) and the CV occupied heating setpoint (**CVHtgOcc-SP**) are not offset.

The operational space temperature setpoint offset (**OprSSO**) value is either added to or subtracted from both the CV occupied cooling setpoint and the CV occupied heating setpoint.

The CV operating cooling setpoint and the CV operating heating setpoint are determined by the current occupancy mode. See Setpoint determination for additional information.

Operational outdoor air temperature

Setpoints and related data

The setpoints and related data include the following items:

- Operational outdoor air temperature (**OprOAT**)
- Outdoor air temperature source (**OATSrc**)

Inputs

The inputs include the following items:

- Network override outdoor air temperature (**NetOAT**) communicated value on FC bus
- Outdoor air temperature input (**OAT**) to OAT pins

Operation

The highest valid priority input is used for operational outdoor air temperature. The operational outdoor air temperature has assigned priority for inputs in the following order from highest to lowest:

- Network override outdoor air temperature (**NetOAT**)
- Outdoor air temperature input (**OAT**)

If the input in use becomes invalid, the operational outdoor air temperature (**OprOAT**) reverts to the next highest priority input.

The outdoor air temperature source describes the input in use for the operational outdoor air temperature, and the indications include the following items:

BAS Override

Indicates the network override outdoor air temperature

Local Input

Indicates outdoor air temperature input

Unreliable

Indicates no valid input is available and control functions that use operational outdoor air temperature (**OprOAT**) are not permitted

The network override space setpoint offset is used if a value is set or communicated within the last 15 minutes. If 15 minutes pass without a communicated value, the UI displays `Value Timed Out` and the next highest priority input is used.

The outdoor air temperature input (**OAT**) is used if the temperature sensor is connected to the OAT pins.

Operational space humidity

Setpoints and related data

The setpoints and related data include the following items:

- Operational space humidity (**OprSH**)
- Space humidity source (**SHSrc**)

Inputs

The inputs include the following items:

- Network override space humidity (**NetSH**) communicated value on FC bus
- Net sensor space humidity value to the SA bus
- Return air humidity (**RAH**) to RAH pins

Dirty Filter Switch can be used for Dehum call

DFS ships as the default setting, but when HGR-En is on, a new point appears “UseDFSforDehum” with enum set “Enabled/Disabled”, default "Disabled". If Disabled, DFS will still alarm Dirty Filter Switch. If Enabled, the HGR Sequencer will read DFS input for a binary call for dehumidification, the same as if RAH% were above setpoint. Normal, Alternate and Auxiliary modes will still work as described. Dehumidification will only shut off when the DFS input goes low. If DFS is used for Dehumidification, that will exclude the use of a Dirty Filter Switch.

A point has been added under the Details → Hot Gas Reheat → Setup menu called “Use DFS For Dehum”. When this is enabled, a high logic signal on the DFS input represents a call to dehumidify. DFS alarms are masked when using this input for dehumidification behavior.

Operation

The operational space humidity (**OprSH**) is only effective if an input has been present since the last RELEARN SYSTEM (Relearn) was performed. The operational space humidity (**OprSH**) parameter is then shown in the UCB display.

The highest priority valid input is used for the operational space humidity (**OprSH**). The operational space humidity (**OprSH**) has assigned priority for inputs in the following order from highest to lowest:

- Network override zone humidity (**NetSH**)
- Net sensor space humidity value
- Space humidity RAH input (**RAH**)

If the input in use becomes invalid, the operational space humidity reverts to the next highest priority input.

The space humidity source describes the input in use for the operational space temperature, and the indications include the following items:

BAS Override

Indicates network override zone humidity

Network Sensor

Indicates a net sensor

Local Input

Indicates space humidity RAH input

Unreliable

Indicates no valid input is available and control functions that use operational space temperature (**OprSH**) are not permitted

The network override zone humidity is used if a value is set or communicated within the past 15 minutes. If 15 minutes pass without a communicated value, the UI displays `Value Timed Out` and the next highest priority input is used.

The net sensor space humidity value is used after approximately 30 seconds from the time a net sensor with space humidity capability is connected to the SA BUS.

The space humidity RAH input is used if the humidity sensor is connected to the RAH pins on the UCB.

If no valid related input is available for the operational space humidity, control functions that use operational space humidity (**OprSH**) are not permitted.

Operational outdoor air humidity

Setpoints and related data

The setpoints and related data include the following items:

- Operational outdoor air humidity (**OprOAH**)
- Outdoor air humidity source (**OAHSrc**)

Inputs

The inputs include the following items:

- Network override outdoor air humidity (**NetOAH**) communicated value on FC Bus
- Outdoor air humidity input (**OAH**) to OAH terminals

Operation

Operational outdoor air humidity (**OprOAH**) is only effective if an economizer board has been connected to the UCB and an input has been present since the last RELEARN SYSTEM (Relearn) was performed. The operational outdoor air humidity (**OprOAH**) parameter then appears in the UCB display. The network override outdoor air humidity (**NetOAH**) and outdoor air humidity input (**OAH**) parameters are only shown in the UCB display menu if an economizer board is connected to the UCB.

The highest priority valid input is used for the operational outdoor air humidity (**OprOAH**). The operational outdoor air humidity (**OprOAH**) has assigned priority for inputs in the following order from highest to lowest:

BAS Override

Indicates network override outdoor air humidity

Local Input

Indicates outdoor air humidity input

Unreliable

Indicates no valid input is available and single enthalpy and dual enthalpy economizer free cooling changeover methods that use operational outdoor air humidity (**OprOAH**) are not permitted

Network override outdoor air humidity (**NetOAH**) is used if a value is set or communicated within the past 15 minutes. If 15 minutes pass without a communicated value, the UI displays `Value Timed Out` and the next highest priority input is used.

Outdoor air humidity input (**OAH**) is used if the humidity sensor is connected to the OAH terminals.

Operational indoor air quality

Setpoints and related data

The setpoints and related data include the following items:

- Operational indoor air quality (**OprIAQ**)
- Indoor air quality source (**IAQSrc**)
- Indoor air quality sensor range (**IAQRange**)

Inputs

The inputs include the following items:

- Network override indoor air quality (**NetIAQ**) communicated value on FC Bus
- Indoor air quality (**IAQ**) to COM terminals

Operation

Operational indoor air quality (**OprIAQ**) is only effective if an economizer board has been connected to the UCB since the last RELEARN SYSTEM (Relearn) was performed. The operational indoor air quality (**OprIAQ**) and network override indoor air quality (**NetIAQ**) parameters are then shown in the UCB display menu.

The highest priority valid related input is used for operational indoor air quality (**OprIAQ**).

The operational indoor air quality (**OprIAQ**) has assigned priority for inputs in the following order from highest to lowest:

- Network override indoor air quality (**NetIAQ**)
- Indoor air quality (**IAQ**)

If the input in use becomes invalid, operational indoor air quality (**OprIAQ**) reverts to the next highest priority input.

The indoor air quality sensor range (**IAQRange**) must be set to match the ppm range of the sensor being used. This allows the control to properly calibrate the 0-10 VDC input from the sensor to match the actual ppm measured by the sensor.

ⓘ **Note:** Network override indoor air quality (**NetIAQ**) is not bound by the indoor air quality sensor range (**IAQRange**)

Indoor air quality source (**IAQSrc**) describes the input currently in use for operational indoor air quality (**OprIAQ**).

BAS Override

Indicates network override indoor air quality

Local Input

Indicates indoor air quality sensor

Unreliable

Indicates no valid related input is available and demand ventilation economizer functions that use operational indoor air quality are not permitted

Network override indoor air quality (**NetIAQ**) is used if a value is set or communicated within the past 15 minutes. If 15 minutes pass without a communicated value, the UI displays `Value Timed Out` and the next highest priority input is used.

Indoor air quality (**IAQ**) is used if the IAQ sensor is connected to the IAQ and COM terminals.

Operational outdoor air quality

Setpoints and related data

The setpoints and related data include the following items:

- Operational outdoor air quality (**OprOAQ**)
- Outdoor air quality source (**OAQSrc**)
- Outdoor air quality sensor range (**OAQRange**)

Inputs

The inputs include the following items:

- Network override outdoor (**NetOAQ**) communicated value on the FC Bus
- Outdoor air quality (**OAQ**) to OAQ and COM terminals

Operation

Operational outdoor air quality (**OprOAQ**) is only effective if an economizer board has been connected to the UCB and a related input has been present since the last RELEARN SYSTEM

(Relearn) was performed. The operational outdoor air quality (**OprOAQ**) parameter is then shown in the UCB display menu. The network override outdoor air quality (**NetOAQ**) parameter is only shown in the UCB display menu if an economizer board is connected to the UCB and triggers the economizer board presence indicator.

The highest priority valid related input is used for operational outdoor air quality (**OprOAQ**).

The operational outdoor air quality (**OprOAQ**) has assigned priority for inputs in the following order from highest to lowest:

- Network override outdoor air quality (**NetOAQ**)
- Outdoor air quality (**OAQ**)

If the input in use becomes invalid, operational outdoor air quality (**OprOAQ**) reverts to the next highest priority input.

Outdoor air quality sensor range (**OAQRange**) must be set to match the ppm range of the sensor being used. This allows the control to properly calibrate the 0 to 10 VDC input from the sensor to match the actual ppm measured by the sensor.

Note: Network override outdoor air quality (**NetOAQ**) is not bound by the outdoor air quality sensor range (**OAQRange**)

Outdoor air quality source (**OAQSrc**) describes the related input in current use for operational outdoor air quality (**OprOAQ**):

BAS Override

Indicates network override outdoor air quality

Local Input

Indicates outdoor air quality sensor

Unreliable

Indicates no valid related input is available for and the differential demand ventilation economizer function that uses operational outdoor air quality (**OprOAQ**) is not permitted

Network override outdoor air quality (**NetOAQ**) is used if a value is set or communicated within the past 15 minutes. If 15 minutes pass without a communicated value, the UI displays `Value Timed Out` and the next highest priority input is used.

Outdoor air quality input (**OAQ**) is used if the OAQ sensor is connected to the OAQ and COM terminals.

Operational purge

Setpoints and related data

The setpoints and related data include the following items:

- Operating purge command (**OprPurgeCmd**)
- Purge command source (**PurgeCmdSrc**)
- Exhaust type (**ExFType**)

Inputs

The inputs include the following items:

- Network override purge command (**NetPurge**) sent through the UI display menu or communicated on the FC Bus
- Local purge command input (**Purge**) - 24 VAC to the PURGE terminal

Operation

The purge function is only effective if an economizer board has been connected to the UCB to trigger the economizer presence indicator. The operating purge command, purge command source, local purge command input, and network override purge command parameters are then shown in the UCB display menu.

Purge command source describes the related input in current use for the purge command. The inputs include the following items:

BAS Override

Indicates network override purge command

Local Input

Indicates local purge command input

The operating purge command indicates **True** in either of the following cases:

- The network override purge command is set to **True** and has not reached or exceeded the 15-minute timeout for communicated values
- The local purge command input indicates **True** - 24 VAC input is applied to Economizer board PURGE terminal

When the operating purge command indicates heating and cooling staging outputs are de-energized regardless of stage **Min On Time** timers. Heating and cooling staging outputs remain de-energized as long as the operating purge command indicates **True**.

- UCB FAN output is energized regardless of anti-short cycle delay timers
- UCB VFD output is 100% (10 VDC)
- Economizer board ECON output increases at a rate of 1% every 2 seconds until it reaches 100% (10 VDC)

In addition to the above, when operating purge command indicates **True** and the exhaust type is set to **None**:

- Economizer board EX-FAN output is off
- Economizer board EX VFD output is 0% (2 VDC)

In addition to the above, when operating purge command indicates **True** and the exhaust type is set to **Non-Modulating**, **Modulating Damper,** or **Variable Frequency Fan**:

- Economizer board EX-FAN output is energized regardless of anti-short cycle delay timers
- Economizer board EX VxFD output is 100% (10 VDC)

Operating purge command indicates **False** if both:

- Network override purge command is set to **False** or a true setting has reached or exceeded the 15-minute timeout for communicated values
- Local purge command input indicates **False** - 24 VAC input is not applied to Economizer board PURGE terminal.

Pre-occupancy purge

Inputs

The inputs include the following items:

- Thermostat only is set to **No**
- Occupancy mode is set to **Schedule**
- Pre-occupancy purge enable is set to **Enable**
- Pre-occupancy purge time
- Pre-occupancy purge upper SAT setpoint
- Pre-occupancy purge lower SAT setpoint
- Economizer board present
- SAT

Outputs

The outputs include the following items:

- FAN
- ECON
- EX FAN (if installed)
- EX FAN VFD (if installed)

Operation

Pre-occupancy purge is an economizer function that inputs the time before occupancy from the schedule and compares it to the pre-occupancy purge time point. If the time before occupancy is less than the pre-occupancy purge time and the control is unoccupied, the control enters pre-occupancy purge mode. The economizer opens all the way, the indoor fan turns on, and it begins monitoring the SAT.

If the supply air temperature rises above the pre-occupancy purge upper SAT setpoint, the control modulates the economizer in an attempt to maintain the pre-occupancy purge upper SAT setpoint.

If the supply air temperature falls below the pre-occupancy purge lower SAT setpoint, the control modulates the economizer in an attempt to maintain the pre-occupancy purge lower SAT setpoint.

Power exhaust during pre-occupancy purge

If a non-modulating power exhaust is installed, the control forces the exhaust fan on and off based on economizer position setpoints.

If a variable frequency power exhaust is installed, the control forces the exhaust fan modulation using the building static pressure setpoint.

If a modulating exhaust damper is installed, the control forces the damper modulation to the building static pressure setpoint.

Termination

The control remains in pre-occupancy purge mode until the system time matches the occupied time. The control then switches to occupied operation.

Quick Start Menu

A new menu with commonly used equipment configuration settings.

A new menu called “Quick Start” was added as the top menu option under the Commissioning menu The new menu contains the following points:

- Number Of Cooling Stages Installed
- Number of Heating Stages Installed
- Number of Heat Pump Stages Installed
- Number of Refrig Systems Installed
- Fan Control Type
- Thermostat Only Control Enabled
- Continuous Fan Operation in Occupied Mode
- Economizer Minimum Position Setpoint
- Supply Air Temperature
- Return Air Temperature
- Outdoor Air Temperature
- Cooling Status
- Heating Status
- Cooling Mode Enabled For Operation
- Heating Mode Enabled For Operation
- Unique Equipment Identifier

Commissioning Mode

A mode of operation is desired where field technicians can directly energize outputs on the control without needing to rely on the normal sequence of operations.

A new menu has been added under Commissioning called “Commissioning Mode” The following outputs can be overridden while commissioning mode is active.

- Supply Fan Command (off/on)
- Fan % Command
- Compressor Stage Command 1
- Compressor Stage Command 2
- Compressor Stage Command 3
- Compressor Stage Command 4
- Condenser Fan 1
- Condenser Fan 2
- Heating Stage Command 1
- Heating Stage Command 2
- Heating Stage Command 3
- Hot Gas Reheat (off/on)
- Hot Gas Reheat (modulating valve %)
- Hot Gas Reheat Bleed Valve Command (Open/Closed)
- Economizer Damper % Command
- Exhaust Fan VFD % Command
- Exhaust Fan Command (off/on)
- Exhaust Damper % Command
- Cancel ASCD Timers

Commissioning Mode Enable point is at top of the new menu.

- Commissioning Mode is active for 60 minutes unless the Extend Commissioning Time function is used.
- Commissioning Mode menu can be exited without impacting the functionality. This allows user to navigate menus to view temps/pressure/etc.

All Safeties can still override commissioning mode. Example: Cannot energize compressor 1 if HPS1 is in alarm

Supply Fan is required before allowing compressor and heat stage outputs.

Compressors being energized requires corresponding condenser fans to be energized.

Constant volume sequences

Thermostat inputs

Setpoints and related data

The setpoints and related data include the following item:

- Thermostat only control enable (**Tstat-Only**) is set to **On**

Inputs

The inputs include the following items:

- 24 VAC to limit switch safety terminal LIMIT, LIM2, LIM3
- 24 VAC to gas valve verification terminal MV, GV2, GV3
- 24 VAC to HPS1 through HPS4 and LPS1 through LPS4
- Evaporator coil temperature sensor EC1, EC2, EC3, and EC4
- 24 VAC to terminals Y1 through Y4
- 24 VAC to terminals W1 through W3
- Operational outdoor air temperature (**OprOAT**) from the sensor to the OAT terminal or a communicated value

Outputs

The outputs include the following items:

- 24 VAC from C1, C2, C3, and C4 compressor outputs
- 24 VAC from CN-Fan and CF2 condenser fan outputs
- 24 VAC from H1, H2, and H3 heat outputs
- 24 VAC from FAN

Compressor operation

This section assumes free cooling is not available.

Compressors are controlled by the Y1 through Y4 thermostat inputs. If the lead/lag function is turned OFF, a Y1 input energizes the C1 output. The thermostat inputs into Y2 through Y4, energize the C2 through C4 outputs respectively.

ⓘ **Note:** If lead/lag function is turned ON, see Lead/lag compressor equalized runtime for additional information.

The FAN output for indoor fan operation energizes with any cooling output after the fan on delay for cool expires.

CN-FAN output energizes when either C1 or C2 is energized.

CF2 energizes when either C3 or C4 is energized.

A 30-second interstage delay occurs when multiple stages are requested.

When the thermostat cooling inputs are lost and the minimum runtime expires, the compressor outputs stage off.

ⓘ **Note:** A Y2 input without a Y1 input energizes C1 first and then C2 30 seconds later. A Y3 input without a Y1 or a Y2 input energizes C1 first, then C2 and C3 in 30-second intervals. Similarly, a Y4 input without a Y1, a Y2, or a Y3 input, energizes C1 through C4 respectively.

Heating operation

Heating stages are controlled by the W1 through W3 thermostat inputs.

- A W1 input energizes the H1 output.
- A W2 input energizes the H2 output.
- A W3 input energizes the H3 output.

When the ignition process is complete, the ignition module energizes the gas valve and provides a 24 V input to the MV terminal on the UCB. This does not apply to units with electric heat.

The FAN ON HEAT DELAY timer starts as soon as 24 V is present on the MV terminal. When the timer expires, the FAN output for the indoor fan operation energizes.

ⓘ **Note:** On units with electric heat, FAN ON HEAT DELAY must be set to 0.

When the thermostat heat inputs are lost and the 120-second Minimum Heat Run Timers have expired, heating outputs stage off. The Fan Off Heat Delay timer starts when all heating outputs are off. When the timer expires, the FAN output for the indoor fan operation de-energizes.

ⓘ **Note:** If 24 VAC is present on W2 without W1, H1 energizes immediately and H2 energize after a 30-second interstage delay. If 24 VAC is present on a W3 without W1 and W2, H1 energizes immediately and H2 energizes after a 30-second interstage delay.

Sensor control

Setpoints and related data

The setpoints and related data include the following items:

- Thermostat only control enable (**Tstat-Only**) OFF
- CV occupied cooling setpoint (**ClgOcc-Sp**)
- CV occupied heating setpoint (**CVHtgOcc-Sp**)
- CV unoccupied cooling setpoint (**ClgUnocc-Sp**)
- CV unoccupied heating setpoint (**CVHtgUnocc-SP**)

Inputs

The inputs include the following items:

- 24 VAC to limit switch safety terminal LIMIT, LIM2, LIM3
- 24 VAC to gas valve verification terminal MV, GV2, GV3
- 24 VAC to HPS1 through HPS4 and LPS1 through LPS4
- Evaporator coil temperature sensors EC1, EC2, EC3, and EC4

- Operational space temperature (**OprST**)
- Operational outdoor air temperature (**OprOAT**)

Outputs

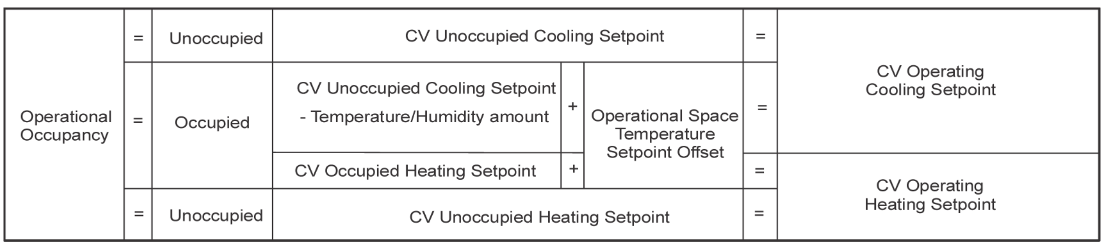
The outputs include the following items:

- 24 VAC from C1, C2, C3, and C4 compressor outputs
- 24 VAC from CN-Fan and CF2 condenser fan outputs
- 24 VAC from H1, H2, and H3 heat outputs
- 24 VAC from FAN

Setpoint determination

Figure 11 shows the setpoint determination. Heating and Cooling setpoints are determined by the current occupancy mode.

Figure 11: Temperature setpoint determination



Low limit tempering

Use low limit tempering in applications that use the HVAC unit as additional ventilation. For example, in a restaurant kitchen. Low limit tempering engages the first stage heat when there are low ambient outside air requirements to keep the supply air at a set minimum temperature. This maintains customer comfort when there is not a call for heat from the thermostat.

To enable low limit tempering, complete the following step.

- Select ***Details*** > ***Control*** > ***Htg*** > ***Setup***. Select **LL_Enable** and press ENTER.

The low limit upper SAT setpoint (**LL_UPSAT_SP**) default is 65. The low limit lower setpoint (**LL_LOWSAT_SP**) default is 60. Both setpoints are adjustable.

Occupied heating and cooling operation

Occupied mode heating and cooling stages are controlled by the staged percent command. The stage percent command increases or decreases based on the relationship to operational space temperature and operational heating or cooling setpoint. The rate of change is determined by the deviation from the setpoint and length of time away from the setpoint

Table 1: PID percent command

No. Stages	PID percent command							
	1st Stage		2nd Stage		3rd Stage		4th Stage[1]	
	On	Off	On	Off	On	Off	On	Off
1	100%	90%						

Table 1: PID percent command

No. Stages	PID percent command							
	1st Stage		2nd Stage		3rd Stage		4th Stage[1]	
	On	Off	On	Off	On	Off	On	Off
2	50%	45%	100%	95%				
3	33.3%	30%	66%	63.2%	100%	96.7%		
4	25%	22.5%	50%	47.5%	75%	72.5%	100%	97.5%

1 The 4th stage applies to cooling operation only.

Compressor operation

This section assumes free cooling is not available.

If the operating space temperature is 0.6°F or greater than the operating cooling setpoint, the staged percent command increases. Compressors turn on based on Table 1.

If the operating space temperature is 0.6°F or less than the operating cooling setpoint, the staged percent command decreases. Compressors turn off based on Table 1.

Compressors stage off in the order in which they turned on. For example, the first compressor to turn on is the last compressor to turn off.

Heating operation

If the operating space temperature is 0.6°F or lower than the operating heating setpoint, the staged percent command increases. Heating stages turn on based on Table 1.

If the operating space temperature is 0.6°F or greater than the operating heating setpoint, the staged percent command decreases. Heating stages turn off based on Table 1.

Heating stages turn off in reverse order, from the highest stage to the lowest stage.

Unoccupied heating and cooling operation

Unoccupied mode heating and cooling stages are not affected by the staged percent command.

Compressor operation

This section assumes Free Cooling is not available.

If the operational space temperature is greater than the CV unoccupied cooling setpoint, begin staging on all available compressors respecting the 15-minute interstage delay. If the operational space temperature drops below the CV unoccupied cooling setpoint - 3°F, turn off all compressors once their respective minimum run timers are satisfied.

Heating operation

If the operational space temperature is less than the CV unoccupied heating setpoint, begin staging on all available heating stages while respecting the 15-minute interstage delay. If the operational space temperature rises above the CV unoccupied heating setpoint + 3°F, turn off all heating stages as soon as their respective minimum run timers are satisfied.

Intellispeed™ fixed variable fan control

Setpoints and related data

The setpoints and related data include the following items:

- Fan control type = fixed variable (**FanCtl-Type**)
- Occupied: no heat or cool % command (**FanOnly-%Cmd**)
- Occupied: one stage of cool % command (**1ClgStg-%Cmd**)
- Occupied: two stage of cool % command (**2ClgStg-%Cmd**)
- Occupied: three stage of cool % command (**3ClgStg-%Cmd**)
- Occupied: four stage of cool % command (**4ClgStg-%Cmd**)
- Occupied: one stage of heat % command (**1HtgStg-%Cmd**)
- Occupied: two stage of heat % command (**2HtgStg-%Cmd**)
- Occupied: three stage of heat % command (**3HtgStg-%Cmd**)

ⓘ **Note:** The fixed variable economizer minimum position sequence uses the same parameters. See Fixed variable, for additional information.

Inputs

No inputs are related to fixed variable fan control (Intellispeed).

Outputs

The outputs include the following items:

- 24 VAC from FAN
- 2 to 10 VDC from VFD

Operation

Fan speed is determined by the status of FAN, cooling, and heating outputs. For example, with the fan running and no cooling outputs, the FAN speed is Occupied: no heat or cool % command. Another example includes one stage of cooling operating the FAN speed is Occupied: one stage of cool % command.

In the unoccupied mode the FAN speed control is the same as in the occupied mode.

Temperature and humidity control

Setpoints and related data

The setpoints and related data include the following items:

- Fan control type - single speed and fixed variable (**FanCtl-Type**)
- Thermostat only control enable (**Tstat-Only**) OFF
- CV occupied cooling setpoint (**ClgOcc-Sp**)
- Temperature/humidity (return) control enable (**TempHumCtl-En**) ON
- Maximum temperature/humidity setpoint offset (**MaxTempHumSpOff**)
- Temperature/humidity setpoint (**TempHum-Sp**)
- Temperature/humidity value per degree offset (**TempHumValPerDegOff**)

Inputs

The input for temperature and humidity control is operating space humidity (**OprSH**).

Outputs

There are no outputs for temperature and humidity control.

Operation

The control lowers the current occupied cooling setpoint in one degree increments when the return humidity increases above the temperature/humidity setpoint.

For example, in an occupied mode with an occupied cooling setpoint of 72°F, a temperature/humidity setpoint of 50%, and the temperature/humidity value that = 1° offset at 5%, the following sequences can occur.

- If the return humidity rises to 55%, the occupied cooling setpoint is lowered to 71°F. If the return humidity decreases below 55%, the occupied cooling setpoint returns to 72°F.
- If the return humidity rises to 60%, the occupied cooling setpoint is lowered to 70°F. If the return humidity decreases below 60%, the occupied cooling setpoint returns to 71°F.

VAV sequences

For all VAV sequences the fan control type (**FanCtl-Type**) must be set to variable speed.

VAV occupied cooling

This section details the SAT control with and without the thermostat input.

Supply air temperature control

Setpoints and related data

The setpoints and related data include the following items:

- Operational VAV cooling setpoint (**OprVAVClg-Sp**)
- VAV cooling supply air temperature upper setpoint (**SATUp-Sp**)
- VAV cooling supply air temperature lower setpoint (**SATLo-Sp**)
- VAV supply air temperature reset setpoint (**SATRst-Sp**)
- Operational space temperature (**OprST**)
- Temperature/humidity control enable (**TempHumCrl-En**)
- Temperature/humidity setpoint (**TempHum-Sp**)

Supply air temperature setpoint determination

If the operational space temperature rises + 2°F or more above the VAV cooling supply air temperature reset setpoint, the VAV cooling supply air temp lower setpoint is used for the operational VAV cooling setpoint.

If the operational space temperature falls below the supply air temperature reset setpoint the supply air temperature upper setpoint is used for the operational VAV cooling setpoint.

If the temperature/humidity control enable is turned on, the temperature/humidity control function also affects the supply air temperature setpoint. The control lowers the current operational VAV cooling setpoint in one degree increments when the return humidity increases above the temperature/humidity setpoint.

For example, with an operational VAV cooling setpoint of 55°F a temperature/humidity setpoint of 50% and the temperature/humidity value per 1°F offset at 5%, the following sequences can occur:

- If the return humidity rises to 55%, the operational VAV cooling setpoint is lowered to 54°F. If the return humidity decreases below 55%, the operational VAV cooling setpoint returns to 55°F.
- If the return humidity rises to 60%, the operational VAV cooling setpoint is lowered to 53°F. If the return humidity decreases below 60%, the operational VAV cooling setpoint returns to 54°F.

Operation

Operation without a thermostat input

For this sequence the thermostat only control enable (**Tstat-Only**) must be OFF.

The supply air temperature is controlled to the operational VAV cooling setpoint. A stage percent command for cooling determines how many stages of cooling are running. The stage percent command increases or decreases based on relationship of the operational VAV cooling setpoint and supply air temperature, see Table 1 for additional information.

The rate of change is determined by the deviation from setpoint and length of time away from setpoint. View the staged cooling command (**StgClgCmd**) on the UCB local display.

If the SAT is above the setpoint by more than 1.8°F, the staged percent command for cooling increases and stages compressors ON based on staging switch points.

If the SAT is below the setpoint by more than 1.8°F, the staged percent command for cooling decreases and stages compressors OFF based on staging switch points.

Operation with thermostat input

For this sequence the thermostat only control enable (**Tstat-Only**) must be ON.

Y1, Y2, Y3, and Y4 provide independent compressor control. See Constant volume sequences for additional operational information.

VAV unoccupied cooling

This section details the VAV unoccupied cooling setpoints, related data, inputs, outputs, and operation.

Setpoints and related data

The setpoints and related data include the following items:

- VAV unoccupied cooling setpoint (**VAVClgUnocc-Sp**)
- Operational space temperature (**OprST**)

Outputs

The output for VAV unoccupied cooling is 24 VAC from C1, C2, C3, and C4 compressor outputs.

Operation

The control must be in an unoccupied mode and not in morning cool-down mode. If the operational space temperature rises higher than the VAV unoccupied cooling setpoint all compressor stages energize with a 15-minute delay between stages.

Compressors remain energized until the operational space temperature reaches the VAV unoccupied cooling setpoint -3°F.

Single zone VAV

This section details the single zone VAV (SZ VAV) setpoints and related data, inputs, outputs, and operation.

Setpoints and related data

The setpoints and related data include the following items:

- VAV cooling SAT upper setpoint (**SATUp-Sp**, AV 29604)
- VAV cooling SAT lower setpoint (**SATLo-Sp**, AV 29605)
- SZ VAV operating cooling setpoint (**OprClgDAT-Sp**, AV 30077)
- VAV operating cooling zone setpoint (**OprSZVAVClg-Sp**, AV 29927)
- Fan control type (**FanCtl-Type**, MV 29555) - Variable Speed
- SZ VAV enabled (**SZVAVEn**, MV29908) - Yes

- SZ VAV occupied cooling setpoint (**SZVAVClgOcc-Sp**, AV 29925)
- SZ VAV unoccupied cooling setpoint (**SZVAVClgOcc-Sp**, AV 29926)
- SZ VAV minimum fan speed (**SZVAVMinFanSpd**, AV 29913)
- SZ VAV cooling load (**SZVAVClgLd**, AV 29935)
- Staged cooling command (**StgClgCmd**, AV 29922)
- Operational occupancy (**OprOcc**, MV 29517)
- Cooling manual tuning (**ClgManualTune**, Not BACnet Exposed)

Inputs

The inputs include the following items:

- Operational space temperature (**OprST**, AV 29522)
- Supply air temperature (**SAT**, AV 29564)
- Evaporator coil sensors (EC1, EC2, EC3, EC4, AV 29663 through AV 29666)

Outputs

The outputs include the following items:

- Fan % command (**FanVFD**, AV 29551)
- Compressor stage commands (C1, C2, C3, C4, MV 29611 through MV 29614)

Operation

ⓘ **Note:** To operate in SZ VAV mode the control must be in an occupied mode.

When there is no demand for cooling and the staged cooling command is 0%, the fan % command is at the SZ VAV minimum fan speed. The SZ VAV operating cooling setpoint is equal to the VAV cooling supply air temperature upper setpoint.

If the operational space temperature is above the SZ VAV occupied cooling setpoint by more than half of the cooling manual tuning amount, the staged cooling command increases. If the operational space temperature is within half of the cooling manual tuning amount of the SZ VAV operating cooling setpoint the staged cooling command does not change. If the operational space temperature is less than half of the cooling manual tuning amount below the SZ VAV operating cooling setpoint, the staged cooling command decreases.

Compressor outputs energize and de-energize based on the staged cooling command according to the following table.

Table 2: SZ VAV PID percent command

No. stages	PID percent command[1]							
	1st stage		2nd stage		3rd stage		4th stage[2]	
	On	Off	On	Off	On	Off	On	Off
1	100%	0%						
2	50%	0%	100%	50%				
3	33%	0%	66%	33%	100%	66%		
4	25%	0%	50%	25%	75%	50%	100%	75%

1 The percent commands are +/-2%

2 The 4th stage applies to cooling operation only.

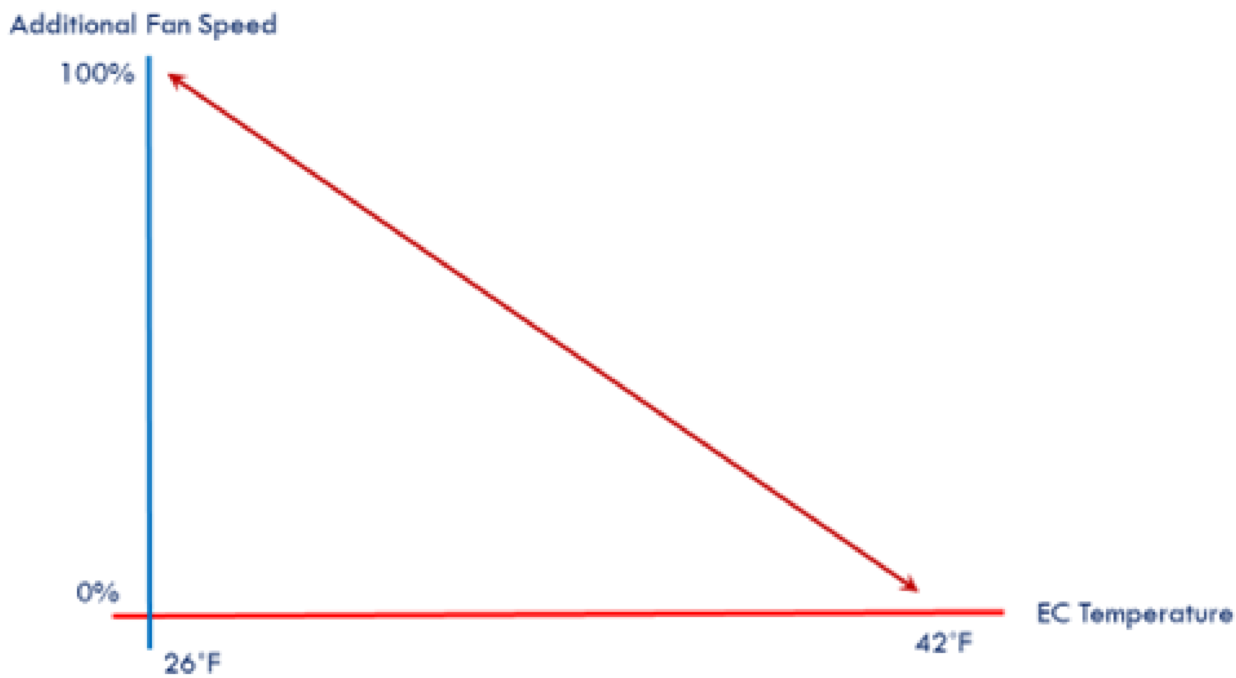
As the staged cooling command increases the SZ VAV operating cooling setpoint decreases proportionately between the VAV cooling SAT upper setpoint and the VAV cooling SAT lower setpoint. As the staged cooling command decreases the SZ VAV operating cooling setpoint increases proportionately between the VAV cooling SAT upper setpoint and the VAV cooling SAT lower setpoint.

- If the staged cooling command is >0%, FanVFD output modulates to control the SAT to the SZ VAV operating cooling setpoint +/-0.6°F.
- If the SAT drops below the SZ VAV operating cooling setpoint by more than 0.60°F, FanVFD increases to raise the SAT within SZ VAV operating cooling setpoint within 0.60°F.
- If the SAT rises above SZ VAV operating cooling setpoint by more than 0.60°F, FanVFD decreases to lower the SAT to within 0.6°F of the SZ VAV operating cooling setpoint.

ⓘ **Note:** The rate of change for the fan to keep the SAT within the control band must be determined.

If any of the evaporator coil sensor values (EC1, EC2, EC3, EC4) go below 42°F, FanVFD increases proportionally to the number of degrees below 42°F according to the following figure.

Figure 12: SZ VAV additional fan speed



ⓘ **Note:** The Fan VFD cannot drop below 20Hz or 33% at any time.

ⓘ **Note:** In compliance with ASHRAE 90.1-2010 Section 6.4.3.10, the fan % command (**FanVFD**) cannot operate above 67% when the staged cooling command (**StgClgCmd**) is at or below 50%. During free cooling operation, the fan cannot operate above 67% if the SZ VAV cooling load is at or below 50%.

Economizer free cooling operation

If free cooling is available and the operating space temperature is greater than the SZ VAV occupied cooling setpoint, FanVFD output changes proportionately between the SZ VAV minimum fan speed and 67% or 100% (maximum fan speed, dependent on the SZ VAV cooling load).

ⓘ **Note:** The operational space temperature and the SZ VAV occupied cooling setpoint drive the SZ VAV cooling load when the unit is free cooling. This process controls the FanVFD speed, as the demand increases, the fan increases CFM to match.

With free cooling available and the SZ VAV cooling load above zero, the SZ VAV operating cooling setpoint resets proportionally between the VAV cooling SAT upper and lower sepoints. The economizer analog output (ECON) modulates to control supply air temperature to the SZ VAV operating cooling setpoint +/-1.8°F. If ECON reaches 100% and remains there for 5 consecutive minutes, the control moves to Econ+Mech mode and the staged cooling command begins to accumulate at a rate determined by how much warmer the supply air temperature is from the SZ VAV operating cooling setpoint (starting above 1.8°F setpoint).

When the SZ VAV cooling load reaches 0%, the control ceases free cooling operations and moves to a satisfied condition where it runs the fan at the SZ VAV minimum fan speed.

Morning cool-down

Setpoints and related data

The setpoints and related data include the following items:

- Morning cool-down enable ON (**MornC-En**)
- Morning cool-down/return air temperature setpoint (**MornCRAT-Sp**)
- Early start period (**EarlyStrtPeriod**)
- Optionally, occupancy BI enabled, optimal start enabled, schedule
- Optionally, operational VAV cooling setpoint (for optimal start)

Inputs

The inputs include the following items:

- Operating space temperature
- Operating occupancy

Outputs

No outputs are required for morning cool-down.

Operation

The following sections outline the operation details.

BI input

With a BI occupied command, the supply fan turns on for a 5-minute stabilization period, and then the operating space temperature is compared to morning cool-down return air temperature setpoint.

If the value is equal to or above the morning cool-down return air temperature setpoint, all compressors operate for at least 5 minutes. If the value is below the morning cool-down return air temperature setpoint, the control goes into occupied mode.

The compressors energize until 5 minutes pass and the operating space temperature is below the morning cool-down setpoint or the early start period expires. Then the control goes into occupied mode.

Optimal start

Historical data determines when the optimal start begins. The optimal start time is always within the same calendar day. All compressors run until the demand is satisfied. The control uses the operational VAV cooling setpoint to determine when the demand is satisfied. Then the control goes into occupied mode.

Schedule

At the early start period prior to the scheduled occupancy, the supply fan turns on for a 5-minute stabilization period and then the operating space temperature is compared to the morning cool-down return air temperature setpoint.

If the value is equal to or above the morning cool-down return air temperature setpoint, all compressors operate for at least 5-minutes. If the value is below the morning cool-down return air temperature setpoint, the control goes into occupied mode.

The compressors energize until 5 minutes pass and the operating space temperature is below the morning cool-down setpoint or the early start period expires. Then the control goes into occupied mode.

VAV heating

Morning warm-up

This section describes the morning warm-up setpoints and related data, inputs, outputs, and operation.

Setpoints and related data

The setpoints and related data include the following items:

- Morning warm-up enable (**MornW-En**) is set to **On**
- Morning warm-up RAT setpoint (**MornWRAT-Sp**)
- Operational space temperature (**OprST**)
- Early start period (**EarlyStrtPeriod**)
- Optionally: occupancy BI enabled, optimal start enabled, schedule
- Optionally: operational VAV heating setpoint

Inputs

The inputs include the following items:

- 24 VAC to limit switch safety terminal LIMIT, LIM2, and LIM3
- 24 VAC to gas valve verification terminals on MV, GV2, GV3,4

Outputs

The output for morning warm-up is 24 VAC for heat stages from terminals H1, H2, and H3 heat outputs.

Operation

The following sections outline the operation details.

BI input

With a BI occupied command the supply fan turns on for a 5-minute stabilization period and then operating space temperature is compared to the morning warm-up return air temperature setpoint.

If the value is equal to or below the morning warm-up return air temperature setpoint, all heat stages operate for at least 5 minutes. If the value is above the morning warm-up return air temperature setpoint, the control goes into occupied mode.

The heat stages energize until 5 minutes pass and the operating space temperature is below the morning warm-up setpoint or the early start period expires. Then the control goes into occupied mode.

Optimal start

Historical data determines when the optimal start begins. The optimal start time is always within the same calendar day. All heating stages run until the demand is satisfied. The control uses the operational VAV heating setpoint to determine when the demand is satisfied. Then the control goes into occupied mode.

Schedule

At the early start period prior to the scheduled occupancy, the supply fan turns on for a 5-minute stabilization period and then the operating space temperature is compared to the morning warm-up return air temperature setpoint.

If the value is equal to or below the morning warm-up return air temperature setpoint, all heating stages operate for at least 5-minutes. If the value is above the morning warm-up return air temperature setpoint, the control goes into occupied mode.

VAV occupied heating

This section describes the VAV Occupied Heating setpoints and related data, inputs, outputs, and operation.

Setpoints and related data

The setpoints and related data include the following items:

- VAV occupied heating enabled (**HtgOcc-En**) ON
- VAV occupied heating setpoint (**VAHtgOcc-SP**)
- Operational space temperature (**OprST**)

Inputs

The inputs include the following items:

- 24 VAC to limit switch safety terminal LIMIT, LIM2, LIM3
- 24 VAC to gas valve verification terminal MV, GV2, GV3

Outputs

The output for VAV occupied heating is 24 VAC from H1, H2, and H3 heat outputs

Operation

The control must be in an occupied mode and not in morning warm-up mode.

If the operational space temperature drops lower than the VAV occupied heating setpoint, all cooling stages de-energize after all compressor minimum runtimes have expired and after the 2-minute cool to heat changeover delay has expired, then all heat stages energize with approximately 30 seconds of delay between stages.

Heat remains energized until the operational space temperature reaches the VAV occupied heating setpoint + 1°F.

Any time the control enters the heat mode, the VAV BOX contact closes.

VAV unoccupied heating

This section details the VAV unoccupied heating setpoints and related data, inputs, outputs, and operation.

Setpoints and related data

The setpoints and related data include the following items:

- VAV unoccupied heating enable (**HtgUnocc-En**) ON
- VAV unoccupied heating setpoint (**VAVHtgUnocc-Sp**)
- Operational space temperature (**OprST**)
- Off during unoccupied (**OffDurUnocc**) No

Inputs

The inputs include the following items:

- 24 VAC to limit switch safety terminal LIMIT, LIM2, LIM3
- 24 VAC to gas valve verification terminal MV, GV2, GV3

Outputs

The output for VAV unoccupied heating is 24 VAC from H1, H2, and H3 heat output.

Operation

The control must be in an unoccupied mode and not in morning warm-up mode.

If the operational space temperature drops lower than the VAV heating unoccupied setpoint, all heat stages energize with approximately 30 seconds of delay between stages.

Heat remains energized until the operational space temperature reaches the VAV heating unoccupied setpoint + 3°F.

Any time the control enters the heat mode, the VAV BOX contact closes.

Duct pressure control

This section describes the duct pressure control setpoints and related data, inputs, outputs, and operation.

Setpoints and related data

The setpoints and related data include the following items:

- Duct pressure setpoint (**DctPrs-SP**)
- Duct static pressure (**DctPrs**)
- Duct pressure shutdown setpoint (**DctShutdownSp**)

Inputs

The input for duct pressure control is 0 to 5 VDC from the duct pressure sensor to terminal DCT PRS.

Outputs

The outputs include the following items:

- 24 VAC from the FAN to energize the fan motor or enable VFD
- 2 to 10 VDC from the VFD terminal.

Operation

When the fan is energized, the 2 to 10 VDC output from VFD terminal is used to maintain the supply duct pressure to the duct pressure setpoint. If the duct pressure is above setpoint, the VFD output decreases. If the duct pressure is below setpoint, the VFD output increases.

The rate of change of the VFD output is determined by the deviation from setpoint and length of time away from the setpoint.

If the duct pressure reaches the duct pressure shutdown setpoint, the fan and all other outputs of the unit de-energize.

ⓘ **Note:** If the unit is in a heating mode, the control continues to vary the DC output to control duct pressure to the duct static pressure setpoint. Therefore, in any VAV heating mode, all VAV boxes must be commanded open far enough to get adequate airflow to support the heating function and to prevent the heat section high temperature limit switches from opening.

Economizer sequences

Several functions can drive the economizer, including minimum position, free cooling, demand ventilation/air quality, economizer loading, and minimum outdoor air supply.

Minimum position sequences

The six minimum position sequences are minimum position, VFD economizer minimum position reset, fixed variable, low ambient minimum position, air monitoring station reset, and demand ventilation.

Minimum position

When the control is in the occupied mode and the FAN output is energized, the economizer is positioned to the minimum position setpoint unless another economizer function commands it open or closed.

When the control is in the unoccupied mode there is no minimum position.

VAV economizer minimum position reset

Setpoints and related data

The setpoints and related data include the following items:

- Economizer damper minimum position low speed fan (**LowSpeedFan-MinPos**)
- Economizer minimum position setpoint (**Econ-MinPos**)
- FAN control type - variable speed (**FanCtl-Type**)

Operation

When the control is in the occupied mode and the FAN output energizes and the VFD output reaches the high-fan speed setting, the economizer damper position is the economizer minimum position setpoint.

When the VFD output reaches then fan low-speed setting, the economizer damper position is the economizer damper minimum position low speed fan.

When the VFD output is between the fan high speed and fan low speed settings, the economizer damper is position proportionally between the economizer minimum position setpoint and the economizer damper minimum position low speed fan.

ⓘ **Note:** To disable the VAV economizer minimum position reset, set the economizer minimum position setpoint and the economizer damper minimum position low speed fan to the same value.

Fixed variable

Setpoints and related data

The setpoints and related data include the following items:

- Economizer damper minimum position low speed fan (**LowSpeedFan-MinPos**)
- Economizer minimum position setpoint (**Econ-MinPos**)
- FAN control type - fixed variable (**FanCtl-Type**)

Operation

This function uses the following parameters to determine the economizer minimum position:

- Fan control type = fixed variable (**FanCtl-Type**)
- Occupied: no heat or cool % command (**FanOnly-%Cmd**)
- Occupied: one stage of cool % command (**1ClgStg-%Cmd**)
- Occupied: two stage of cool % command (**2ClgStg-%Cmd**)
- Occupied: three stage of cool % command (**3ClgStg-%Cmd**)
- Occupied: four stage of cool % command (**4ClgStg-%Cmd**)
- Occupied: one stage of heat % command (**1HtgStg-%Cmd**)
- Occupied: two stage of heat % command (**2HtgStg-%Cmd**)
- Occupied: three stage of heat % command (**3HtgStg-%Cmd**)

When the control is in the occupied mode and the FAN output energizes and the VFD output reaches 100%, the economizer damper position is the economizer minimum position setpoint.

When the VFD output reaches the lowest percent command of the parameters above, the economizer damper position is the economizer damper minimum position low speed fan.

When the VFD output is between 100% and the lowest percent command, the economizer damper is positioned proportionally between the economizer minimum position setpoint and the economizer damper minimum position low speed fan.

ⓘ **Note:** To disable the fixed variable economizer minimum position reset, set the economizer minimum position setpoint and the economizer damper minimum position low speed fan to the same value.

Low ambient minimum position

Setpoints and related data

The setpoints and related data include the following items:

- Low ambient economizer minimum position (**LowAmb-MinPos**)
- Low ambient economizer setpoint (**LowAmb-Sp**)

Operation

The low ambient economizer minimum position overrides all other minimum position functions.

When the control is in the occupied mode, the FAN output is energized, and the operational OAT is below the low ambient economizer setpoint, the economizer is positioned to the low ambient economizer minimum position. When the Operational OAT is equal to or above the low ambient economizer setpoint, it exits the low ambient economizer setpoint mode.

Air monitoring station reset

Setpoints and related data

The setpoints and related data include the following items:

- Fresh air intake setpoint (**MOAFlow-Sp**)
- Fresh air intake value (**Fr-Air**)

- Fresh air max sensor range (**MOA-Range**)
- Air enable (**FRSHAir-En**)

Inputs

The input for air monitoring station reset is Fr-Air.

Operation

The fresh air max sensor range must match the range of the air monitoring station on the unit.

When the fresh air intake value falls below the fresh air intake setpoint the economizer damper position increases above minimum position until the fresh air intake value equals the fresh air intake setpoint +/- 40 cfm.

When the fresh air intake value rises above fresh air intake setpoint the economizer damper position decreases until the fresh air intake value equals the fresh air intake setpoint or it reaches minimum position setpoint.

ⓘ **Note:** The low ambient minimum position may force the damper position below the current setpoint and disables the air monitoring station reset.

Demand ventilation

This section details the setpoints and related data, inputs, outputs, general functionality, and operation regarding the economizer's demand ventilation feature.

Setpoints and related data

The setpoints and related data include the following items:

- Demand ventilation mode of operation (**DVent-Mode**)
- Demand ventilation maximum economizer position (**DVentMaxEconPos**)
- Demand ventilation differential setpoint (**DVentDiff-Sp**)
- Demand ventilation indoor air quality setpoint (**DVentIAQ-Sp**)
- Indoor air quality sensor range (**IAQRange**)
- Outdoor air quality sensor range (**OAQRange**)
- Supply air temperature (**SAT**)
- Operational indoor air quality (**OprIAQ**)
- Operational outdoor air quality (**OprOAQ**)

Outputs

The output for demand ventilation is 2 to 10 VDC from the ECON terminal to the economizer actuator.

Operation

The control must be in occupied status with the indoor fan operating. If the low ambient minimum position is in effect, it overrides the demand ventilation operation.

If the demand ventilation mode of operation is set to enabled and the operational indoor CO_2 level is greater than the demand ventilation setpoint +100 ppm, the current operating minimum position increases as follows.

- With a CO_2 level between the demand ventilation setpoint +101 ppm and +200 ppm, the operating minimum position increases 1% per minute.
- With a CO_2 level greater than the demand ventilation setpoint +200 ppm, the operating minimum position increases 2% per minute.

When the CO_2 levels drop to equivalent values below the demand ventilation setpoint, the current operating minimum position decreases at the same rates.

While in a demand ventilation mode, if the supply air temperature drops below 49°F, the economizer outside air dampers close until the supply air temperature rises above 49°F but does not go below the current economizer operating minimum position. The economizer then modulates to control the supply air temperature at 50°F.

ⓘ **Note:** The exception to this rule occurs when hydronic heat enable and SAT tempering with hydronic heat enable (40°F default) are both on. Hydronic heat is used to control the supply air temperature in this situation and the hydronic heat tempering setpoint is above 45°F.

If differential AQ enable is on and the OAQ is greater than or equal to the IAQ by more than the demand ventilation differential setpoint, the outside air dampers close completely and override all other minimum position functions.

Free cooling changeover options

Four types of free cooling selection (**FreeClg-Sel**) options are available: dry bulb temperature, single enthalpy, dual enthalpy, differential dry bulb, and auto.

Setpoints and related data

The setpoints are related data include the following items:

ⓘ **Note:** All the setpoints are free cooling setpoints.

- Economizer free cooling type (**FreeClg-Sel**)
- Free cooling current mode (**FreeClg-Mode**)
- All compressors OFF in free cooling (**AllCompOff-Econ**)
- Economizer outdoor air temperature enable setpoint (**EconOAT-SpEn**)
- Economizer outdoor air enthalpy setpoint (**EconOAEnth-Sp**)
- VAV cooling supply air temperature upper setpoint (**SATUp-Sp**)
- VAV cooling supply air temperature lower setpoint (**SATLo-Sp**)
- Outdoor air enthalpy (**OA-Enth**)
- Return air enthalpy (**RA-Enth**)

Inputs

The inputs include the following items:

- Operational outdoor air temperature (**OprOAT**)
- Operation outdoor air humidity (**OprOAH**)

- Supply air temperature sensor (**SAT**)
- Return air temperature (**RAT**)
- Operational space humidity (**OprSH**)

Changeover options

Auto

The control determines the type of free cooling changeover based on which sensors are present and reliable. Conditions include the following items:

- Operational space temperature and operational outdoor temperature = dry bulb changeover
- Operational space temperature, operational outdoor temperature, and operational outdoor humidity = single enthalpy
- Operational space temperature, operational outdoor temperature, operational outdoor humidity, and operational space humidity = dual enthalpy
- If the operational outdoor air temperature value is unreliable, free cooling is not available.

Dual enthalpy

The control determines the type of free cooling changeover based on which sensors are present and reliable. Conditions include the following items:

- Operational space temperature and operational outdoor temperature = dry bulb changeover
- Operational space temperature, operational outdoor temperature and operational outdoor humidity = single enthalpy
- Operational space temperature, operational outdoor temperature, operational outdoor humidity, and operational space humidity = dual enthalpy
- If the operational outdoor air temperature value is unreliable, free cooling is not available.

Single enthalpy

The control determines the type of free cooling changeover based on which sensors are present and reliable. Conditions include the following items:

- Operational outdoor air temperature = dry bulb changeover
- Operational outdoor air temperature and outdoor air humidity = single enthalpy
- If either the operational space temperature or the outdoor air dry bulb value is unreliable, free cooling is not available.

Dry bulb

The control determines the type of free cooling changeover based on which sensors are present and reliable. Conditions include the following items:

- Return and operational outdoor air temperature = dry bulb changeover
- If either the return or outside air dry bulb value is unreliable, free cooling is not available.

Differential Dry Bulb

A mode which compares the indoor dry bulb temperature to the outdoor dry bulb temperature in order to determine if economizer cooling is available.

Additional logic and configuration settings have been added to compare the Space Temperature to the Outdoor Air Temperature has been added. When the Outdoor Air Temperature is lower than the Space Temperature, economizer cooling is available. A new Enum set was required to make this change only on this platform. Default value will remain as “Auto”.

Changeover methods

Dry bulb changeover

This section applies when the free cooling current mode is dry bulb.

For dry bulb economizer operation, the outside air is suitable for free cooling if the operational outdoor air temperature is 1°F below the economizer OAT enable setpoint and 1°F below the return air temperature.

Free cooling is no longer available if the operational outdoor air temperature rises above either the economizer OAT enable setpoint or the return air temperature.

Single enthalpy changeover

This section applies when the free cooling current mode is single enthalpy.

For single enthalpy economizer operation, the outdoor air is suitable for free cooling if the outdoor air enthalpy is at least 1 BTU/lb below the economizer outdoor air enthalpy setpoint and the operational outdoor air temperature is no greater than the RAT plus 9°F.

Free cooling is no longer available if the operational outdoor air temperature rises above the RAT plus 10°F or the outdoor air enthalpy rises above the economizer outside air enthalpy setpoint.

Dual enthalpy changeover

This section applies when free cooling current mode is dual enthalpy.

For dual enthalpy economizer operation, the outdoor air enthalpy must be lower than the return air enthalpy by 1 BTU/lb and the operational outdoor air temperature is no greater than the RAT plus 9°F.

Free cooling is no longer available if the operational outdoor air temperature rises above the RAT plus 10°F or the outdoor air enthalpy rises above the return air enthalpy setpoint.

CV option A thermostat sequence

When the control determines that the outdoor air is suitable, the first stage of cooling is always free cooling.

If the parameter all compressors off in free cooling is on, free cooling is used regardless of the number of cooling stages demanded.

Cooling stages set to one for single compressor unit

With a stage 1 cooling demand (Y1 input), the economizer modulates to get SAT to VAV cooling supply air temperature upper setpoint +/-5°F. If the Y1 input remains on for 20 minutes, the C1 output energizes and the economizer opens to 100%.

With stage 2 cooling demand (Y2 input) and the Y1 input has been present less than 20 minutes, then the economizer opens to 100%.

If the Y1 or Y2 has been present for more than 20 minutes, then the C1 output energizes.

Cooling stages set to two for a two compressor unit

With a stage 1 cooling demand (Y1 input), the economizer modulates to get the SAT to the VAV cooling supply air temperature upper setpoint +/-5°F.

With a stage 2 cooling demand (Y2 input), the economizer modulates to 100% and energizes one compressor output. After 20 minutes, the second compressor output energizes.

When the Y2 stage 2 cooling demand is removed, all compressor outputs are de-energized and the economizer modulates to get the SAT to the upper SAT setpoint +/-5°F.

ⓘ **Note:** If the SAT limit for cooling enabled is turned on, the 20-minute timer reapplies when appropriate to re-energize the compressor output.

Cooling stages set to four for a four compressor unit

With a stage 1 cooling demand (Y1 input), the economizer modulates to get the SAT to the upper SAT setpoint +/-5°F.

With a stage 2 cooling demand (Y2 input), the economizer opens to 100% and the first compressor output energizes.

With a stage 3 cooling demand (Y3 input), a second compressor output energizes.

With a stage 4 cooling demand (Y4 input), a third compressor output energizes and 20 minutes after the Y4 input the fourth compressor output energizes.

When each cooling demand is removed, the compressor outputs de-energize in reverse order without time delays. When only a Y1 input remains, the economizer controls the SAT to the upper SAT setpoint +/- 5°F.

ⓘ **Note:** If the SAT limit for cooling enabled is turned on, the 20 minute timer reapplies when appropriate to re-energize the compressor output.

CV option B thermostat sequence

Cooling stages set to one for single compressor unit

With a stage 1 cooling demand (Y1 input), the economizer modulates to get the SAT to the upper SAT setpoint +/-5°F.

If the stage 1 cooling demand (Y1 input) remains on for 20 minutes, the economizer remains at 100% for an additional 5 minutes, and the SAT is greater than the upper SAT setpoint + 5°F, the compressor output energizes.

With a stage 2 cooling demand (Y2 input), the economizer modulates to get the SAT to the lower SAT setpoint +/-5°F.

If the stage 2 cooling demand (Y2 input) remains on, the economizer remains at 100% for 5 minutes, and the SAT is greater than the lower SAT setpoint + 5°F, the compressor output energizes.

If the economizer remains at the minimum position for 5 consecutive minutes, the compressor output turns off.

Cooling stages set to two or more for multiple compressor units

With a stage 1 cooling demand (Y1 input) the economizer modulates to get the SAT to the upper SAT setpoint+/- 0.5°F.

With a stage 2 cooling demand (Y2 input), the economizer modulates to get the SAT to the lower SAT setpoint+/-.0.5°F.

If the stage 2 cooling demand (Y2 input) remains on, the economizer remains at 100% for 5 minutes and the SAT is greater than the lower SAT setpoint + 5°F, the compressor output energizes.

If the economizer position remains at 100% for another 5 minutes, the next available compressor turns on. This process repeats every 5 minutes until all the compressors energize.

If the economizer position drops below 100% and does not reach the minimum position then returns to 100% and remains at 100% for 5 minutes, the next available compressor energizes. If the economizer position remains at 100%, the process repeats every 5 minutes until all the compressors energize.

Any time the economizer remains at the minimum position for 5 consecutive minutes, the last energized compressor turns off. If it remains at the minimum position, the compressors de-energize every 5 minutes until all the compressor are off.

Y3 and Y4 inputs have no additional impact on economizer operation.

Sensor

CV option A occupied

When free cooling is available and the operating space temperature is greater than the operating cooling setpoint, the dampers modulate to control the upper SAT setpoint +/- 0.5°F.

If the economizer output is at 100% for 5 consecutive minutes and the operating space temperature is 0.6°F or greater than the operating cooling setpoint, the staged percent command starts to increase and energizes compressors. See Table 1 for additional information.

As soon as the staged percent command begins to increase, the economizer remains at 100%. If the operating space temperature drops to less than 0.6°F above the operating cooling setpoint, the staged percent command holds the current value.

If the operating space temperature drops 0.6°F or more below the operating cooling setpoint, the staged percent command begins to decrease.

If the staged percent command remains at 0 for 5 consecutive minutes the economizer modulates to control to the upper SAT setpoint +/-0.5°F.

CV option B occupied

When free cooling available and the operating space temperature is greater than the operating cooling setpoint, the dampers modulate to control the upper SAT setpoint +/-0.5°F.

If the economizer position remains at 100% for 5 consecutive minutes, then the dampers modulate to control to the lower SAT setpoint +/-0.5°F.

If the economizer position remains at 100% for 5 consecutive minutes and the SAT is greater than the lower SAT setpoint +5°F, the first compressor output energizes. If the economizer position remains at 100% for another 5 minutes and the SAT is greater than the lower SAT setpoint +5°F, the second compressor output energizes. This process repeats every 5 minutes until all the compressors energize.

If the economizer position drops below 100% and does not reach minimum position then returns to 100%, remains at 100% for 5 minutes, and the SAT is greater than the lower SAT setpoint +5°F, the next available compressor energizes. If the economizer position remains at 100%, the process repeats every 5 minutes until all the compressors energize.

Any time the economizer remains at the minimum position for 5 consecutive minutes or the SAT is lower than the lower SAT setpoint -5°F, the last energized compressor turns off. If it remains at the minimum position or the SAT remains lower than the lower SAT setpoint -5°F, the compressors de-energize every 5 minutes until all the compressors are off.

If all compressor outputs de-engerize, the economizer modulates to control to the upper SAT setpoint +/-0.5°F.

When the cooling demand ends the compressors de-energize immediately and the dampers return to the operating minimum position.

CV option A and option B unoccupied

If the operating space temperature is greater than the unoccupied cooling setpoint, the economizer modulates to control to the lower SAT setpoint +/-5°F.

If the operating space temperature is greater than the unoccupied cooling setpoint for 10 or more minutes, then all compressor outputs energize with a 15 minute delay.

If the operating space temperature is less than the unoccupied cooling setpoint -3°F, then all compressor outputs de-energize and the economizer closes.

VAV unit sensor option A

The operating VAV SAT setpoint is determined by the reset function not by the number of compressors operating.

When free cooling available and the SAT is above the operating VAV SAT setpoint, the dampers modulate to control the operating, upper or lower, SAT setpoint +/-0.5°F.

If the economizer output is at 100% for 5 consecutive minutes and the operating space temperature is 0.6°F or greater than the operating cooling setpoint, the control starts to energize compressors. See Table 1 for additional information.

As soon as the staged percent command begins to increase, the economizer remains at 100%. If the SAT drops to less than the operating VAV SAT setpoint +1.8F, the staged percent command holds the current value.

If the SAT drops to less than the operating VAV SAT setpoint -1.8°F, the staged percent command begins to decrease.

If the staged percent command remains at 0% for 5 consecutive minutes, the economizer modulates to control to the upper SAT setpoint +/-0.5°F.

VAV unit sensor option B

When free cooling available and the SAT is greater than the operating VAV SAT setpoint, the dampers modulate to control the operating VAV SAT setpoint +/-0.5°F.

If the economizer position remains at 100% for 10 consecutive minutes and the SAT is greater than the operating VAV SAT setpoint +5°F, the first compressor output energizes. If the economizer position remains at 100% for another 5 minutes and the SAT is greater than the operating VAV SAT setpoint +5°F, the second compressor output energizes. If the economizer position remains at 100%, the process repeats every 5 minutes until all the compressors energize.

If the economizer position drops below 100% and does not reach the minimum position then returns to 100%, remains at 100% for 5 minutes, and the SAT is greater than the operating VAV SAT setpoint +5°F, the next available compressor energizes. If the economizer position remains at 100%, the process repeats every 5 minutes until all the compressors energize.

Any time the economizer remains at the minimum position for 5 consecutive minutes or the SAT is lower than the operating VAV SAT setpoint -5°F, the last energized compressor turns off. If it remains at the minimum position or the SAT remains lower than the operating VAV SAT setpoint -5°F, the compressors de-energize every 5 minutes until all the compressors are off.

If all compressor outputs de-engerize, the economizer modulates to control to operating VAV SAT Setpoint+/-0.5°F.

When the cooling demand ends the compressors de-energize immediately and the dampers return to operating minimum position.

Economizer loading

Setpoints and related data

The setpoints and related data is economizer loading enable (**EconLoad-En**) set to on.

Operation

The economizer loading function only works when only one compressor is operating.

If the SAT is less than the SAT low limit setpoint and the operating OAT is greater than 60°F, the economizer output increases to control the SAT to the operating SAT setpoint +/-0.5°F.

User enabled Calibration Fault Detection

While the functionality to detect if a damper feedback was out of calibration has always been in place, there existed no place for the end user to enable this functionality.

A point has been added to the Details? Economizer?Setup menu which allows this functionality to be enabled. The name of this point is “Calibration Fault Detect Enable”.

- BACnet: CalFaultDetectEn; MV:30067
- Modbus: CalFaultDetectEn; HR:843
- N2: CALFLTDET; ADI:191

Power exhaust

Four power exhaust options are available: non-modulating, modulating, variable frequency drive (VFD), and none.

Non-modulating power exhaust

Setpoints

The setpoints and related data include the following items:

- Economizer enable (**Econ-En**) ON
- Power exhaust fan type (**ExFType**) non-modulating
- Econo damper position fan on (**EconDmpPosFanOn**)
- Econo damper position fan off (**EconDmpPosFanOff**)

Inputs

No inputs are present for non-modulating power exhaust.

Outputs

The outputs include the following items:

- 2 to 10 VDC from ECON
- 24 VAC from EX-FAN to energize exhaust fan

Operation

The control compares the economizer output to the economizer damper position fan on and off.

Next the control energizes the exhaust fan when the economizer output is greater than the economizer damper position fan on setpoint.

Finally, the control de-energizes the exhaust fan when the economizer output is less than the economizer damper position fan off setpoint.

Modulating power exhaust

Setpoints

The setpoints and related data include the following items:

- Power exhaust fan type (**ExFType**) modulating damper
- Exhaust damper position fan on (**ExDmpPosFanOn**)
- Exhaust damper position fan off (**ExDmpPosFanOff**)
- Building pressure setpoint (**Bldg-Sp**)
- Building pressure reading (**Bldg-Pres**)

Inputs

The input for modulating power exhaust is: 0 to 5 VDC from building pressure sensor to terminals BLDG PRES.

Outputs

The outputs include the following items:

- 2 to 10 VDC from EX VFD for exhaust discharge damper modulation.
- 24 VAC from EX-FAN to energize exhaust fan

Operation

If the building pressure is above the building pressure setpoint, the exhaust damper output (**EX VFD**) increases to open the exhaust damper. If the building pressure is below the building pressure setpoint, the exhaust damper output (**EX VFD**) decreases to close exhaust damper.

The EX-FAN output energizes when the exhaust damper output is greater than the exhaust damper position fan on.

The EX-FAN output de-energizes when the exhaust damper output is less than the exhaust damper position fan off.

Pressurize function

Previously, the SSE board only supported the Purge function when the purge BI was activated. A pressurize mode is requested to also be associated with this BI to be competitive with similar products.

When the system is configured to Pressurize Instead of Purge, the Supply Fan will be energized at 100%, Heat/Cool are disabled, the Outdoor Air Damper opens to 100%, and the exhaust fan is turned off.

New configuration parameter called “Pressurize Instead of Purge” has been added under the Commissioning → Options menu.

- BACnet: PressurizeNotPurge; MV:30068
- Modbus: PressurizeNotPurge; HR:844
- N2: PRESSURIZE; ADI:192

Modulating power exhaust with VFD

Setpoints and related data

The setpoints and related data include the following items:

- Power exhaust fan type (**ExFType**) variable frequency fan
- Building pressure setpoint (**Bldg-Sp**)
- Building pressure reading (**Bldg-Pres**)

Inputs

The input for modulating power exhaust with VFD is 0 to 5 VDC from building pressure sensor to terminal BLDG PRES.

Outputs

The outputs include the following items:

- 2 to 10 VDC from EX VFD

- 24 VAC from EX-FAN

Operation

If the building pressure is above the building pressure setpoint, the exhaust output (**EX VFD**) increases. If the building pressure is below the building pressure setpoint, the exhaust output (**EX VFD**) decreases.

The EX-FAN binary output is energized any time the EX VFD analog output is greater than 2.16 VDC.

The EX-FAN binary output is de-energized any time the EX VFD analog output is less than or equal to 2.16 VDC.

The rate of change of the analog output is determined by the deviation form setpoint and length of time away from setpoint.

ERV Pivot function in VAV Mode

Any time the ERV Enable is set to YES the control should never look for a building pressure sensor on any Exhaust Type.

ⓘ **Note:** Any time the ERV Enable is set to YES the control should never look for a building pressure sensor on any Exhaust Type

ⓘ **Note:** To simplify the programming, when ERV Enable is set to YES the EX VFD output can be programmed to go to 10 vdc when in free cooling and with a call for cooling for both non-pivoting and pivoting ERV’s.

If we follow Note 2, we really only need 2 ERV sequences.

Sequence 1, which covers 3-40 ton constant volume and 3-25 ton VAV units with both non-pivoting and pivoting ERV’s

- Fan Control Type - Single Speed, Fixed Variable, or Variable Speed
- Exhaust Type - Non-Modulating
- ERV Enable - Yes
- EX FAN output is ON when FAN output is ON in occupied mode
- EX VFD is at 10 vdc (100%) when FAN output is ON and free cooling is available with a call for cooling
- No EX FAN or EX VFD output in unocc unless ERV Unoccupied Fan Enabled is Yes

Sequence 2, which covers 25 to 50 ton VAV units and 25-50 ton VAV units with non-pivoting ERV

- Fan Control Type - Variable Speed
- Exhaust Type - Variable Frequency Drive
- ERV Enabled - Yes
- EX FAN output is ON when FAN output is ON in occupied mode
- EX VFD output is equal to FAN VFD output

ERV interaction

The ERV function interacts directly with the exhaust control function. Only enable the ERV Interaction on VAV units equipped with exhaust VFDs.

Setpoints and related data

The setpoints and related data include the following items:

- Power exhaust fan type (**ExFType**) variable frequency fan
- Fan control type (**FanCtlType**) variable speed
- ERV installed
- ERV unoccupied fan
- Eff occupancy
- ERD state

Outputs

The outputs include the following items:

- 2 to 10 VDC from EX VFD
- 24 VAC from EX-FAN

Operation

The ERV function provides input to the exhaust control sequence by determining if energy recovery is installed and when it is active. The ERD state is determined based on Table 3.

Table 3: Energy recovery determination

ERV installed	ERV unocc fan	Eff occupancy	State
Disable	*	*	OFF
Enable	Enable	*	ON
Enable	Disable	Occupied	ON
Enable	Disable	Unoccupied	OFF
* This state has no effect on the output.			

When the ERV state is on, and applied to a VAV unit with exhaust VFDs, the EX VFD output is controlled by tracking the VFD OUTPUT of the supply fan.

When the ERV installed is disabled, the exhaust VFDs are controlled based on building static pressure. See Modulating power exhaust with VFD, for additional information.

When the ERV installed is enabled and ERV unoccupied fan is disabled, the exhaust outputs are turned off in the unoccupied mode.

On any unit without exhaust VFDs, the ERV installed parameter must be set to disabled.

Air proving switch setup

Setpoints and related data

The setpoints and related data include the following items:

- Air proving switch (APS) setup
    - Constant volume
    - Variable volume
    - None
- Fan control type
    - Single speed
    - Not used
    - Fixed variable
    - Variable speed

Inputs

The inputs include the following items:

- Air proving switch (APS)
- Duct pressure 0 to 5 VDC (DCT PRS)

Operation

Fan control type set to single speed or fixed variable, APS set to none

The fan command energizes the fan output. No APS mechanism is required.

Fan control type set to single speed or fixed variable, APS set to CV

With any fan command, the APS must close within 60 seconds. If the APS does not close within the 60 seconds, the fan command and all heating or cooling outputs turn off. The alarm `unit locked out due to APS` appears on the UI.

After the APS is proven, if it opens for more than 2 seconds, the fan output de-energizes. If the APS does not close within the 60 seconds, the fan command and all heating or cooling outputs turn off. The alarm `unit locked out due to APS` appears.

The fan retries after 30 minutes of any unit lock out.

If the APS is closed when the fan command is off, the alarm `unit lock out due to APS` appears. The fan command remains off.

Fan control type set to single speed, variable speed, or fixed variable, APS set to variable volume

ⓘ **Note:** If the fan control type is set to variable speed, the APS set-up automatically sets to variable volume. The parameter no longer appears in the menu.

With any fan command, duct pressure must reach 0.10 in/w.c. within 60 seconds. If the pressure point does not close within the 60 seconds, the fan command and all heating or cooling outputs turn off. The alarm `unit locked out due to APS` appears.

After the pressure point is proven if the duct pressure drops below the 0.10 in./w.c. for more than 2 seconds, the fan command and all heating or cooling outputs turn off. The alarm `unit locked out due to APS` appears.

The fan retries after 30 minutes of any unit lock out.

Self test sequencer

Setpoints and related data

The setpoints and related data include the following items:

- Heat type = gas/electric (heat pump and hydronic heating supported later)
- Number of compressors
- Number of heat stages
- Number of gas valves
- Heat pump stages
- Duct static pressure setpoint
- Fan control type
- APS setup

Inputs

The inputs include the following items:

- Fan VFD fault
- 24 VAC for outputs
- Fan overload fault
- Supply air temperature
- Building static pressure
- Duct static pressure
- Pause
- Reset input
- Cancel
- Air proving switch
- Economizer prompt (`EconOpen?`)
- Fan Prompt (`AirFlow?`)
- HPS 1 through 4
- LPS 1 through 4
- Freeze stat 1 through 4 (this is driven by the EC temperature sensors)
- MV

- GV 2
- GV 3
- Limit switch 1 through 3 (4stage LIM2, LIM3)

Outputs

The outputs include the following items:

- FAN
- VFD
- C1
- C2
- CN-FAN
- CF2
- H1
- H2
- H3
- C3
- C4
- ECON
- EX VFD

Operation

The self test sequencer steps through the unit subsystems one at a time depending on the hardware options programmed on the control. See Table 4 for the possible test outcomes.

Each test has a stabilize period before it energizes the corresponding equipment. Only during the fan test is everything off or 0% actuated. For all other tests, the FAN or VFD are the only outputs on during the stabilize period.

ⓘ **Note:** The control stops all current operation and begins the fan test when you select **Start** from the user interface. The fan test must prove airflow before the control proceeds with any other test.

The following table shows the expected outputs for the self test. The shaded cells indicate the output turns during the self test.

Table 4: Expected outcomes for the self test

Test mode	Fan	CF1	C1	C2	H1	H2	CF2	C3	C4	H3	ECON	EX VFD
Fan test	ON	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	0%	0%
Compressor test 1	ON	ON	ON	OFF	OFF	OFF	OFF	OFF	OFF	OFF	0%	0%
Compressor test 2	ON	ON	OFF	ON	OFF	OFF	OFF	OFF	OFF	OFF	0%	0%

Table 4: Expected outcomes for the self test

Test mode	Fan	CF1	C1	C2	H1	H2	CF2	C3	C4	H3	ECON	EX VFD
Compressor test 3	ON	OFF	OFF	OFF	OFF	OFF	ON	ON	OFF	OFF	0%	0%
Compressor test 4	ON	OFF	OFF	OFF	OFF	OFF	ON	OFF	ON	OFF	0%	0%
Heating 1 test	ON	OFF	OFF	OFF	OFF	ON	OFF	OFF	OFF	OFF	0%	0%
Heating 2 test	ON	OFF	OFF	OFF	OFF	OFF	ON	OFF	OFF	OFF	0%	0%
Heating 3 test	ON	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	ON	0%	0%
Economizer test	ON	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	Ramp until SAT changes +/- 2°F	0%
Power exhaust test	ON	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	0%	Ramp until BLD PRS drops >.05 in. wc

The control uses sensor feedback to verify the operation of the system while the equipment is being checked. Exceptions to the sensor feedback include the following items:

- If an APS and duct static pressure sensor are not installed, a prompt appears on the UI to check for FAN ON and airflow.
- If the OAT is within 2 degrees of the SAT, the economizer test prompts the UI for verification that the Economizer is opening for 10 minutes. For example, outdoor is 72°F and supply to space is 71°F. You must perform a visual inspection of the economizer status.

You can perform commands from the UI during the self test. The commands and control reactions to the commands are described in Table 5.

Table 5: Self test sequencer UI commands

UI command	Smart Equipment control reaction
Pause	Causes the sequence to hold any outputs ON for 10 minutes. This excludes safety trips.
Reset	Erases the previous self test results and prepares the self test sequencer for another test run.
Cancel	Stops the self test sequencer and returns the SEC to normal operation.

Results

You can view the results from the self test sequencer on the local UI. You can also view results from a USB flash drive if you connect it to the UCB before you initiate a self test. The results are put into a folder on the flash drive.

Possible result categories are described in Table 6.

Table 6: Self test results

Test(result category)	Possible results
Fan (Fan)	Fail - APS on early
	Fail - APS off
	Pass
	Fail
Compressors (C1, C2, C3, C4)	Fail - HPS
	Fail - Frz
	Fail - LPS
	Fail - LS
	Warning - SAT not dropped
	Pass

Table 6: Self test results

Test(result category)	Possible results
Heating stages (H1, H2, H3)	Fail - HPS
	Fail - LPS
	Fail - LS
	Fail - GV off
	Pass
	Warning - SAT not increased
Economizer	Fail - Damper
	Pass
Power exhaust	Warning - BSP not dropped
	Pass

Self test timing

Table 7 shows the self test time.

Table 7: Self test time

Test portion	Time (seconds)
Fan test stabilize	30
Fan test check (APS)	90
Fan test check (none, prompt time)	90
Fan test check (variable, DPS)	30
C1 stabilize	180
C1 check	180
C2 stabilize	180
C2 check	180
C3 stabilize	180
C3 check	180
C4 stabilize	180
C4 check	180
H1 stabilize	180
H1 check	60
H2 stabilize	180
H2 check	60
H3 stabilize	180
H3 check	60
H3 stabilize	180
Economizer stabilize	180
Economizer check (before prompt)	600
Economizer check (prompt)	600
Power exhaust stabilize	180
Power exhaust check	90
Total if all tests are run to full timeout	4230

Load shed and redline

This section relates to California Title 24 compliance.

Direct load shed

Setpoints and related data

There are no setpoints or related data for direct load shed.

Inputs

The input is direct load shed (**DirLoadShd**).

Operation

If the direct load shed is set to yes, the compressors stage off for 5 minutes. After the 5-minute disable period, the compressors stage on and the communicated value returns to no.

Indirect load shed

Setpoints and related data

The setpoints and related data include the following items:

- Load shed active (**LoadShedEnable**)
- Load shed rate limit (**LoadShedRateLim**)
- Load shed adjust (**LoadShedAdjust**)

Inputs

No inputs apply to indirect load shed.

Operation

When the effective setpoint reaches the operational cooling setpoint, load shed active set to yes, the load shed rate limit gradually increases the setpoint over a 1-hour period. The default for load shed rate limit is 0.066 degrees per minute (4 degrees per hour). The load shed adjust default is 4 degrees. The gradual adjust methods eliminates the compressors from staging on and off rapidly.

Heat pump

This section describes cooling and heating setpoints and related data, inputs, outputs, and operation with a heat pump unit configuration.

This section does not try to determine how a heating or cooling call is made. Only features unique to heat pump setpoints and related data, inputs, outputs, and operation are described.

Setpoints and related data

The setpoints and related data include the following items:

- Number of cooling stages installed
- Number of heating stages installed, any and all compressors are considered one stage
- Number of heat pump stages (**#HtPumpStgs**), this is the same as the number of cooling stages installed
- Number of refrigeration systems (**#RefrigSys**), this is the number of physical coolant circuits
- Defrost curve selection
- The Outdoor Air Temperature Permission setpoint is exposed in the Details - Heat Pump menu. This temperature represents the outdoor air temperature above which defrost cycles are not permitted. If users are experiencing issues where a defrost cycle is required, but not occurring due to the outdoor air temperature, adjusting this setpoint may help.

Inputs

The inputs include the following items:

- Operational space temperature (**zone control**)
- Applicable thermostat inputs (**Tstat-Only control**)
    - Y1
    - Y2
    - W1
    - W2
- CC1
- CC2
- OAT
- LIMIT

Outputs

The outputs include the following items:

- C1

- C2
- FAN
- CN-FAN
- H1 [as Rev Valve]
- H2 [Aux Heat]

Operation

The following sections describe the operation details.

Cooling

Cooling calls are handled the same way as non-heat pump cooling units with one exception.

Note: An exception to this is during cooling, the control energizes the H1 output to turn on the reversing valve.

The H1 output to the reversing valve remains energized between calls for cooling. If a heating call arises, the H1 output turns off.

Heating

All available compressor outputs are energized.

If there is a first stage call for heating, thermostat or zone sensor/network, all available compressors stage on with a 30-second delay between compressors.

The cooling fan on delay and cooling fan off delay are used for the first stage of heat pump heating.

During a first stage of heating, the H1 output turns off and remain off between heat calls.

If there is a second stage call for heating, the H2 or AUX output energizes the emergency/aux heating.

If a thermostat calls for W2 only, only the H2 output energizes. The heating fan on delay and heating fan off delay are used.

Defrost

The heat pump defrost cycle only applies during compressor heating operation.

- The H1 output is de-energized.
- The C1 and/or C2 outputs are (and possibly H2) energized.
- The CN-FAN output is energized.

Defrost cycle initiation

Number of refrigeration systems **(#RefrigSys)** is set to 1

When the intersection of the operational outdoor air temperature **(OprOAT)** and the condenser coil temperature 1 **(CC1)** remain in the demand defrost region for 4½ minutes, the defrost cycle is initiated in the following cases:

- Defrost curve selection 1, 2, 3 or 4 - 40 minutes have elapsed since the previous defrost cycle or UCB boot-up

- Defrost curve selection 5 - 60 minutes have elapsed since the previous defrost cycle or UCB bootup
- Defrost curve selection 6 - 30 minutes have elapsed since the previous defrost cycle or UCB bootup

Number of refrigeration systems **(#RefrigSys)** is set to 2 or more

When the intersection of the operational outdoor air temperature **(OprOAT)** and either the condenser coil temperature 1 **(CC1)** or the condenser coil temperature 2 **(CC2)** remain in the demand defrost region for 4½ minutes, the defrost cycle initiates based on the same conditions as if the number of refrigeration systems is set to 1.

Number of refrigeration systems **(#RefrigSys**) is set to 1

When the intersection of the operational outdoor air temperature **(OprOAT)** and the condenser coil temperature 1 **(CC1)** remain in the forced defrost region for 4½ minutes, the defrost cycle is initiated in the following case:

- Defrost curve selection 1, 2, 3, 4, 5 or 6 - 6 hours have elapsed since the previous defrost cycle or UCB boot-up

Number of refrigeration systems **(#RefrigSys)** is set to 2 or more

When the intersection of the operational outdoor air temperature **(OprOAT)** and either the condenser coil temperature 1 **(CC1)** or the condenser coil temperature 2 **(CC2)** remain in the forced defrost region for 4½ minutes, the defrost cycle is initiated in the following case:

- Defrost curve selection 1, 2, 3, 4, 5 or 6 - 6 hours have elapsed since the previous defrost cycle or UCB boot-up

At the initiation of the defrost cycle the following outputs occur:

- The H1 output energizes
- The H2 output energizes or remains energized
- The C1 and/or C2 output remain energized
- The CN-FAN output is de-energized

Defrost cycle termination

If the number of refrigeration systems **(#RefrigSys)** is set to 1, the defrost cycle continues until one of the following cases occur:

- Defrost curve selection 1, 2, 3, 4 or 5: the condenser coil temperature 1 **(CC1)** reaches the 40°F defrost termination temperature or 8 minutes have elapsed since the initiation of the defrost cycle.
- Defrost Curve selection 6: the condenser coil temperature 1 **(CC1)** reaches the 50°F defrost termination temperature or 10 minutes have elapsed since the initiation of the defrost cycle - pinked due to possible production variation.

If the number of refrigeration systems **(#RefrigSys)** is set to 2, the defrost cycle continues until one of the following cases occur:

- Defrost curve selection 1, 2, 3, 4 or 5: both the condenser coil temperature 1 **(CC1)** and the condenser coil temperature 2 **(CC2)** reach the 40°F defrost termination temperature or 8 minutes have elapsed since the initiation of the defrost cycle. Within the 8-minute period; if either CC1 or CC2 is above the 40°F defrost termination temperature and the remaining CC input has not reached 40°F, the CC input above 40°F holds the corresponding C output on until that CC input reaches the 50°F defrost cutout temperature. If the remaining CC input has not reached 40°F and the other CC input reaches 50°F, the CC input above the 50°F defrost cutout temperature turns off the corresponding C output for the remainder of the defrost cycle. The C output that was turned off due to defrost cutout temperature can resume compressor heating operation once the defrost cycle terminates and that C output ASCD expires.

- Defrost Curve selection 6 - both Condenser Coil Temperature 1 **(CC1)** and Condenser Coil Temperature 2 **(CC2)** reach the 50°F defrost termination temperature or 10 minutes have elapsed since the initiation of the defrost cycle Within the 10-minute period; if either CC1 or CC2 are above the 50°F defrost termination temperature and the remaining CC input has not reached 50°F, the CC input above 50°F holds the corresponding C output on until that CC input reaches the 60°F defrost cutout temperature. If the remaining CC input has not reached 50°F and the other CC input reaches the 60°F defrost cutout temperature, the CC input above 60°F turns off the corresponding C output for the remainder of the defrost cycle. The C output that was turned off due to defrost cutout temperature can resume compressor heating operation once the defrost cycle terminates and that C output ASCD expires.

The heat pump heating operation according to the demand resumes when the defrost cycle terminates.

Initiation of the defrost cycle is prevented by temperature sensor input in the following cases:

- If the operational outdoor air temperature (**OprOAT**) is less than -25°F ±1°F or greater than 50°F ±1°F.

- If the CC1 and CC2 condenser coil temperatures are both greater than 40°F ±1°F.

Within the boundaries of the operational outdoor air temperature (**OprOAT**) greater than -25°F ±1°F or less than 50°F ±1°F and the condenser coil temperature (CC1 and CC2) less than 40°F ±1°F, demand defrost and forced defrost regions for defrost cycle initiation are determined by the defrost curve selection, see the following figures.

Figure 13: Smart Equipment defrost curve selection 1

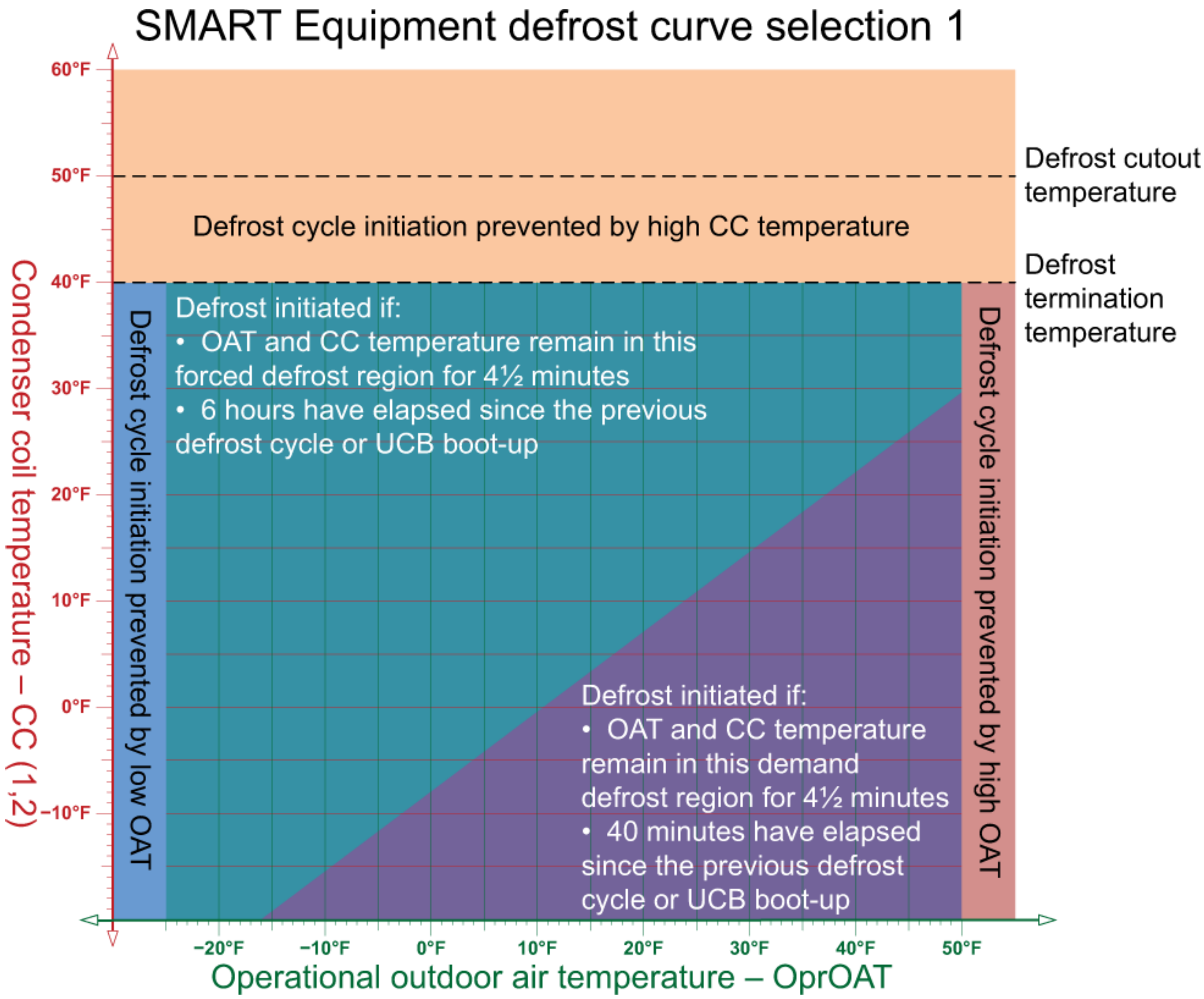


Figure 14: Smart Equipment defrost curve selection 2

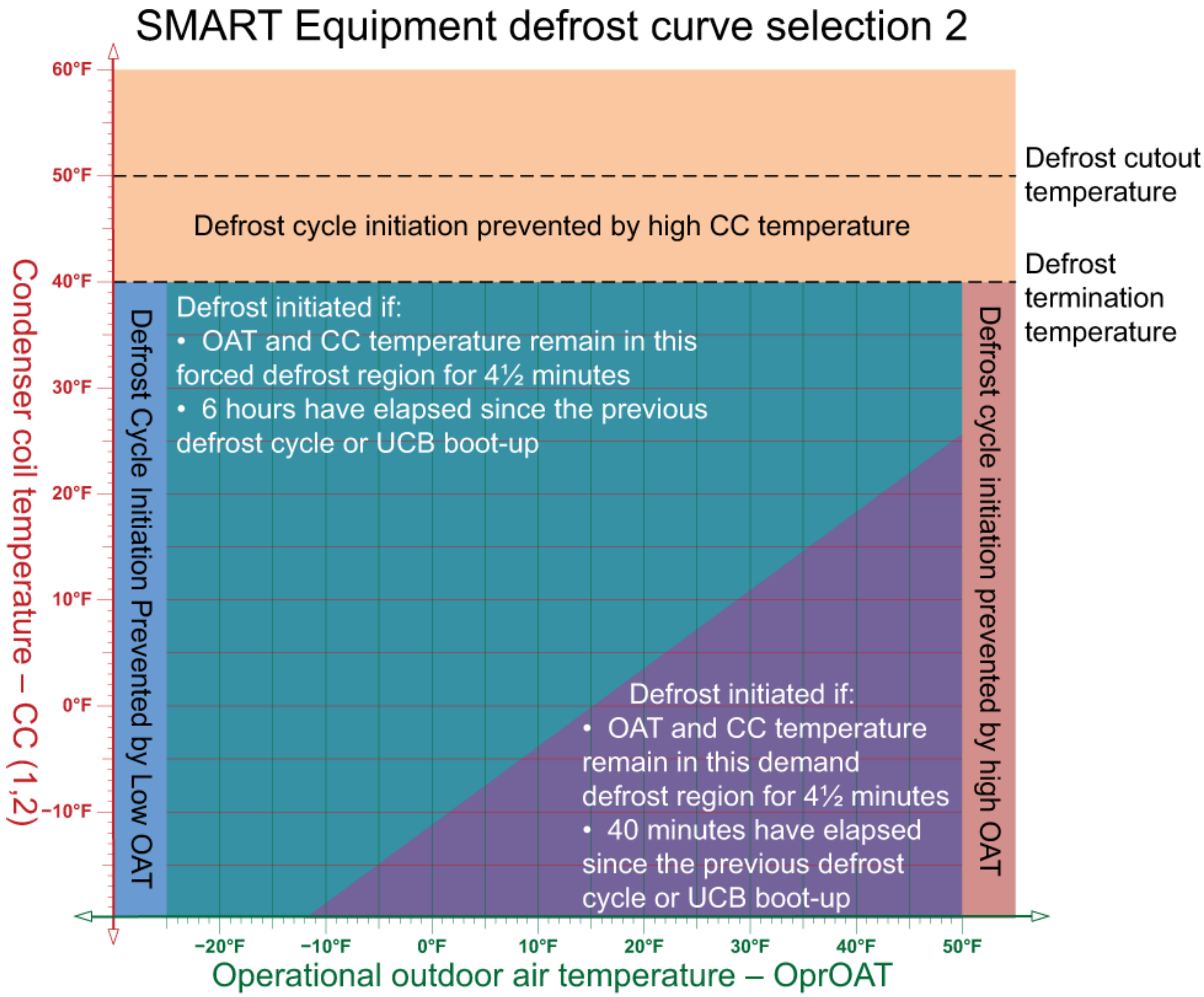


Figure 15: Smart Equipment defrost curve selection 3

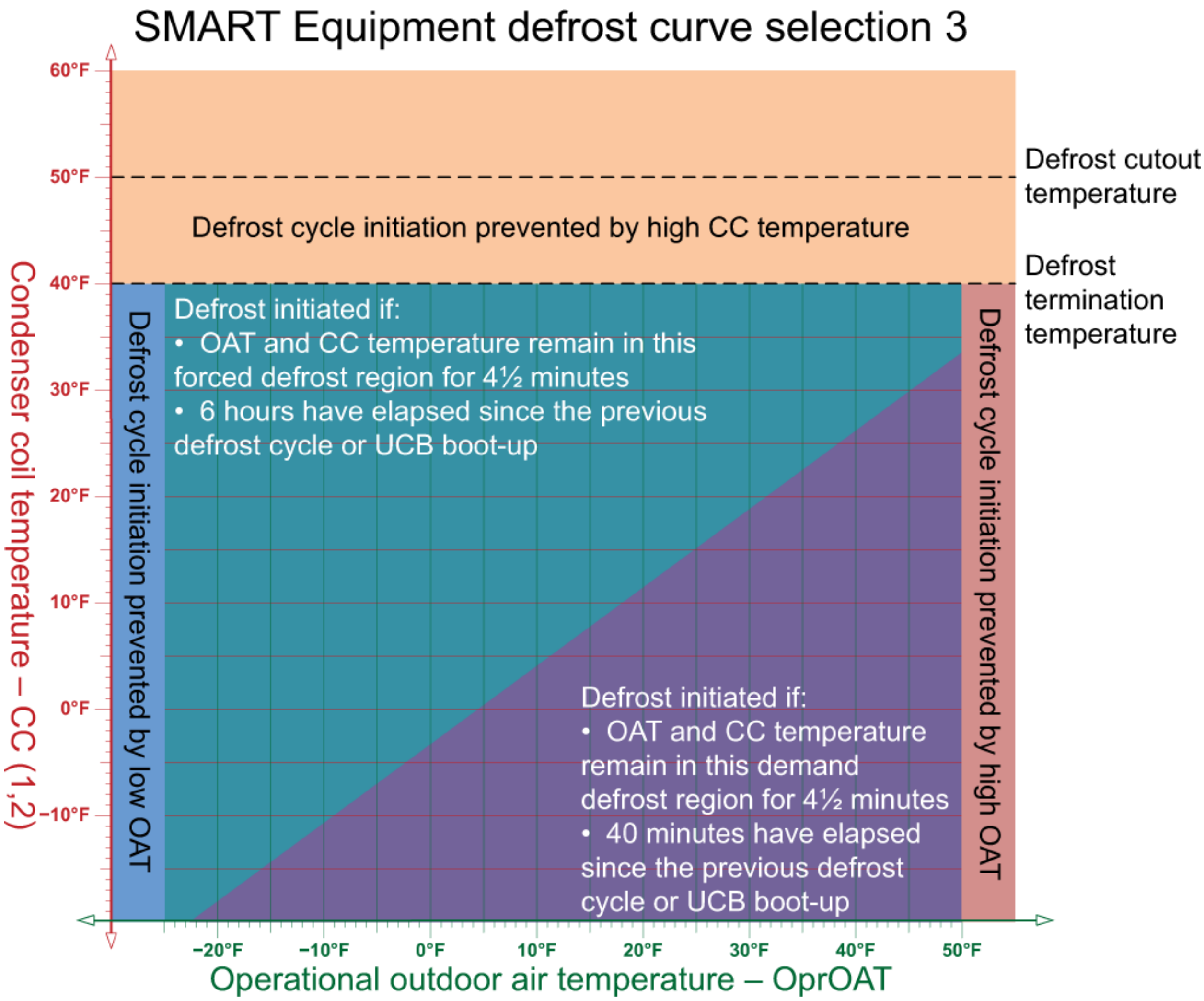


Figure 16: Smart Equipment defrost curve selection 4

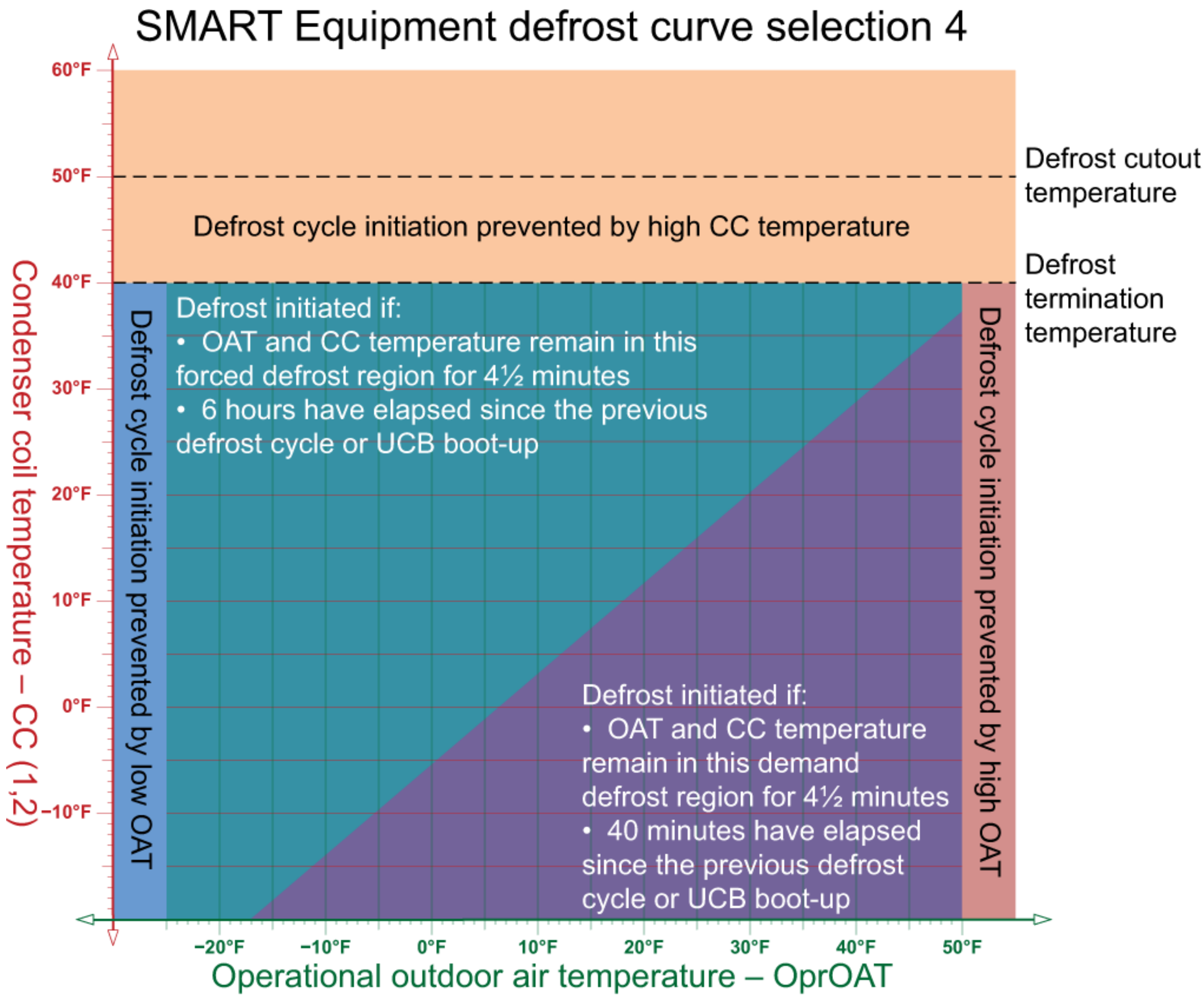


Figure 17: Smart Equipment defrost curve selection 5

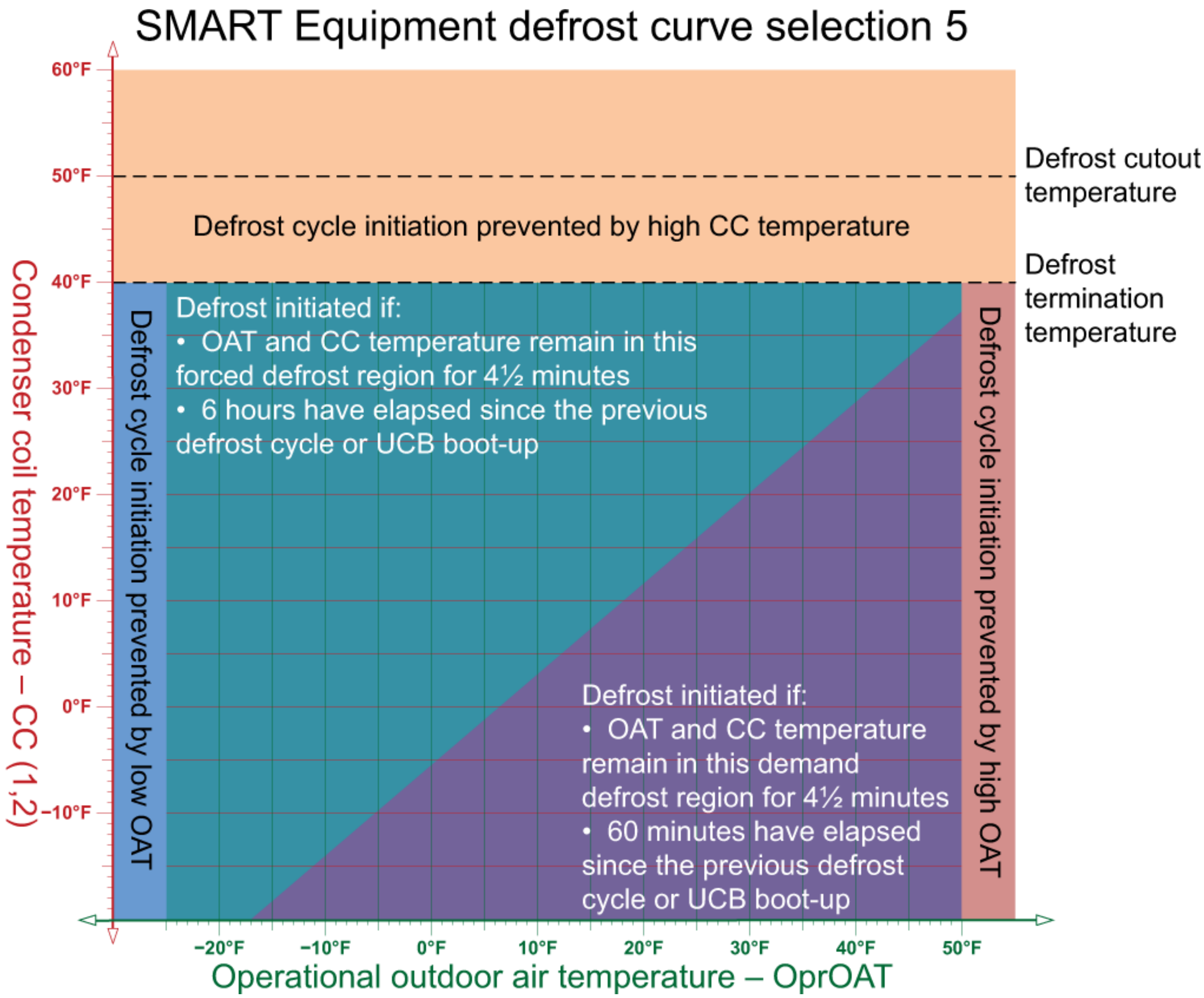


Figure 18: Smart Equipment defrost curve selection 6 - standard or replacement board

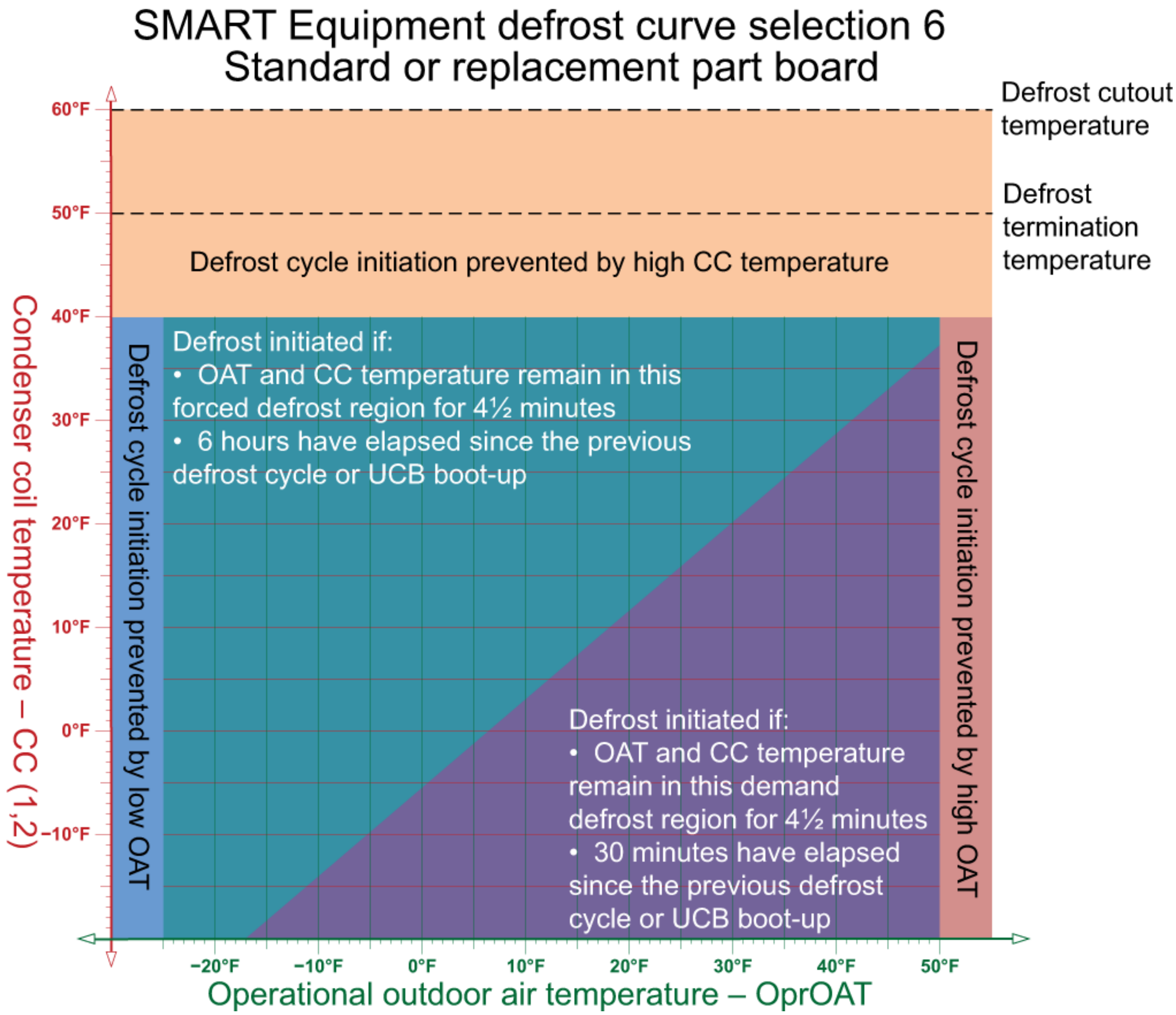


Figure 19: Smart Equipment defrost curve selection 6 - 3 ton Core heat pump

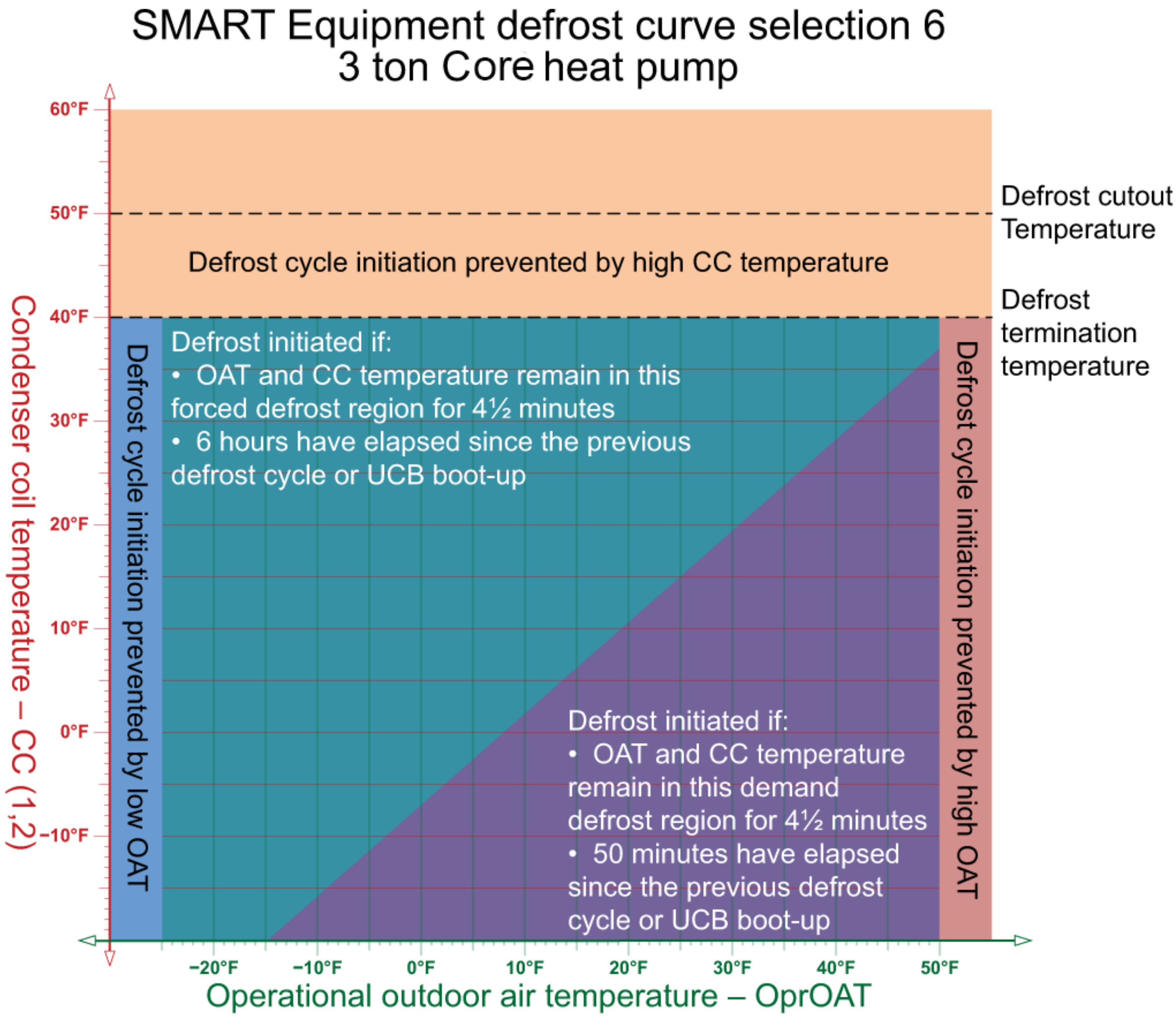


Figure 20: Smart Equipment defrost curve selection 6 - 4 ton Core heat pump

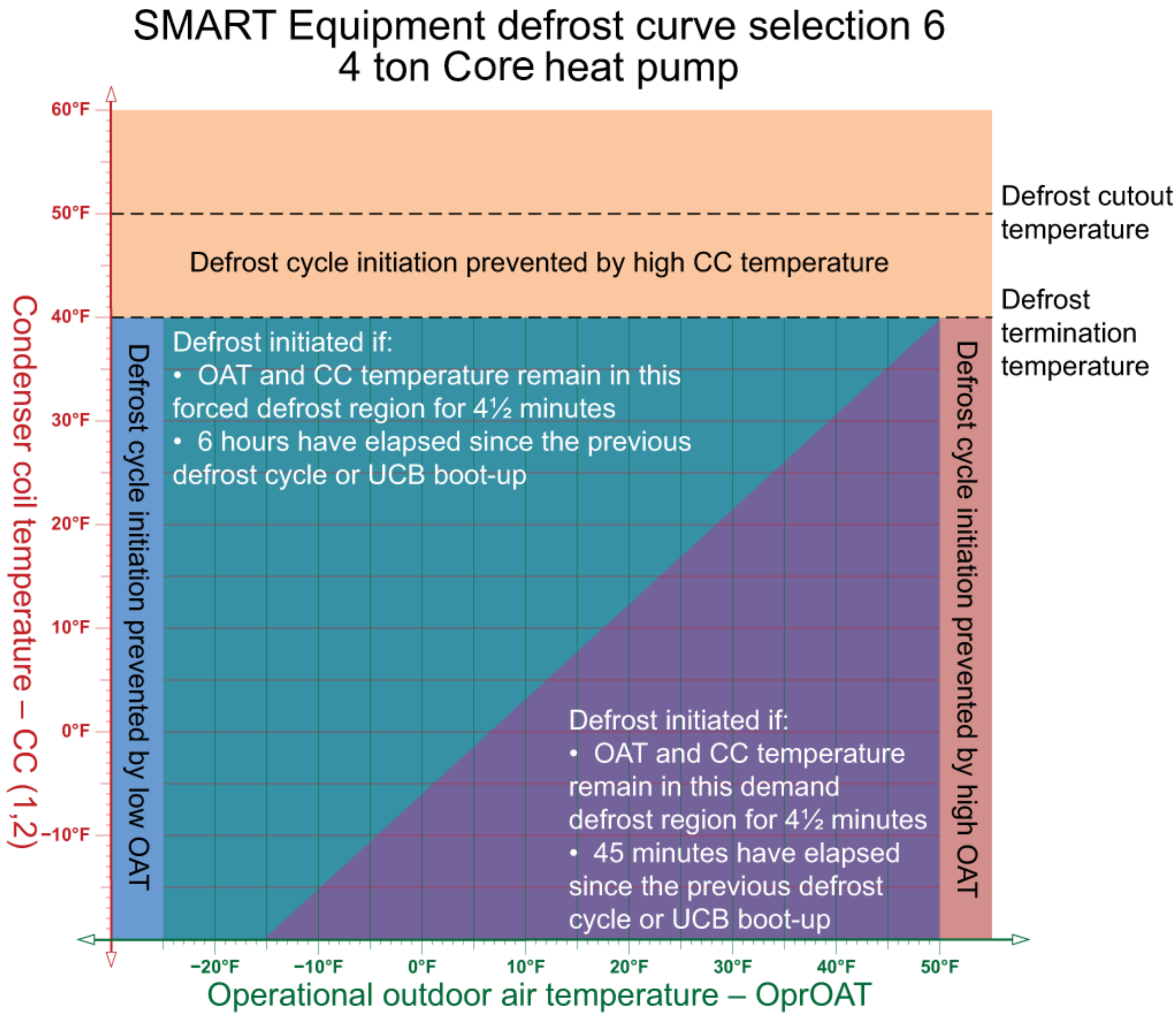
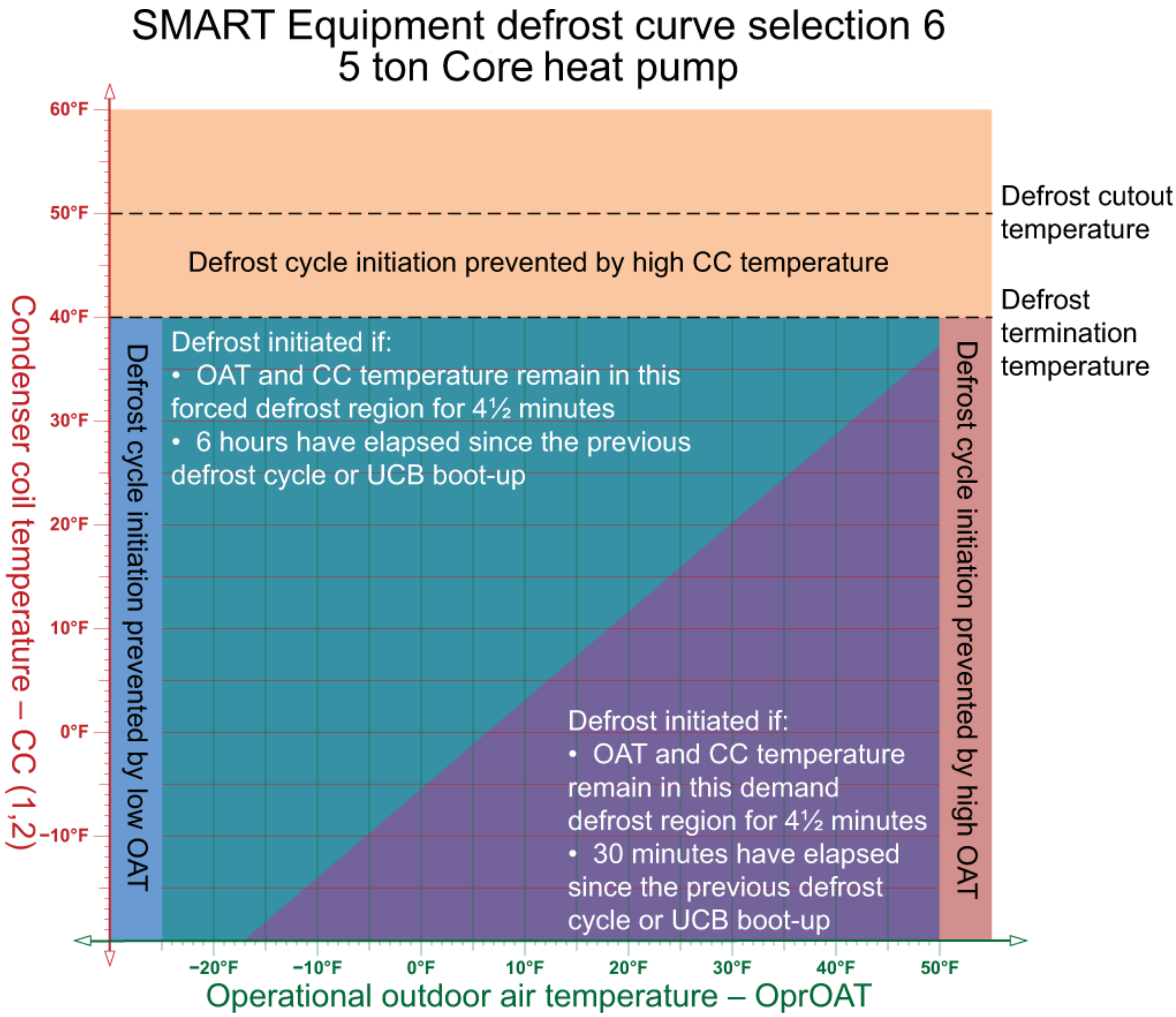


Figure 21: Smart Equipment defrost curve selection 6 - 5 ton Core heat pump



ⓘ **Note:** There is a ±1°F tolerance between demand defrost and forced defrost regions for defrost cycle initiation, the diagonal line in the figures.

Unit protection

This section is broken down into several categories for system safeties: low voltage, high pressure switch, low pressure switch, SD, limit, and main valve.

Low voltage

Setpoints and related data

The setpoints and related data include the following items:

- Outputs disabled due to low input voltage (**UCBLowVolt**)
- Outputs limited due to low input voltage (**UCBBrownOut**)

Inputs

The input for low voltage is the supply voltage to UCB - UCB 24VAC input (**UCB24VForOutp**).

Outputs

The outputs for low voltage are all relay outputs.

Operation

The UCB monitors the 24 VAC for low voltage conditions and has two thresholds, one at 18.0 VAC and one at 20.4 VAC.

If the UCB needs to turn on a relay output, it determines if the voltage is above 20.4 VAC before it energizes the output. If the voltage is not above 20.4 VAC, it holds off additional relay outputs and displays the appropriate alarm on the LCD. Any relay outputs that are already energized continue in that state.

If the voltage drops below 18.0 VAC, the UCB de-energizes the relay outputs and displays the appropriate alarm.

ⓘ **Note:** If W1 is present, the UCB energizes the indoor fan relay output even with a low voltage detected.

High pressure switch

Setpoints and related data

The setpoints and related data include the following items:

- Number of cooling stages installed (**#ClgStgs**)
- Compressor stage command (**Ci** for i=1 to 4)
- High pressure limit (**HPSi** for i=1 to 4)
- High pressure lockout (**HPSi-LO** for i=1 to 4)
- Reset lockouts (**ResetLO**)

Inputs

The input for the high pressure switch is contact closure from the appropriate refrigerant circuit high pressure switch (HPS1, HPS2, HPS3, HPS4).

Outputs

The output for the high pressure switch is the output relay for the appropriate refrigerant circuit (C1, C2, C3, C4).

Operation

The control only reads this input when it has the compressor relay turned on. If the high pressure switch opens for more than two line cycles, the UCB turns off the compressor relay and starts the ASCD. After the ASCD times out, the UCB turns on the compressor relay as long as there is still a call for Y.

The UCB logs the first incident and tracks the runtime. If the high pressure switch opens three times within 2 hours of run time, it locks out the compressor and displays an alarm on the LCD. While the UCB has all compressors locked out, it turns off the condenser fan.

Any time a lockout occurs and the call for Yx goes away, this resets the lockout.

Any high or low pressure switch or freeze stat error during minimum runtime terminates the minimum runtime.

ⓘ **Note:** To manually reset the lockout condition, navigate to the **ResetLO** point in the user interface and change the value from no to yes.

Low pressure switch

Setpoints and related data

The setpoints and related data include the following items:

- Number of cooling stages installed (**#ClgStgs**)
- Compressor stage command (**Ci** for i=1 through 4)
- Low pressure limit (**LPSi** for i=1 through 4)
- Low pressure lockout (**LPSi-LO** for i=1 through 4)
- Low ambient cooling stages 10 on 5 off setpoint (**LowAmb10On5OffSp**)
- Reset lockouts (**ResetLO**)
- Operational outdoor air temperature (**OprOAT**)

Inputs

The input for the low pressure switch is contact closure from the appropriate refrigerant circuit low pressure switch (LPS1, LPS2, LPS3, LPS4).

Outputs

The output for the low pressure switch is the output relay for appropriate refrigerant circuit (C1, C2, C3, C4).

Operation

When this input is open, the compressor does not start.

Once the output relay has been energized, the low pressure switch does not affect the compressor output until the compressor has been running for the minimum time. If the operational outdoor air temperature is greater than the low ambient cooling stages 10 on 5 off setpoint, then the minimum time is 30 seconds. Otherwise it is 120 seconds and the limit for the low pressure switch trips toward a lockout is disabled. The low pressure switch does not lock out the compressors.

After the minimum time (30 seconds or 120 seconds), if the low pressure switch has been open or becomes open for more than 5 seconds, the UCB terminates any remaining minimum compressor runtime, de-energizes the output relay, and starts the ASCD. After the ASCD, the UCB turns on the compressor as long as there is still a call for Y and the low pressure switch has closed.

The UCB logs the first incident and tracks run time. If not in low ambient conditions and the low pressure switch opens three times within one hour of run time, it locks out the compressor relay and displays an alarm on the LCD.

Note: To manually reset the lockout condition, navigate to the **ResetLO** point in the user interface and change the value from no to yes.

Evaporator coil - freeze condition

Setpoints and related data

The setpoints and related data include the following items:

- Number of cooling stages installed (**#ClgStgs**)
- Compressor stage command (**Ci** for i=1 through 4)
- Freeze condition setpoint (**Freeze-Sp**)
- Freeze condition lockout (**FSi-LO** for i=1 through 4)
- Reset lockouts (**ResetLO**)

Inputs

The input for the low pressure switch is the 10k NTC type 3 thermistor for each installed cooling circuit evaporator (EC1, EC2, EC3, EC4).

Outputs

The outputs include the following items:

- Freeze condition (**FSi** for i=1 through 4)
- Output relay for the appropriate refrigerant circuit (C1, C2, C3, C4)

Operation

If an evaporator temperature below the freeze condition setpoint (**Freeze-Sp**) is detected, the UCB sets the freeze condition (FS1, FS2, FS3, FS4) to true. If it is true, the UCB terminates any minimum compressor run time, de-energizes the compressor output relay, and starts the 5-minute ASCD. After the ASCD, the UCB energizes the compressor output relay as long as the evaporator temperature is above the freeze condition setpoint and there is still a call for Y. The default value for the freeze condition setpoint is 26 °F.

While the freeze condition is true, the compressor (**Cx**) does not run.

The UCB logs the first incident and tracks the run time. If the evaporator temperature alarms three times within 2 hours of run time, it locks out the compressor output relay and flags an alarm.

The exception to lockout of the compressor output relay is when the unit is operating in low ambient mode. In this mode a low evaporator coil temperature does not lock out the compressor. An error count of less than 3 is cleared and is not allowed to increment until after the low ambient mode disables. While low ambient is enabled and C1 is kept off because of the evaporator temperature, the LCD shows a status of low ambient rather than the freeze condition.

While FSx is True and preventing the compressor output relay from energizing, the fan remains on.

Any time a lockout occurs and Yx goes away, the lockout resets for one trip only and the alarm stops flashing on the LCD.

Off resets any FSx error counts less than 3 and stops any FSx LCD alarm. Three error counts produce a lockout.

ⓘ **Note:** To manually reset the lockout condition, navigate to the **ResetLO** point in the user interface and change the value from no to yes.

Alarm reset occurs when the evaporator freezestat temperature reaches 39°F. The unit is not locked out on a critical alarm but the alarm remains in the alarm history.

Fan overload

Setpoints and related data

The setpoints and related data include the following items:

- Unit locked out supply fan overload (**FanOvrload-LO**)
- Reset lockouts (**ResetLO**)

Inputs

The input for fan overload is contact closure from fan overload (**FanOvrload**).

Outputs

The output for fan overload is the output relay for fan, compressors, and condenser fans.

Operation

Any time the fan overload contact opens for more than 5 seconds, the UCB shuts down the fan, all of the compressors, and the condenser fan outputs. If the contact closes, the UCB clears the alarm. If the contact does not close within 15 minutes the UCB flags an alarm, turns on the X line, and displays the appropriate alarm code on the LCD.

If voltage returns, the UCB logs the first incident and tracks the run time. If the fan overload contact opens three times within 2 hours of run time, the UCB shuts down. It locks out the compressors, turns off the indoor fan, turns off the outdoor fan, turns on the X line, and displays the appropriate LCD alarm.

If the UCB senses W1 and a fan overload fault, it does not lock out the fan. As long as there is a W1 present, the UCB retries the fan each time the switch closes.

ⓘ **Note:** This alarm is only reset through a power down, or through the **ResetLO** command from the LCD.

Shut down

Setpoints and related data

No setpoints and related data are specific to unit protection shut down.

Inputs

The input for shut down is contact closure, shutdown input/smoke detector (**SD**).

Outputs

No outputs are unique to unit protection shut down.

Operation

Any time the contact opens, all power is removed to the output relay coils. This immediately de-energizes all relay outputs. The control generates an alarm and displays it on the LCD.

ⓘ **Note:** Any additional unit interrupt devices, such as float switches or external shutdown relays, must be wired in series with this contact to disable the unit.

Limit

Setpoints and related data

- Heat limit switch lockout (**LimitLO**)
- Heat limit 2 switch lockout (**Lim2LO**)
- Heat limit 3 switch lockout (**Lim3LO**)
- Reset lockouts (**ResetLO**)

Inputs

The input for limit is 24VAC monitoring at the limit input on the UCB (Limit, Lim2, Lim3).

Outputs

The output for limit is the output relay for fan and heat stages.

Operation

When the UCB senses 0 VAC at the limit switch input, it energizes the indoor blower relay and it performs the fan delay off when the limit returns to normal and senses 24 VAC.

If the limit trips while in a fan minimum off time, the UCB immediately energizes the indoor blower relay ignoring the fan minimum off time.

The UCB logs the first incident and tracks the run time. If the limit switch opens three times within one hour of run time, it flags an alarm and lock on the indoor blower relay and disables heating.

ⓘ **Note:** To manually reset the lockout condition, navigate to the **ResetLO** point in the user interface and change the value from no to yes.

Heat Limit Switches do not have to disable Cooling

On all previous software, the Heat Limit Switch would lockout both heating and cooling operation. An option to allow cooling operation while the Heat Limit Switch is in Alarm would allow the unit to cool as needed without risk to heat fault behaviors.

A user configuration option has been added which allows cooling functionality to ignore the Heat Limit Switch.

Enable Point “Cooling Allowed During Heat Limit”.

- Commissioning → Options
- Details → Heating → Setup
- BACnet: CoolDuringHeatLimit; MV:30071
- Modbus: CoolDuringHeatLimit HR:845
- N2: CLGINHTLIM; ADI:193

Main valve

Setpoints and related data

The setpoints and related data include the following items:

- Number of gas valves installed (**#GasVlvs**)
- Reset lockouts (**ResetLO**)

Inputs

The inputs include the following items:

- 24 VAC monitoring at the MV input on the UCB (MV, GV2, GV3)
- 24 VAC from terminal W1

Outputs

The output for the main valve is the output relay for fan.

Operation

Any time the UCB senses W1 and does not read voltage at the gas valve for a continuous 5-minute period, it flags an alarm and displays an alarm on the user interface. If GV reappears after the alarm, the alarm is reset and normal operation occurs. If W1 goes away, the UCB resets the alarm.

Any time the UCB senses GV voltage without W1 the UCB energizes the fan relay immediately. If the voltage remains for a continuous 5-minute period, the UCB flags an alarm, locks on the fan relay, and displays the alarm on the user interface. If the GV voltage goes away, the alarm is reset and the fan performs a delay off.

Note: To manually reset the lockout condition, navigate to the **ResetLO** point in the user interface and change the value from no to yes.

Hardware reset

Hardware resets are linked to various conditions and settings, including free stat, high pressure switch event, limit switch 1. See the Shut down section for operation information.

Scheduling/occupancy determination

Setpoints and related data

The setpoints and related data include the following items:

- Occupancy mode (**OccMode**)
- Network temporary occupancy request (**NetTempOcc**)
- Network occupancy request (**NetOcc**)
- Temporary occupancy timeout (**TempOccTimeout**)

Inputs

The inputs include the following items:

- Occupancy input (**OCC**)
- Schedule occupancy (accessible through MAP or NAE only)
- Net sensor request (no EM values)

Outputs

The outputs include the following items:

- Occupancy input source (**OccSrc**)
- Operational occupancy (**OprOcc**)

Operation

ⓘ **Note:** This section presumes the UCB is not part of a Verasys or CCS system.

When the occupancy mode is set to external the operational occupancy is determined by one of the following: occupancy input, network occupancy request, or a net sensor occupancy request. If any one input is occupied, then the operational occupancy is occupied. If all inputs are unoccupied, then the operational occupancy is unoccupied.

When the occupancy mode is set to schedule, the operational occupancy is determined by the interaction of schedule occupancy and net sensor occupancy request. The following points apply:

- If temporary occupancy input is false, then the operational occupancy is based strictly off the schedule occupancy. The schedule occupancy is changeable through the MAP Gateway. The default schedule is occupied M-F 8:00a.m.-5:00p.m.
- If temporary occupancy input is true and scheduled occupancy is unoccupied and network temporary occupancy request is true, then operational occupancy is bypass (occupied) for the duration of the temporary occupancy timeout.
- If temporary occupancy input is true and scheduled occupancy is occupied, then operational occupancy is occupied.

Space temperature alarming

Setpoints and related data

The setpoints and related data include the following items:

- Space temperature alarm setpoint offset (**STAlarmOffset**)
- Space temperature alarm time delay (**STAlarmDelay**)
- CV operational cooling setpoint (**OprCVCgl-Sp**)
- CV operational heating setpoint (**CVOprHtg-Sp**)

Inputs

The input for space temperature alarming is operational space temperature (**OprST**).

Operation

If either the space temperature alarm offset setpoint or the space temperature alarm time delay are set to 0, the space temperature alarming function is disabled.

After 10 minutes of cooling operation, if the operational space temperature is greater than the CV operating cooling setpoint plus the space temperature alarm setpoint offset, the space temperature alarm time delay timer starts. If the timer expires, a space temperature alarm occurs.

After 10 minutes of heating operation, if the operational space temperature is less than the CV operating heating setpoint plus the space temperature alarm setpoint offset, the space temperature alarm time delay timer starts. If the timer expires, a space temperature alarm occurs.

If the operational space temperature moves within the CV operating cooling/heating setpoint plus the space temperature alarm setpoint offset, the space temperature alarm time delay timer is reset to 0. If the operational space temperature does not move to the setpoint for another 10 minutes, the timer starts again.

Network Occupancy Override Timeout

If communications are lost from a BAS, the control should automatically revert to occupied. This can be accomplished using some type of watchdog timer on the BAS communication to the NetOCC point.

When this feature is enabled, if the BAS does not write to the NetOCC point within the timeout time (default 15 minutes; user configurable), the control will revert to the Occupied state.

Hot gas reheat

Setpoints and related data

The setpoints and related data include the following items:

- Hot gas reheat alternate operation enabled (**HGRAlt-En**)
- Hot gas reheat enabled for operation (**HGR-En**)
- Hot gas reheat alternate operation writable (**HGRAltWrite**)
- Hot gas reheat humidity setpoint (**HGRHum-Sp**)
- HGR unoccupied humidity setpoint (**HGRUnoccHum-Sp**)
- HGR enabled for unoccupied operation (**HGRUnocc-En**)
- HGR humidity setpoint differential (**HGR-Diff**)
- Aux mode enable setpoint (**Mode**)

Inputs

The input for hot gas reheat is operational space humidity (**OprSH**).

Outputs

The output for hot gas reheat is 24 VAC from AUX-HGR to energize the hot gas reheat solenoid.

Operation

Normal occupied operation mode

If the return humidity is greater than or equal to the hot gas reheat humidity setpoint and there is no demand for cooling, the C1 output energizes and the AUX-HGR output energizes. The control remains in this state until the humidity drops below the HGR humidity setpoint differential (**HGR-Diff**).

If there is a demand for one stage of cooling and the return humidity is greater than or equal to the hot gas reheat humidity setpoint, the C1 output energizes but the AUX-HGR output de-energizes.

Any additional cooling demands energize compressor outputs but do not change the status of the AUX-HGR output.

ⓘ **Note:** If the parameter HGR enabled for unoccupied operation is enabled during unoccupied mode, the control works the same as described above and uses the HGR unoccupied humidity setpoint instead.

Alternate mode

If the return humidity is greater than or equal to the hot gas reheat humidity setpoint and there is no demand for cooling, the C1 and AUX-HGR outputs energize and C2 energizes. The control remains in this state until the humidity drops below the HGR humidity setpoint differential.

If there is a demand for one stage of cooling and the return humidity is greater than or equal to the hot gas reheat humidity setpoint, the C1 and AUX-HGR outputs energize and C2 energizes.

If there is a demand for both first and second cooling stages and the return humidity is greater than or equal to the hot gas reheat humidity setpoint, the C1 and C2 outputs energize and AUX-HGR de-energizes.

ⓘ **Note:** If the parameter HGR enabled for unoccupied operation is enabled during unoccupied mode, the control works the same as described above and uses the HGR unoccupied humidity setpoint instead.

Table 8 describes the dehumidification sequence for both the standard and alternate modes. This table applies as long as the return humidity is greater than or equal to the HGR humidity setpoint.

Table 8: Dehumidification sequence in normal and alternate mode

Request	Normal mode			Alternate mode		
	HGR	C1	C2	HGR	C1	C2
Dehumidification	On	On	Off	On	On	On
One stage of cooling (Y1)	Off	On	Off	On	On	On
Two stages of cooling (Y2)	Off	On	On	Off	On	On

ⓘ **Note:** The demands for cooling are defined in the sensor operation.

Aux mode

Alternate mode enables a second stage of cooling with a dehumidification call. This adds capacity to remove humidity from the air but it may also lead to over cooling if there is no thermal demand in the space. Aux mode combines alternate mode and normal mode, and selects the appropriate mode in relation to the cooling staged percent command value.

If aux mode is on, one of the following sequences occur:

- Dehumidification call with cooling staged percent command = 0%: the control overrides to normal mode
- Dehumidification call with cooling staged percent command > 0%: the control overrides to alternate mode

If aux mode is off, the control uses the configured mode and does not switch modes based on the thermal load in the space.

Aux mode is disabled by default. You can enable aux mode through the MAP Gateway or the UCB:

- MAP Gateway: ***Commissioning*** > ***HGR*** > ***Aux Mode*** > ***On/Off***
- Local UI: ***Details*** > ***HGR*** > ***Setup*** > ***Mode*** > ***On/Off***

The enable point for aux mode is not available in BAS front ends as a setup parameter.

Freezestat alarm

A freezestat must be field-supplied and field-installed.

When 24 VAC is not present on terminal FSHW and the outdoor air temperature is greater than 40°F, no action is taken and the unit operates normally.

When 24 VAC is not present on terminal FSHW and the outdoor air temperature is 40°F or less, the hot water valve opens 100%, the indoor fan de-energizes, the economizer outside air damper is fully closed, and all other fans de-energize.

The control returns to normal if either 24 VAC is present on terminal FSHW **or** the outdoor air temperature rises above 40°F.

Modulating HGR functionality

New logic for modulating HGR has been added. The logic used for modulating HGR is distinctly different from the existing HGR logic in the SSE controls.

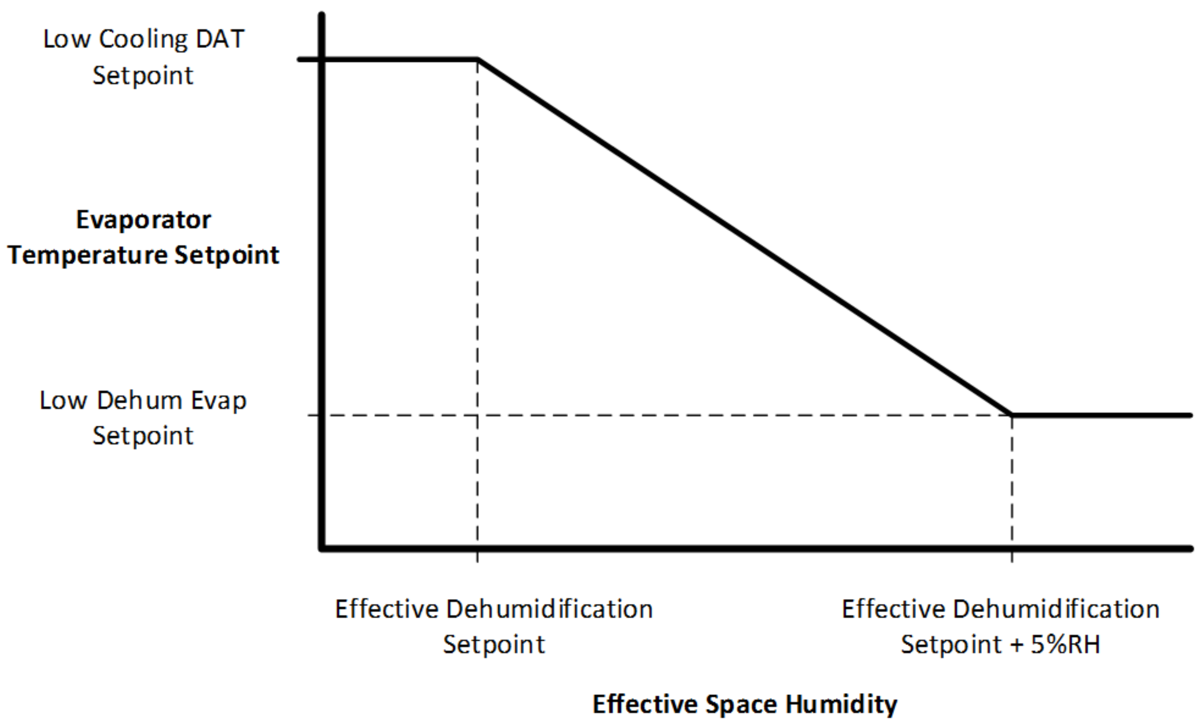
1. When modulating HGR behavior is required, compressors with be staged such that the Evaporator Leaving Air temperature is controlled to setpoint.

    - Traditional thermostat calls will not directly causes compressors to stage on/off. However, they are used to determine if there is a demand for cooling.

    - Evaporator Leaving Air Temperature setpoint is derived by comparing the space humidity to the humidity setpoint. The higher the humidity, the lower the setpoint.

    - The Evaporator Leaving Air Temperature setpoints are limited by adjustable setpoints.

Figure 22: Effective Space Humidity Graph



2. When modulating HGR is active, the modulating HGR valve opens/closes to control the Supply Air Temperature to setpoint.

    - The minimum and maximum position of the modulating HGR valve is enforced.

    - The maximum value may be allowed to reach 100% when this functionality is enabled and the modulating HGR valve has been at maximum value for 60 seconds.

3. The existing HGR binary output is used to control bleed valve functionality.

    - This output is energized when modulating HGR is inactive.

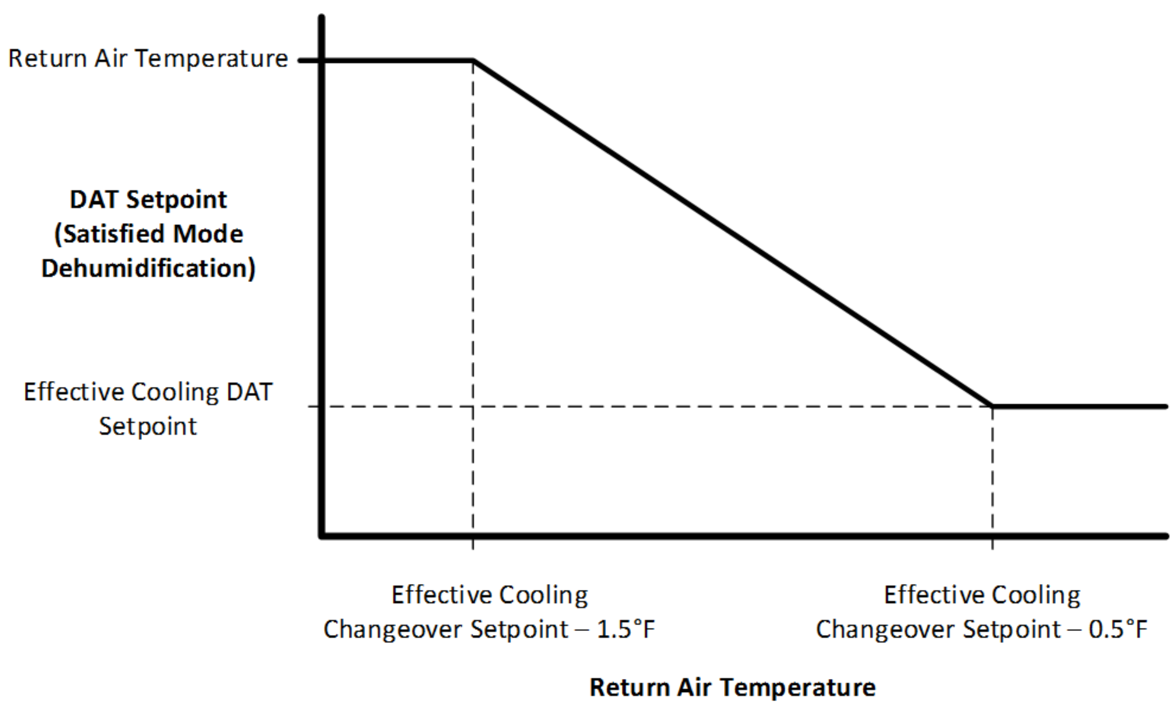
- After exiting modulating HGR, this output will remain de-energized for 2 minutes.

4. There are 2 main modes of modulating HGR operation: dehumidification without a cooling demand and dehumidification with a cooling demand.

    - A new parameter has been added to enable/disable dehumidification when there is no cooling demand. Note that this replaces the Normal/Alternative/Hybrid configuration.

    - Dehumidification without a cooling demand - In this mode, the objective is to allow minimal temp change between the return and supply air. However, some amount of overcooling is allowed. The Modulating HGR valve controls the supply air temperature. The setpoint for this supply air temperature is derived by comparing the return air temperature to the space temperature setpoint. The lower the return air temperature goes away from setpoint, the higher the supply air temperature setpoint for HGR will go. This setpoint is limited between the cooling discharge air setpoint and return air temperature.

Figure 23: Return Air Temperature Graph



    - Dehumidification with a cooling demand - In this mode, the modulating HGR will control the Supply Air Temperature to the Cooling Effective DAT setpoint.

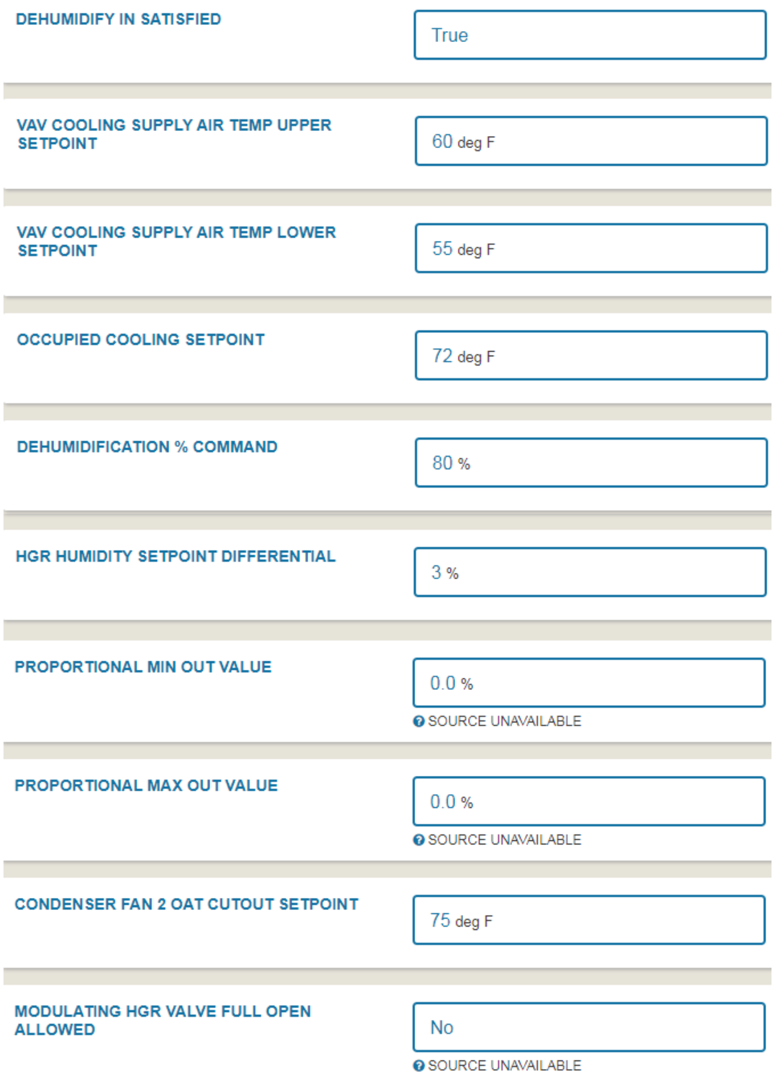
New User Parameters

All adjustments needed for modulating HGR functionality can be found in the Details ? Hot Gas Reheat setup and service menus.

- Dehumidify In Satisfied – This allows the system to run HGR Operation when there is no cooling demand

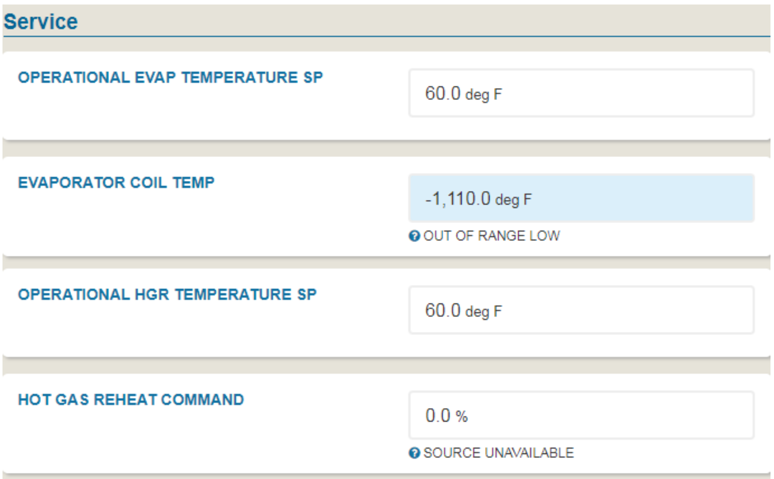
- VAV Cool SAT Upper Setpoint – Used to determine SAT setpoint in cooling. Still linked to actual operation in VAV mode.
- VAV Cool SAT Lower Setpoint – Used to determine the high range of the Evap Air Temp Setpoint
- Occupied Cooling Setpoint – Used to determine how far below setpoint the zone temp has gone
- Dehumidification % Command – This is the dehumidification fan speed for fixed variable fans
- Proportional Min Out Value – This is the HGR valve Minimum position (default value of 20%) MUST BE FACTORY CONFIGURED
- Proportional Max Out Value – This is the HGR valve Maximum position (default value of 80%) MUST BE FACTORY CONFIGURED
- Condenser Fan 2 OAT cutout Setpoint – This is the outdoor air temp below which condenser fan 2 will turn off during HGR. A 2 degree differential is enforced to avoid cycling.
- Modulating HGR Valve Full Open Allowed – This parameter allows the HGR to exceed its max limit if it has been at max for more than 1 minute.

Figure 24: MAP View Hot Gas Reheat Setup Menu



- Operational Evap Temperature Setpoint – This value is the current setpoint that the compressors will control to.
- Evaporator Coil Temp – This is the current temperature of the evaporator leaving air temperature
- Operational HGR Temperature SP – This is the Supply Air Temperature that the modulating HGR valve will control to.
- Hot Gas Reheat Command – This is the current valve position of the modulating HGR valve.

Figure 25: MAP View Hot Gas Reheat Service Menu



Dehum Fan Speed in Fixed Variable

When in Hot Gas Reheat, a separate fan speed provides adequate airflow.

Equipment Impacted

Systems utilizing Fixed Variable Speed fan configurations

ⓘ **Note:** No other fan configurations are capable of supporting this functionality

Implementation Method

A new configuration point has been added to allow all systems using Fixed Variable Speed fan configurations to set a different speed for use with Hot Gas Reheat. This speed is enforced when the system is operating one compressor with Hot Gas Reheat active. If additional compressors are energized, the appropriate 2nd, 3rd, or 4th stage fan speed will take priority.

ⓘ **Note:** For systems requiring additional outputs be energized in conjunction to C1 in order to fully load the HGR circuit, these additional stages ARE NOT considered such that they would override the dehumidification fan speed.

Lead/lag compressor equalized runtime

Setpoints and related data

The setpoints and related data include the following items:

- Lead/lag enable (**LeadLag-En**)
- Compressor 1 accumulated runtime (**C1RunTim**)
- Compressor 2 accumulated runtime (**C2RunTim**)
- Compressor 3 accumulated runtime (**C3RunTim**)
- Compressor 4 accumulated runtime (**C4RunTim**)
- Fan control type (**FanCtl-Type**)
- Hot gas reheat (**HGR-En**)
- Hot gas bypass enable (**HGP-Inst**)

Operation

The following sections describe the operation sequences.

Constant volume or VAV, no hot gas reheat, no hot gas bypass

At the initiation of each cooling demand the compressor with the lowest run hours energizes first. The compressor with the next number of lowest run hours energizes next, and so on. At the termination of the cooling demand, the compressor with the most run hours stages off first, and so on in reverse order.

Constant volume, no hot gas reheat, yes hot gas bypass enable

If the SAT is less than 45°F, the lead/lag function disables. If the SAT is greater than 45°F, see the section above for details.

Constant volume or VAV, yes hot gas reheat, yes/no hot gas bypass enable

If the AUX-HGR output is energized, the lead/lag function is disabled. In any cooling mode, except hot gas reheat, see the section above for details.

If a reheat demand is added when there is a first stage call for cooling and the C2 output is on, the C2 output de-energizes, and the C1 and AUX-HGR outputs energize. If the reheat demand is satisfied and first stage cooling call remains, the AUX-HGR output de-energizes and C1 remains energized until the cooling demand is satisfied.

VAV, no hot gas reheat, yes hot gas bypass enable

If the fan operation is above 50%, see Constant volume or VAV, yes hot gas reheat, yes/no hot gas bypass enable.

If compressor operation is ongoing and C1 is not running, and the fan speed drops below 50%, the compressors stage off and stage back on in order.

Low ambient operation

Setpoints and related data

The setpoints and related data include the following items:

- Cooling OAT cutout enable (**ClgOATCutout-En**) Yes
- Cooling OAT cutout (**ClgOATCutout**)
- Low ambient 10 on 5 off setpoint (**LowAmb10On5OffSp**)

Operation

If cooling OAT cutout enable is set to yes, the compressor operation is not permitted if the OAT is less than the cooling OAT cutout.

If cooling OAT cutout enable is set to no, the compressors cycle 10 minutes on and 5 minutes off if the OAT is less than the low ambient 10 on 5 off setpoint (**LowAmb10On5OffSp**) setpoint.

If a compressor is in the 10-minute on cycle and the evaporator temperature (EC1 through EC4) drops below 26°F, the compressor output de-energizes and the 5-minute ASCD starts. After the 5-minute ASCD expires, the compressor output is permitted.

Any time the compressor output de-energizes due to the evaporator coil temperature protection, it does not count towards a hard compressor lockout.

Pump out operation

Parameters

The parameter is pump out enabled set to on.

Operation

With split system heat pumps, pump out enable should never be turned on.

See the thermostat or sensor sections in Constant volume sequences if pump out is turned off.

If pump out is turned on, when the C1 output energizes, the condenser fan (**CN-Fan**) energizes when either the low pressure switch 1 (**LPS1**) opens or 5 minutes elapse.

If C1 is energized, and the accumulated C1 runtime is greater than 1 hour more than C2 accumulated runtime, C2 energizes for 5 minutes.

If C2 is energized, and the accumulated C2 runtime is greater than 1 hour more than the C1 accumulated runtime, C1 energizes for 5 minutes.

4-Pipe split sequence

Inputs

The inputs include the following items:

- Thermostat only is set to yes
- 4-pipe split enabled is set to yes
- Number of cooling stages
- Number of refrigeration systems installed
- Y1, Y2, Y3, Y4

Outputs

The outputs include the following items:

- C1, C2, C3, C4
- CN-FAN, CF2

Operation

4-pipe split mode is used for outdoor split systems that may be piped to two or more separate air handlers. A Y1 input call directly turns on C1, a Y2 input directly turns on C2, and so on. The parameter thermostat only control enabled and the parameter 4-pipe split enable must be set to yes.

The number of cooling stages and the number of refrigeration systems are both set to 2

When the control receives a Y1 call, it stages on the CN-FAN output for the outdoor fan. 3 seconds later, the C1 output energizes.

When the control receives a Y2 call, it stages on the CN-FAN output for the outdoor fan. 3 seconds later, the C2 output energizes. The number of cooling stages and the number of refrigeration systems installed must both be at least 2.

When the control loses the Y1 call, it de-energizes the C1 output. If C2 is off, the CN-FAN also immediately de-energizes. If C2 is energized, the CN-FAN stays on.

When the control loses the Y2 call, it de-energizes the C2 output. If C1 is off, the CN-FAN also immediately de-energizes. If C1 is energized, the CN-FAN stays on.

The number of cooling stages and the number of refrigeration systems are both set to 4

When the control receives a Y3 call, it stages on the CF2 output for the outdoor fan. 3 seconds later, the C3 output energizes. The number of cooling stages and the number of refrig systems installed must both be at least 3.

When the control receives a Y4 call, it stages on the CF2 output for the outdoor fan. 3 seconds later, the C4 output energizes. The number of cooling stages and number of refrig systems installed must both be 4.

When the control loses the Y3 call, it de-energizes the C3 output. If C4 is off, CF2 also immediately de-energizes. If C4 is energized, CF2 stays on.

When the control loses the Y4 call, it de-energizes the C3 output. If C4 is off, CF2 also immediately de-energizes. If C4 is energized, CF2 stays on.

Timing

If multiple Y calls are received at the same time, there is a 5-second interstage delay between the compressor outputs instead of the usual 30 seconds.

Alarms

Alarm list

Alarms are categorized into three groups based on severity: critical, service priority, and service. The following tables describe the non-FDD alarms. For FDD alarms, see Table 12.

Table 9: Critical alarms

Alarm	How it happens
C1 Locked Out Due to High Pressure	Three HPS1 trips within 2 hours.
C2 Locked Out Due to High Pressure	Three HPS2 trips within 2 hours.
C3 Locked Out Due to High Pressure	Three HPS3 trips within 2 hours.
C4 Locked Out Due to High Pressure	Three HPS4 trips within 2 hours.
C1 Locked Out Due to Low Pressure	Three LPS1 trips within 1 hour.
C2 Locked Out Due to Low Pressure	Three LPS2 trips within 1 hour.
C3 Locked Out Due to Low Pressure	Three LPS3 trips within 1 hour.
C4 Locked Out Due to Low Pressure	Three LPS4 trips within 1 hour.
C1 Locked Out Due to Coil Freeze	Three FS1 trips within 2 hours.(Evap Coil Temp < Evap Coil Temp Cutout SP)
C2 Locked Out Due to Coil Freeze	Three FS2 trips within 2 hours.(Evap Coil Temp < Evap Coil Temp Cutout SP)
C3 Locked Out Due to Coil Freeze	Three FS3 trips within 2 hours.(Evap Coil Temp < Evap Coil Temp Cutout SP)
C4 Locked Out Due to Coil Freeze	Three FS4 trips within 2 hours.(Evap Coil Temp < Evap Coil Temp Cutout SP)
Exhaust Fan VFD Failure	EX VFD BI trips(must be set up as Exhaust or Variable Frequency Fan)
HS1 Locked Out Due to Limit Switch	Three LS1 trips within 1 hour.
HS2 Locked Out Due to Limit Switch	Three LS2 trips within 1 hour.
HS3 Locked Out Due to Limit Switch	Three LS3 trips within 1 hour.
Unit Shutdown Due to Smoke, etc.	SD input loses 24 VAC.
Supply Fan VFD Failure	Fan VFD Input trips(must be set up as NOT Single Speed)
No Heat-Cool Due to Unreliable Space-T	Input Unreliable
4-Stage Communication Failure	4-Stage board goes from Online to Offline.
Economizer Communication Failure	Economizer board goes from Online to Offline.
Outputs Disabled Due to Low Input V	Blackout Conditions
Outputs Limited Due Brownout Input V	Brownout Conditions
Unit Locked Out Due to APS	Three APS trips within 1.5 hours.(if APS is installed or based on Duct Pressure if Variable Speed Fan enabled).
Unit Locked Out Due to Supply Fan OL	Three FAN OVR trips within two hours.
Unit Locked Out Due to High Duct-P	Duct Static Pressure is greater than the High Duct Static Pressure Setpoint.

Table 10: Service priority alarms

Alarm	How it happens
Evaporator Coil Temp 1 Sensor Failure	Input unreliable and Number of Cooling Stages >= 1
Condenser Coil Temp 1 Sensor Failure	Input unreliable and Number of Cooling Stages >= 1
Evaporator Coil Temp 2 Sensor Failure	Input unreliable and Number of Cooling Stages >= 2
Condenser Coil Temp 2 Sensor Failure	Input unreliable and Number of Cooling Stages >= 2
Evaporator Coil Temp 3 Sensor Failure	Input unreliable and Number of Cooling Stages >= 3
Condenser Coil Temp 3 Sensor Failure	Input unreliable and Number of Cooling Stages >= 3
Evaporator Coil Temp 4 Sensor Failure	Input unreliable and Number of Cooling Stages >= 4
Condenser Coil Temp 4 Sensor Failure	Input unreliable and Number of Cooling Stages >= 4
Building Pressure Sensor Failure	Input unreliable
Outdoor Air Temperature Sensor Failure	Input unreliable
Return Air Temperature Sensor Failure	Input unreliable and Variable Speed Fan
Supply Air Temperature Sensor Failure	Input Unreliable AND (Econ Comm Status = Online OR Mixed Air Sequencer = DAT Control)
Unit Shutdown Due to Supply Fan Overload	FAN OVR Trip (but less than three in one hour as that would cause 'Unit Locked Out Due to Supply Fan OL')
Main Controller Calibration Error	Missing Cal Data

Table 10: Service priority alarms

Alarm	How it happens
FDDM Controller Calibration Error	Missing Cal Data
Econ Controller Calibration Error	Missing Cal Data
4-Stage Controller Calibration Error	Missing Cal Data
Unit Shutdown Due to Air Proving Switch	Cmd but no proof for >= 90 seconds (if this happens less than three in 1.5 hours; otherwise that would cause 'Unit Locked Out Due to APS')
FDDS Controller Calibration Error	Missing Cal Data

Table 11: Service alarms

Alarm	How it happens
Duct Pressure Sensor Failure	Input Unreliable and Variable Speed Fan
Return Air Humidity Sensor Failure	Input unreliable
Outdoor Air Humidity Sensor Failure	Input unreliable
Supply Humidity Sensor Failure	Input unreliable
Indoor Air Quality Sensor Failure	Input unreliable
Outdoor Air Quality Sensor Failure	Input unreliable
Fresh Air Intake Sensor Failure	Input unreliable
Mixed Air Temp Sensor Failure	Input unreliable
Space Indoor temp Sensor Failure	Input unreliable
Space Offset Sensor Failure	Input unreliable
C1 Shutdown Due to High Pressure	HPS1 Trip
C2 Shutdown Due to High Pressure	HPS2 Trip
C3 Shutdown Due to High Pressure	HPS3 Trip
C4 Shutdown Due to High Pressure	HPS4 Trip
C1 Shutdown Due to Low Pressure	LPS1 Trip
C2 Shutdown Due to Low Pressure	LPS2 Trip
C3 Shutdown Due to Low Pressure	LPS3 Trip
C4 Shutdown Due to Low Pressure	LPS4 Trip
C1 Shutdown Due to Coil Freeze	FS1 Trip (Evap Coil Temp < Evap Coil Temp Cutout SP)
C2 Shutdown Due to Coil Freeze	FS2 Trip (Evap Coil Temp < Evap Coil Temp Cutout SP)
C3 Shutdown Due to Coil Freeze	FS3 Trip (Evap Coil Temp < Evap Coil Temp Cutout SP)
C4 Shutdown Due to Coil Freeze	FS4 Trip (Evap Coil Temp < Evap Coil Temp Cutout SP)
Low Outdoor Air Temp Cooling Cutout	OAT < OAT Cooling Cutout
Econ Economizing When it Should Not	Economizer Damper % Command > Min OA Position + FDD Damper Min Position Tolerance
Econ Not Economizing When It Should	Economizer Damper % Command < Min OA Position + FDD Damper Min Position Tolerance
Economizer Damper Not Modulating	ABS (Economizer Damper % Command - Economizer Damper Position) > FDD Economizer Damper Allowed Error
Economizer Letting In Excess Outdoor Air	(Economizer Damper % Command > Min OA Position + FDD Damper Min Position Tolerance AND Ramp Min OA) OR (Economizer Damper % Command > FDD Damper Min Position Tolerance AND Ramp Closed)
HS1 Shutdown Due to Limit Switch	LS1 Trip
HS2 Shutdown Due to Limit Switch	LS2 Trip
HS3 Shutdown Due to Limit Switch	LS3 Trip
HS1 Off Due to Gas Valve	H1 with no GV1 for >=6 minutes
HS2 Off Due to Gas Valve	H2 with no GV2 for >=6 minutes
HS3 Off Due to Gas Valve	H3 with no GV3 for >=6 minutes
Dirty Filter	DFS Trip
FDD 1 Communication Failure	FDD Master Online -> Offline
FDD 2 Communication Failure	FDD Slave Online -> Offline
Unit has Received a Purge Request	PURGE-S on Econ trip
Excessive Supply Air Temp Cooling	SAT < Excessive SAT Cooling Sp AND SAT Limit for Cooling Enable

Table 11: Service alarms

Alarm	How it happens
HS1 Gas Valve Failure	GV1 on without H1 for >= 5 seconds
HS2 Gas Valve Failure	GV2 on without H2 for >= 5 seconds
HS3 Gas Valve Failure	GV3 on without H3 for >= 5 seconds
Excessive Supply Air Temp Heating	SAT > Excessive SAT Heating SP AND SAT Air Temp Limit for Heat Enabled
Space Temperature Cooling Alarm	Space Temp > Operating Cooling SP for more than 60 minutes
Hot H20 FS Open to Prevent Coil Freeze	Hydronic Heating Enabled and (HW Freeze BI trip and Unreliable OAT) or HW Freeze BI trip and OAT is less than 40°F
Hot H20 FS Opened When It Should Not	Hydronic Heating Enabled and OAT is greater than 40°F and HW Freeze BI trip
Space Temperature Heating Alarm	Space Temp is less than Operating Heating SP for more than 60 minutes.
Not Economizing - No Supply Air Sensor	Free Cooling Available and MA Sequencer = DAT Control and SAT Unreliable or SAT Unreliable and MA Sequence = Zone Control and MA State = Mech and Free Cooling Available or Tstat Only and Mech and Free Cooling Available
Using Return Instead of Space Temp	Effective Zone Source = Return Air Temp and Not TStat Only
Air Proving Switch is Stuck Closed	APS is closed, but fan command is not given

Disable or Enable FDD Alarms

Alarms associated with the FDD boards have the ability to be masked so that they do not cause an active service alarm when the alarms are disabled. The status should still continue to update correctly for monitoring purposes. The Disable/Enable point should be exposed to the BAS.

The current COV increment for the FDD diagnostic status is set to 7 days. The COV for this should be set to 0 in the firmware, which will allow the displays and BAS to immediately show changes of the Cooling Circuit Test Status to the display and BAS. The source utilized to generate alarms was updated such that custom logic in the application is now responsible for handling of the FDD alarms. Logic was then added to the FDD application which will only allow 1 new fault every 7 days (replicates existing behavior). Logic was also added which allows the alarms to be turned off without impacting the operation of the FDD algorithm.

Configuration Points

- Commissioning → Options → “FDD Alarm Enable” (Default value is “Disabled”)
- BACnet: FDDAlarmEn MV:30076
- Modbus: FDDAlarmEn HR:848
- N2: FDDALMEN ADI:196

Disable or Enable Economizer Sensor Fault Indications

Alarms associated with sensors on economizer control have the ability to be masked so that they do not cause active alarms when sensors were never installed. The open terminals on the economizer control have traditionally been known to cause false sensor faults. A previous version attempted to somewhat decrease these faults, but was known to not be able to fully correct the issue.

All faults associated with the sensors located on the economizer can now be Disabled or Enabled. By default, the faults are enabled. Only the fault indications are masked, any required changes to system operation due to a failed sensor are not impacted by this change.

Configuration Points:

- Commissioning → Options → “Econ Sensor Fault Indications” (Default value is “Enabled”)
- BACnet: EconSensorFaults MV:30078

- Modbus: EconSensorFaults HR:849
- N2: ECONSNSFLT ADI:197

FDD alarms

The FDD alarms are described in the following table.

Table 12: FDD alarms

BACnet® state number	FDD alarm	Diagnosis explanation	Recommendation
235 236 237 238	C1, C2, C3, C4 Refrigerant Low	In a TXV system, the refrigerant circuit has a lower sub-cooling value than expected and the superheat is not high. The target sub-cool is 10°F, with an acceptable tolerance of +/-5°F, therefore the sub-cool value is <5°F.	This may indicate that there is less refrigerant charge in the system than expected. Inspect both evaporator and condenser coils for proper airflow Check the system for leaks
239 240 241 242	C1, C2, C3, C4 Excessive Refrigerant Flow	The evaporating temperature is high (>7°F of goal), the superheat is low (see below), and the sub-cooling is low (<5°F). In a TXV system, the superheat is acceptable when it is within +/-5°F of the goal. The goal is determined by the normal model based on the design EER, the type of metering device, the return air wet bulb temperature, and the ambient temperature. In a Fixed orifice system, the superheat is acceptable when it is within +/-10°F of the goal. The goal is determined from the charging chart, using the ambient temperature and return air wet bulb temperature.	There is excessive refrigerant flow into the evaporator and giving it the ability to absorb heat. The CFM is potentially too high Inspect TXV for normal function Inspect percentage of outside air as there is excessively high amount of mixed air across the evaporator
243 244 245 246	C1, C2, C3, C4 Inefficient Compressor	The evaporator temperature is >15°F of the goal value	Inspect the high-side and low-side pressure Verify TXV operation Inspect filter drier for excessive delta T Inspect the outside air damper/ economizer for excessive outside air Contact Technical Services before changing the compressor
247 248 249 250	C1, C2, C3, C4 Refrigerant Flow Restriction	Possible Condition 1) The superheat is high (>10°F of the goal) AND the sub-cool is high (>10°F of the goal). Possible Condition 2) Evaporator temperature is low (>10°F of the goal) AND Superheat is high (>10°F of the goal) AND sub-cool is high (>15°F) AND COA is greater than the goal	Inspect for plugged or restricted filter drier Inspect TXV for normal operation Inspect condenser coil for possible restriction Inspect unit refrigerant piping for damage or possible restriction
251 252 253 254	C1, C2, C3, C4 High Side Heat Transfer Problem	The condensing temperature is high (>10°F of the goal). The goal is determined by the normal model based on the design EER, the metering device type, and the refrigerant type and in the case of a fixed orifice machine the return air wet bulb temp.	It is difficult for the condenser to reject heat. Inspect the condenser coil for debris. Clean coils if debris present Inspect the condenser fan assembly, electrical supply, motor capacity, fan blades

Table 12: FDD alarms

BACnet® state number	FDD alarm	Diagnosis explanation	Recommendation
255 256 257 258	C1, C2, C3, C4 Low Side Heat Transfer Problem	The Evaporator temperature is colder than expected (<10°F of the goal). The goal is determined by the normal model based on the design EER, the metering device type, the refrigerant type, the return air wet bulb temp and the ambient temp. AND the superheat is low (<10°F of the goal). For a TXV system, the goal is determined by the normal model based on the design EER, the metering device type, the refrigerant type, the return air wet bulb temp and the ambient temp. For a Fixed Orifice System, The goal is determined from a charging chart using ambient temp and return air wet bulb temp.	Inspect the evaporator for debris Inspect the evaporator blower, clean wheel, motor electrical, VFD drive parameters, motor capacitor, belts, bearing Inspect registers and grills for proper setting and airflow Measure the unit airflow per instruction manual
259 260 261 262	C1, C2, C3, C4 Reduce Evaporator Airflow	The Evaporator temperature (suction pressure) is higher than expected (>7°F of the goal). The goal is determined by the normal model based on the design EER, the metering device type, the refrigerant type, the return air wet bulb temp and the ambient temp. AND the superheat is high (>10°F of the goal). For a TXV system, the goal is determined by the normal model based on the design EER, the metering device type, the refrigerant type, the return air wet bulb temp and the ambient temp. For a Fixed Orifice System, The goal is determined from a charging chart using ambient temp and return air wet bulb temp. AND the sub-cool is high (>15°F)	Adjust airflow per instruction manual Consider the fact that high-static drive models may develop more CFM than desired
263 264 265 266	C1, C2, C3, C4 Add Charge	The system has lower than expected sub-cooling and the evaporating temperature (suction pressure) is low. This may indicate there is less refrigerant charge in the system than expected. The system has lower than expected sub-cooling and the evaporating temperature (suction pressure) is low. This may indicate there is less refrigerant charge in the system than expected.	Inspect the unit for leaks Recover unit charge Repair leaks if found Weigh-in refrigerant per unit data tag charge
267 268 269 270	C1, C2, C3, C4 Insufficient Refrigerant Flow	Possible Condition 1) The superheat is high (>10°F of the goal) AND the sub-cool is high (>10°F of the goal). Possible Condition 2) Evaporator temperature is low (>10°F of the goal) AND Superheat is high (>10°F of the goal) AND sub-cool is high (>15°F) AND COA is greater than the goal	Same as restriction. Follow the same actions
271 272 273 274	C1, C2, C3, C4 Recover Charge	The system has higher than expected sub-cooling and the condensing temperature (discharge pressure) is higher than expected at that specific ambient temperature. This may indicate there is more refrigerant charge than expected.	There is too much refrigerant in the system. Remove refrigerant while monitoring refrigerant performance
199 200 201 202	C1, C2, C3, C4 Liquid Temp Greater Than Cond Temp	The Liquid line temperature is >4F of the Condenser temperature target. It appears there is hot gas in the liquid line.	Substantially under-charged unit with hot gas passing through the condenser coil, thus affecting the liquid line sensor. Look for the cause of the undercharge

Table 12: FDD alarms

BACnet® state number	FDD alarm	Diagnosis explanation	Recommendation
171 172 173 174	C1, C2, C3, C4 Basic Data Not Available	One or more sensors are not available. Sensor inputs provide a Present Value attribute along with a Reliability attribute which varies based upon sensor type. Reliability: reliability of the Present Value. One of the values from the Reliability enumeration set. Value can come from 3 sources: Hardware: This is the normal source of the reliability, it comes with the Present Value updates. Different hardware implementations may generate different values for Reliability. Out of Service CMD: The Out of Service command will place the object in out of service state, and specify a value for Present Value and set the Reliability to "Reliable". Out of Service: While out of service the object will allow the Reliability to be written directly. Some examples: UNRELIABLE_HIGH, UNRELIABLE_LOW, OPEN, SHORTED, COMM_LOSS, INPUT_OUT_OF_RANGE.	Inspect the unit electrical supply. Identify any high (wild) leg. Place on L2 if present Inspect the low voltage transformer tap for correct selection Inspect the unit for proper unit electrical grounding Inspect units equipped with 2 control transformers for proper phasing. Should be 1-2 volts between the two 24V outputs.
303 304 305 306	C1, C2, C3, C4Unit Off	The compressor appears to not be running because the differences in suction and liquid pressures are too small to prove operation.	
175 176 177 178	C1, C2, C3, C4 Return Air Wet-Bulb Temp Out of Range	In a fixed orifice system ONLY. The valid range of ambient temperature in the charge chart is between 55°F and 115°F. The target superheat value is not available	Inspect the integrity of the sensor Inspect the integrity of the sensor wiring
179 180 181 182	C1, C2, C3, C4 Ambient Temp Too Low	The measured ambient temperature (OAT) is <55°F or there is an issue with the sensor or its connection.	Consider using an additional source to determine the actual outdoor ambient temperature. If it is <55°F, it is too low to make a reliable diagnosis. Consider installing a low-ambient operating kit for low ambient operation
183 184 185 186	C1, C2, C3, C4 Ambient Temp Too High	The measured ambient temperature (OAT) is >115°F or there is an issue with the sensor or its connection.	Consider using an additional source to determine the actual outdoor ambient temperature. If it is >115°F, it is too high to make a reliable diagnosis. Verify the proper application and placement of unit. Ensure that all clearances are met per Tech Guide
187 188 189 190	C1, C2, C3, C4 Return Air Wet-Bulb Temp Too Low	The Return air wet bulb temperature is lower than the return air wet bulb temperature correlating to 0% Relative humidity for the given return air temperature. RAT is from a wired TYPE3 10Kohm Thermistor RAH is from a wired 0-10VDC Humidity sensor (or an optional Network Sensor). The Return-Air Wet Bulb Temperature is a calculated value from the Super Application within the UCB. The value is only used for FDD and not used for control (not presented when FDD option is not available).	Verify space conditions compared to the sensor reading Verify sensor integrity Verify sensor wiring

Table 12: FDD alarms

BACnet® state number	FDD alarm	Diagnosis explanation	Recommendation
191 192 193 194	C1, C2, C3, C4 Return Air Wet-Bulb Temp Too High	The Return air wet bulb temperature is >76°F, or higher than the return air wet bulb temperature corresponding to 95% return air humidity for a given return air temperature. RAT is from a wired TYPE3 10Kohm Thermistor RAH is from a wired 0-10VDC Humidity sensor (or an optional Network Sensor). The Return-Air Wet Bulb Temperature is a calculated value from the Super Application within the UCB. The value is only used for FDD and not used for control (not presented when FDD option is not available).	Verify space conditions compared to the sensor reading Verify sensor integrity Verify sensor wiring
195 196 197 198	C1, C2, C3, C4 Condensing Temp Less Than Ambient	The condensing temperature is 4°F below the Ambient temperature (OAT)	Verify condenser coil sensor integrity Verify sensor wiring Inspect the condenser coil for restriction ahead of the sensor
203 204 205 206	C1, C2, C3, C4 Suction Temp Less Than Evap Temp	The condensing temperature is lower than the ambient temperature.	Inspect if the unit is operating in a low ambient environment without a low ambient kit installed
207 208 209 210	C1, C2, C3, C4 Evap Temp Greater Than Ambient Temp	The evaporating temperature is higher than the ambient temperature by >2°F	The unit may be operating in a low outdoor ambient condition Inspect the unit for proper application and unit placement The unit may be installed in a process cooling environment
211 212 213 214	C1, C2, C3, C4 Liquid Temp Less Than Ambient Temp	The liquid line temperature is less than the ambient temperature.	Inspect the unit for possible restriction on the liquid line ahead of the liquid line sensor
215 216 217 218	C1, C2, C3, C4 Invalid Suction or Ambient Temp	Suction line temperature is >2°F higher than the OAT.	The unit may be operating in a low ambient condition Verify sensor integrity
219 220 221 222	C1, C2, C3, C4 Invalid RA Dry-Bulb or Wet-Bulb Temp	Diagnostic module detects that the return air wet bulb temperature is warmer than the return dry wet bulb temperature. Suspect sensors interchanged or one or both sensors are faulty. RWB cannot be less than RA.	Inspect sensor integrity Verify the correct sensor location as connected to the control
223 224 225 226	C1, C2, C3, C4 Invalid Liquid and Suction Pressure	Suction line pressure is greater than the liquid line pressure. (should be very rare in a fixed piping DX circuit)	Verify actual pressures Verify sensor integrity Verify that the sensor electrical connection point is correct
227 228 229 230	C1, C2, C3, C4 Invalid Suction Temp	Suction line temperature is > than the condenser temperature.	Inspect for proper sensor wiring connection point Inspect sensor integrity of both sensors

Table 12: FDD alarms

BACnet® state number	FDD alarm	Diagnosis explanation	Recommendation
279 280 281 282	C1, C2, C3, C4 Return Air Dry-Bulb Temp Too Low	The measured return air temperature is <62°F	Inspect space conditions Verify that the unit application is not installed to a process cooling environment Inspect the return duct for unwanted infiltration Inspect sensor integrity
283 284 285 286	C1, C2, C3, C4 Return Air Dry-Bulb Temp Too High	The measured return air temperature is >84°F	Inspect space conditions Verify that the unit application is not installed to a process cooling environment Inspect the return duct for unwanted infiltration Inspect sensor integrity
314 315 316 317	C1, C2, C3, C4 EI Below 75% Expected Performance	Efficiency Index (EI) is the ratio of measured cooling efficiency to expected cooling efficiency under that set of driving conditions. This ratio is converted to a percentage (if the ratio is 0.75, percentage is 75%). Measured performance (efficiency and capacity) is calculated by reading the sensors installed on the unit. Expected performance is calculated based on a proprietary algorithm that takes into account the unit setup information and the driving conditions (RAT, RAH, OAT). The performance model is tuned to predict unit performance within +/- 10%.	Inspect the unit installation for application suitability Verify all system operations Verify adequacy of ductwork and outside air quantities Verify that the unit is not applied to a process cooling environment
275 276 277 278	C1, C2, C3, C4 CI Below 75% Expected Performance	Capacity Index (CI) is the ratio of measured cooling capacity to expected cooling capacity under that set of driving conditions. This ratio is converted to a percentage (if the ratio is 0.75, percentage is 75%). Measured performance (efficiency and capacity) is calculated by reading the sensors installed on the unit. Expected performance is calculated based on a proprietary algorithm that takes into account the unit setup information and the driving conditions (RAT, RAH, OAT). The performance model is tuned to predict unit performance within +/- 10%.	Inspect the unit installation for application suitability Verify all system operations Verify the adequacy of ductwork and outside air quantities Verify that the unit is not applied to a process cooling environment
322 323 324 325	C1, C2, C3, C4 EI+CI Below 75% Expected Performance	Efficiency Index and Capacity Index are <75%	Inspect the unit installation for application suitability Verify all system operations Verify the adequacy of ductwork and outside air quantities Verify that the unit is not applied to a process cooling environment
287 288 289 290	C1, C2, C3, C4 FDD Not Functioning Sensor Unreliable	For a given cooling circuit, a Pressure or Temperature AI sensor wired directly to the FDD module has a 'Present Value' reading which is 'Unreliable' (refer to the previous reliability definition).	Verify sensor integrity Verify sensor wiring Verify proper unit control voltages
291 292 293 294	C1, C2, C3, C4 FDD Not Monitoring Conditions Unreliable	Error reading the RWB, RDB, or OAT information which is being provided by the UCB to the FDD module(s).	Verify sensor integrity Verify sensor wiring Verify proper unit control voltages

Table 12: FDD alarms

BACnet® state number	FDD alarm	Diagnosis explanation	Recommendation
295 296 297 298	C1, C2, C3, C4 FDD Not Monitoring Equipment Data	There is an error with reading the Equipment Model configuration data (e.g. number of cooling circuits, refrigerant-type, elevation, etc). Factory settings might not be established - or are invalid.	This unit may have a replacement board where the factory parameters/data may be missing, or data have been compromised. Verify that unit data is present in the control data parameters

For third-party SEC integration, all faults are represented as BACnet® Multistate Value (MSV) objects. You must add one to all MSV known states which equate to an equipment fault number to obtain a valid reading and description from the fault table. If the state number is 123, for example, the fault table look up that is valid for this state is 124.